Feb. 17, 1953 J. R. KUENEMAN ET AL 2,628,788

GYRATORY CRUSHER

Filed Dec. 30, 1946 6 Sheets-Sheet 1

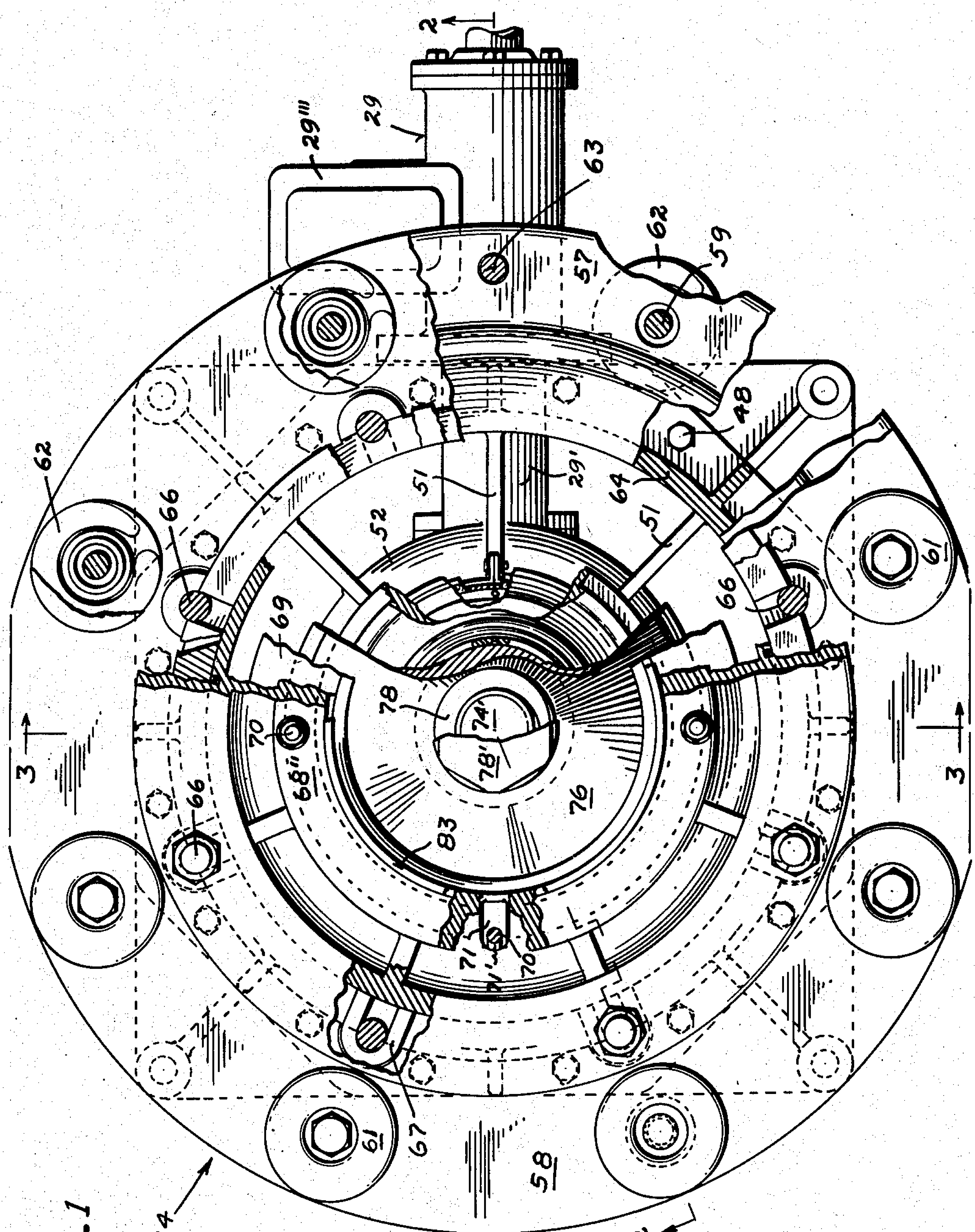

FIG. 1

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GYRATORY CRUSHER

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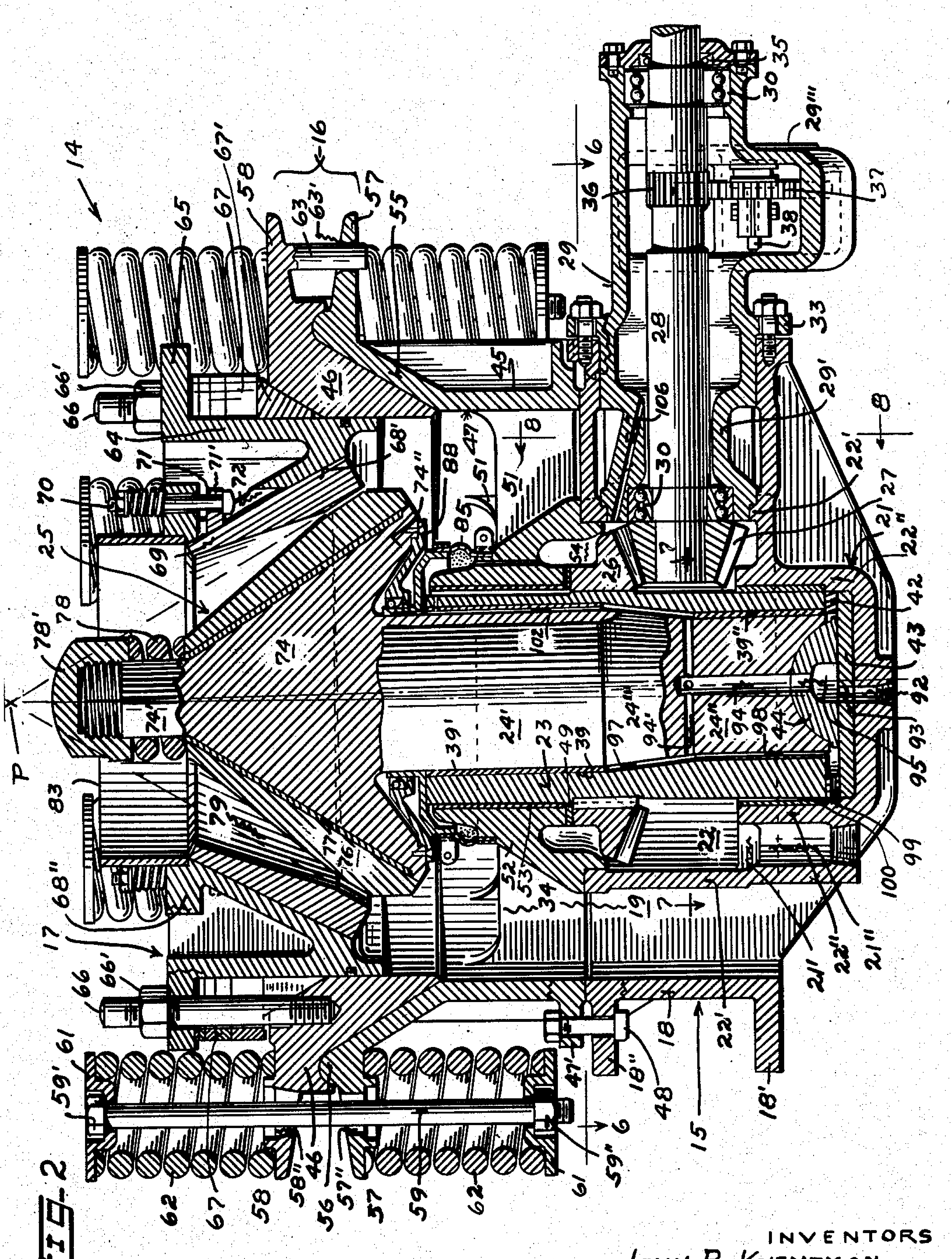

FIG. 2

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GYRATORY CRUSHER

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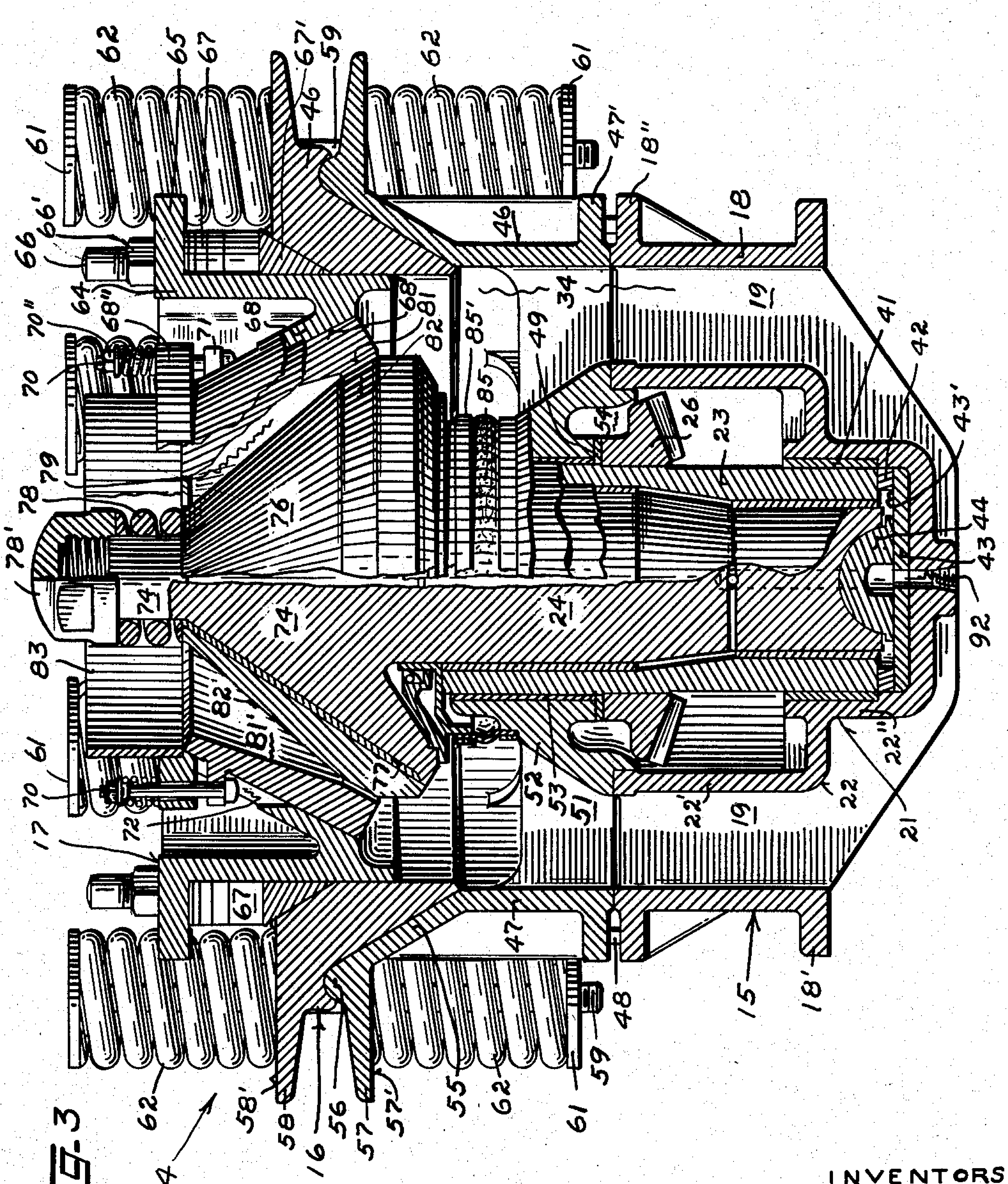

FIG. 3

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GYRATORY CRUSHER

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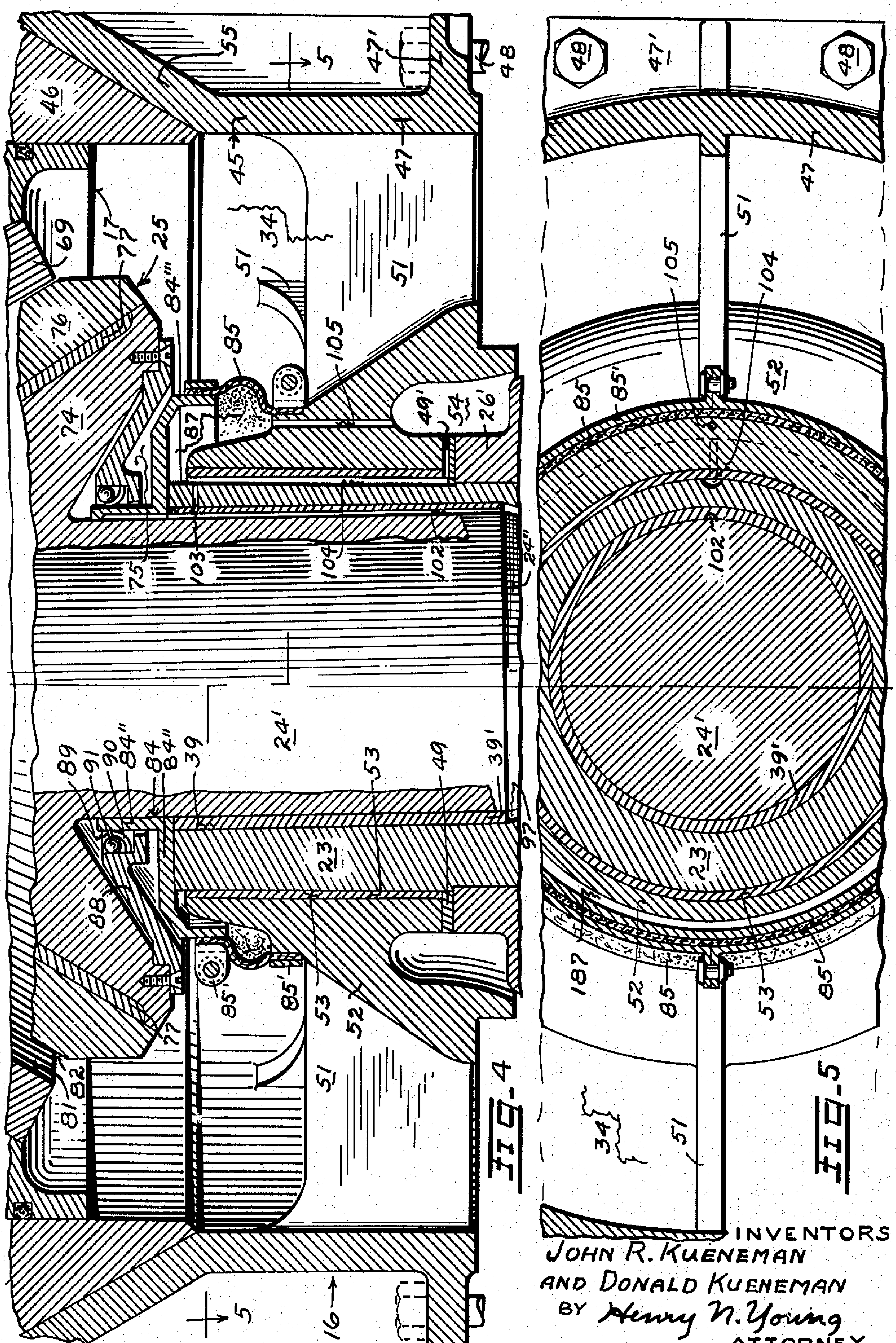

FIG. 4

FIG. 5

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GYRATORY CRUSHER

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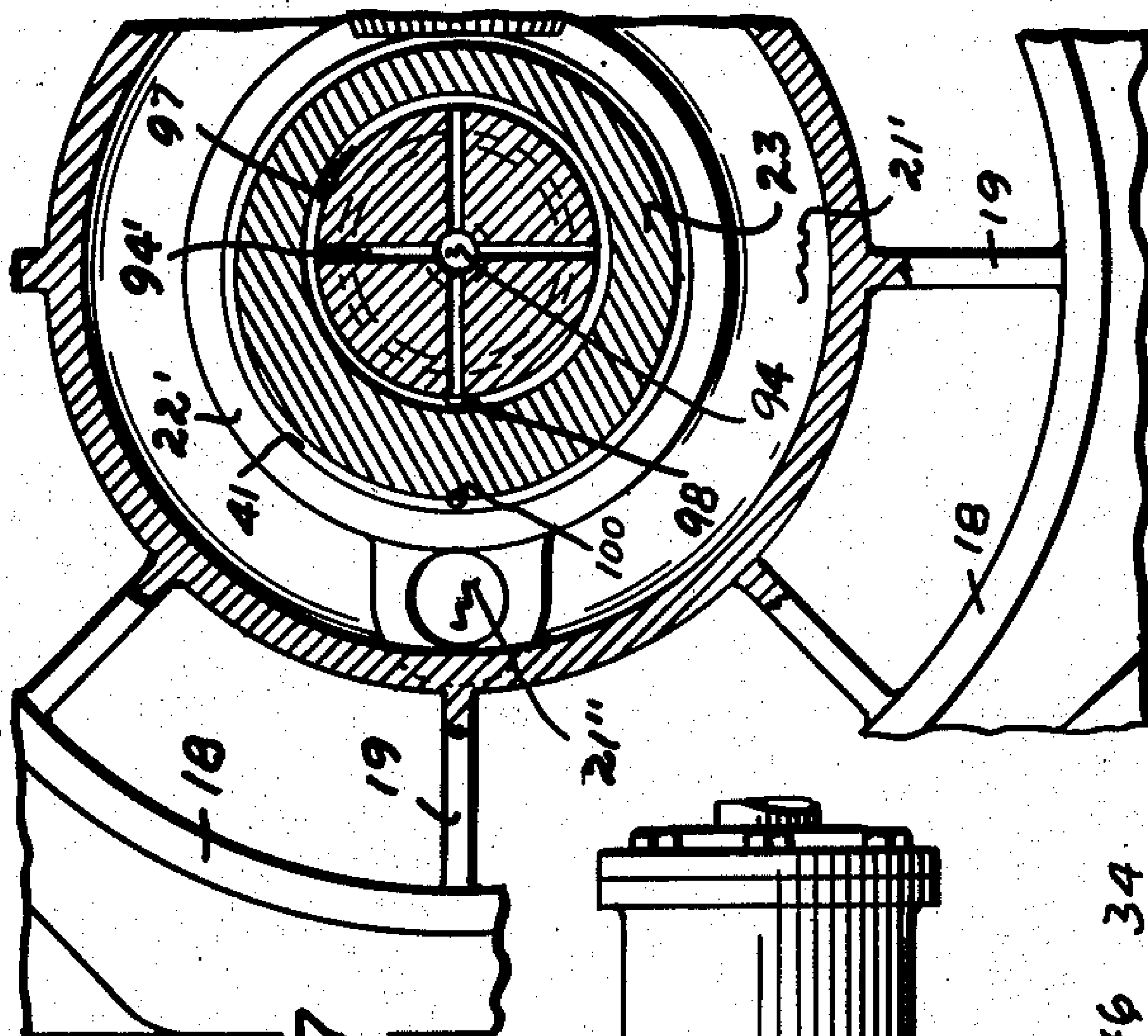

FIG. 7

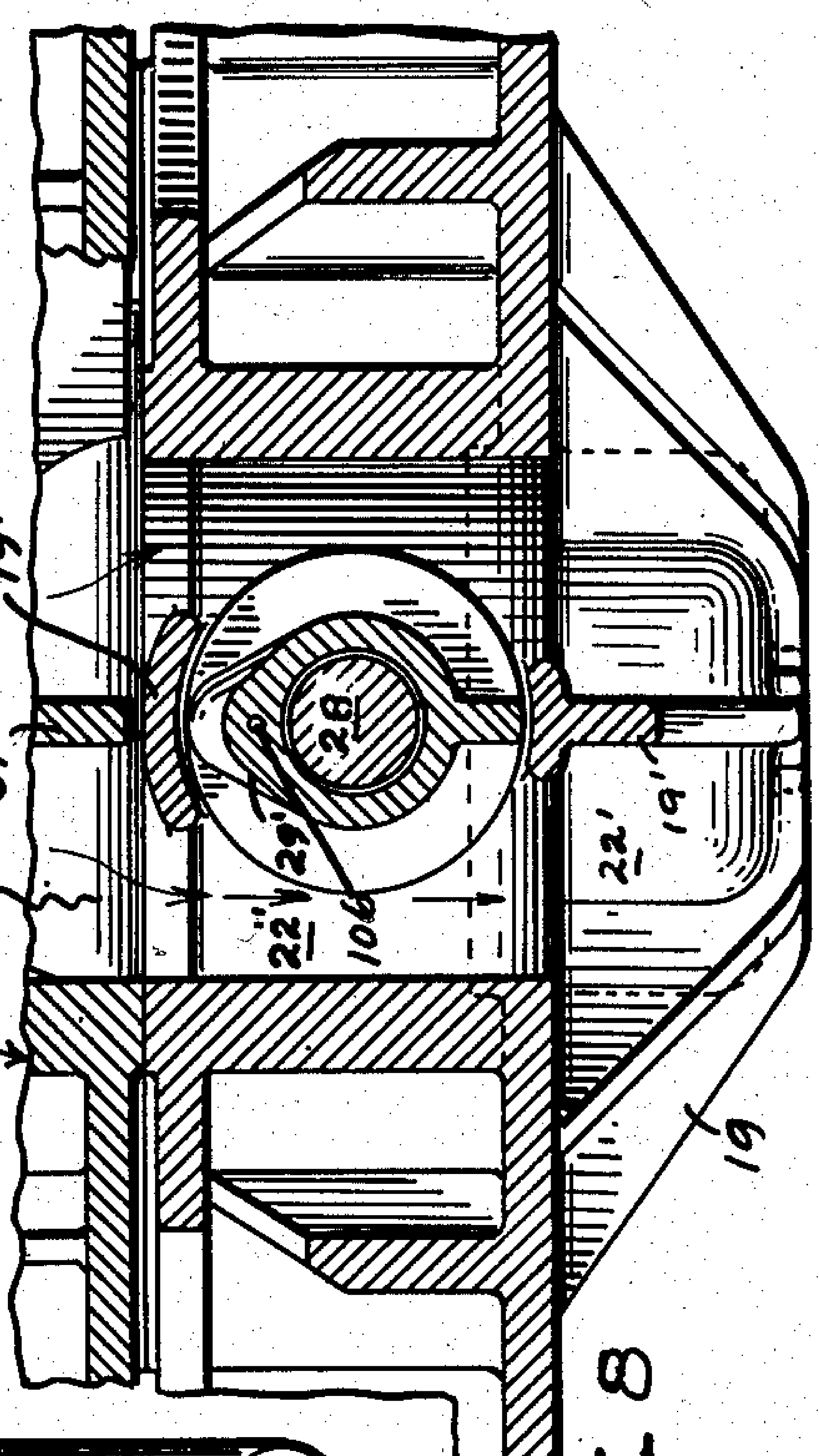

FIG. 8

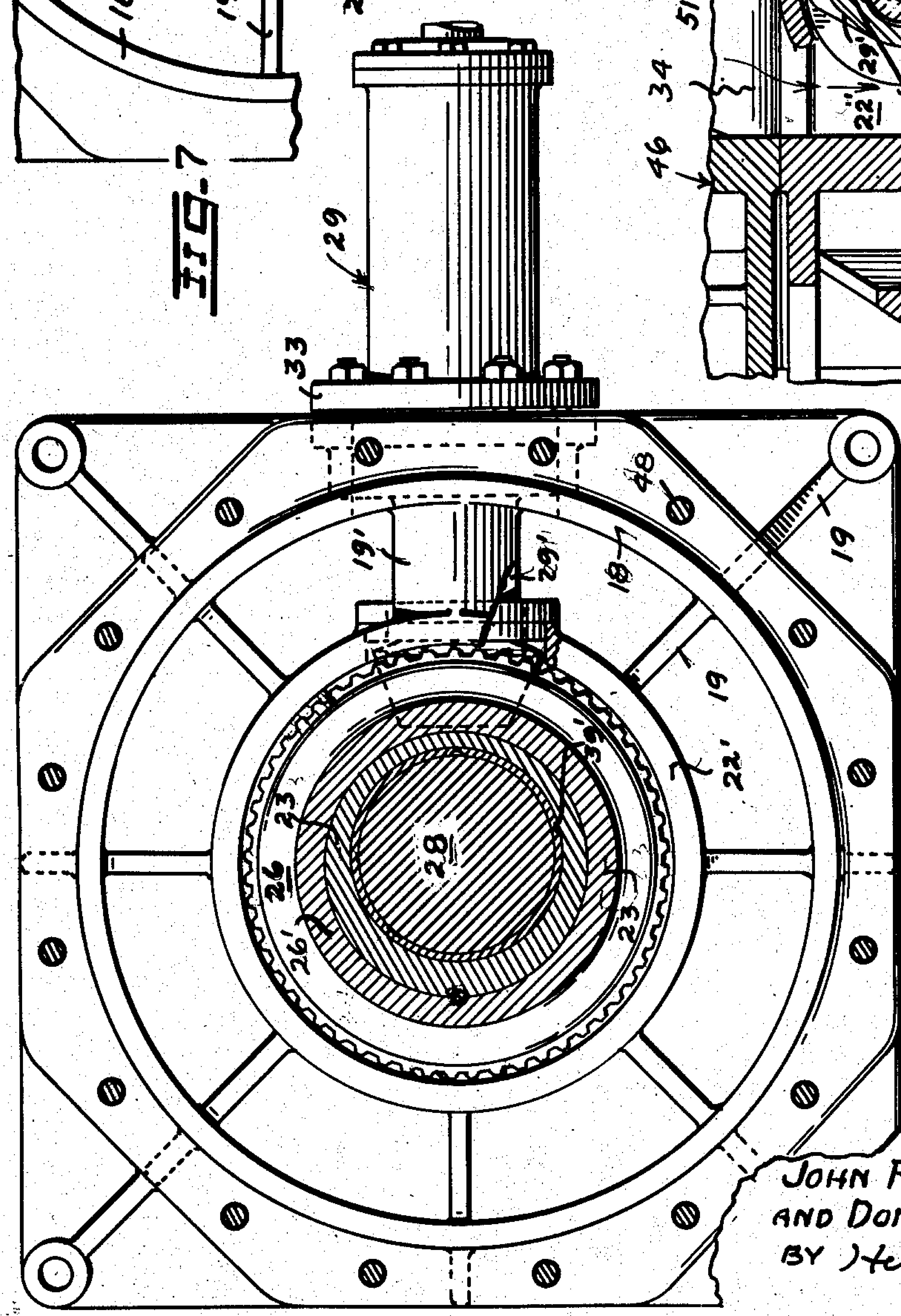

FIG. 6

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GYRATORY CRUSHER

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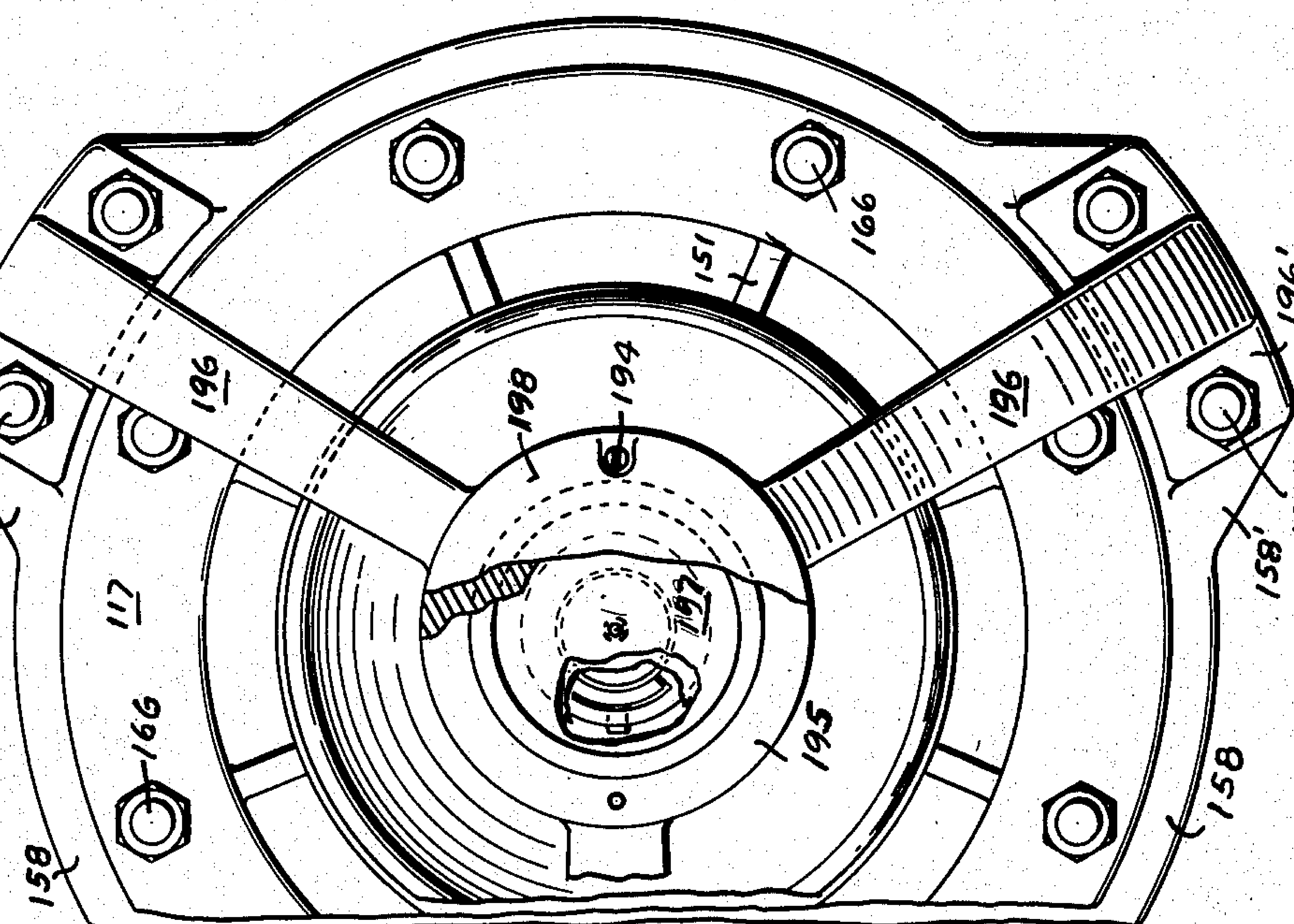

FIG. 10

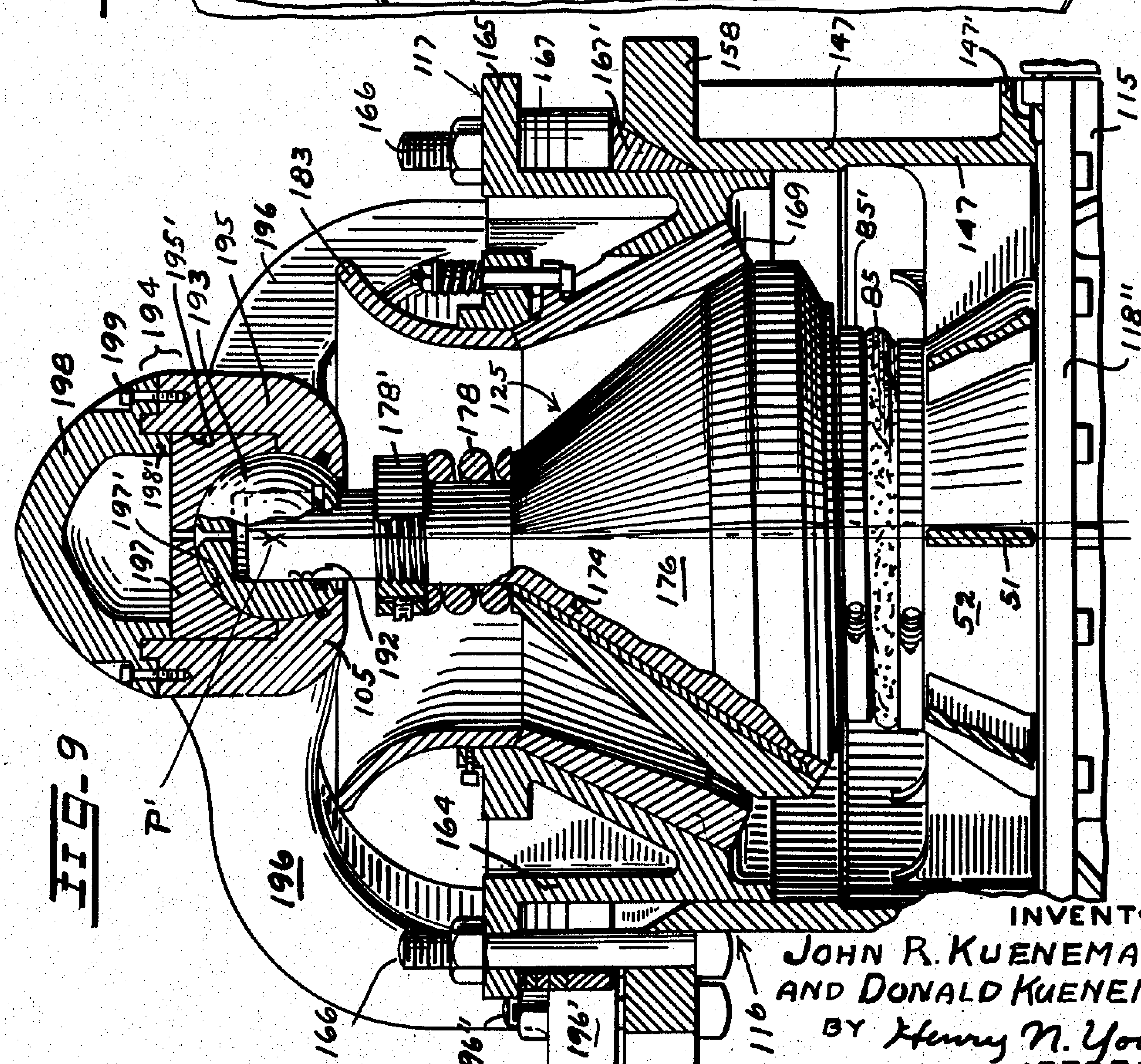

FIG. 9

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UNITED STATES PATENT OFFICE

2,628,788

GYRATORY CRUSHER

John R. Kueneman and Donald Kueneman, Oakland, Calif.

Application December 30, 1946, Serial No. 719,236

7 Claims. (Cl. 241—215)

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The invention relates to a gyratory crusher in which the material to be crushed is allowed to flow by gravity through a crushing zone between a fixed upright conical concave and a gyratory conical head within the concave.

An object of the invention is to provide a crusher of the character described providing a minimum of relatively lateral motion between the working faces of a concave and a cooperating cone, whereby to minimize wear on the crushing faces and the production of fines.

Another object is to provide a crusher of the character described which has a relatively low height for its duty.

A further object is to provide a particularly effective dust shield for the various bearings of the structure.

An added object is to provide an improved lubrication system for a crusher of the present character.

Yet another object is to provide a gyratory crusher having a particularly simple and effective means for effecting a relative axial adjustment of the concave and cone whereby to vary the maximum size of crushed particles delivered from the crushing zone.

A still further object is to provide an automatic overload release for oversize and noncrushable pieces or articles from the crushing zone.

A general object is to provide a gyratory crusher of maximum capacity, minimum weight, minimum first cost, and minimum operating cost for its duty.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth or be apparent from the following description of typical embodiments thereof, and in the accompanying drawings, in which,

Figure 1 is a plan view of a crusher embodying the features of present invention, portions of the structure being broken away.

Figure 2 is a sectional elevation at the broken line 2—2 in Figure 1.

Figure 3 is a sectional elevation at the line 3—3 Figure 1.

Figure 4 is an enlarged fragmentary showing of a portion of Figure 1 at lubrication and dust seal devices for the working head.

Figure 5 is a section taken at the stepped line 5—5 in Figure 4.

Figure 6 is a plan view of the lower body member of the crusher taken generally at the line 6—6 in Figure 2.

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Figure 7 is a fragmentary section at the line 7—7 in Figure 2.

Figure 8 is a fragmentary section at the line 8—8 in Figure 2.

Figure 9 is a sectional elevation corresponding to the upper portion of Figure 2 and disclosing certain modifications of the crusher thereat.

Figure 10 is a fragmentary plan view of the structure of Figure 9, portions of said structure being broken away.

As particularly illustrated in Figures 1 to 8 inclusive, the features of present invention are embodied in a crusher structure 14 comprising a generally tubular housing or frame having its axis upright, said frame mounting the various operative members of the crusher assembly and comprising a bottom section 15 mounting an intermediate section 16, which in turn mounts a top section 17.

The bottom frame section 15 comprises a tubular exterior wall 18 providing a radial support flange 18′ at its bottom, and a radial flange 18″ at its top for use in securing the overlying frame section 16 to it. Webs 19 extend radially inwardly from the wall 18 to a cup-like part 21 having its axis coincident with the axis of the wall cylinder; in the present structure, the wall 18 and webs 19 and cup 21 are integrally related for the provision of section 15 as a single cast unit. The side wall 22 of the cup 21 is intermediately stepped inwardly from its upper portion 22′ whereby its lower portion 22″ has a bore of somewhat less diameter than that of the upper portion, the lower cup portion within the wall 22′ comprising a socket rotatably receiving the bottom portion of a sleeve member 23 which in turn rotatably receives the bottom portion of a stem or spindle 24 which carries a conical working head 25 for coaction with a relatively fixed and enclosing concave carried by the upper frame section 17.

The sleeve 23 is carried for rotation by a suitable power means and fixedly amounts a ring gear 26 intermediately thereof for rotation in the larger upper portion of the cup 21 defined within the wall 22′, said gear 26 comprising a bevel gear in constant engagement with a bevel pinion 27 carried by a shaft 28 which extends radially into the annular upper cup space about the sleeve 23 from a shaft housing 29. The inner end of the shaft housing 29 is particularly shown as being circumferentially stepped outwardly from its inner end for the seated fitting of its end shoulder so provided with a complementary shoulder provided at the outer end of an opening through the cup wall 22'. The exterior of the housing 29 slidably fits an opening through the frame wall 18 coaxial with the first hole, and a radial flange 33 provided on the housing is arranged for bolting to the wall 18 for seating the housing end at the wall 22' while securing the housing to the frame. Anti-friction bearings 30 at the housing ends journal the shaft in the housing.

Noting that the space between the walls 18 and 22 provides the lower portion of a flow passage 34 for crushed material falling from the crushing zone above it, the portion 29' of the housing 29 which extends through said space is desirably formed and positioned to interfere as little as possible with the passage of the material through the space. Accordingly, the housing portion 29' is contracted to just receive the shaft 28 freely thereat and is disposed in the plane of a web 19' which is appropriately cut away to receive the housing in its plane. Preferably, and as shown, the portion of the web 19' which overlies the housing is laterally widened as a tube portion to provide a protective shield above the housing thereat, the housing portion 29' preferably being of teardrop cross-section and being provided with a radial bottom fin 29'' in coplanar relation with the bottom portion of the flange 19'. In this manner, the housing 29 is arranged to interfere to a minimum extent with the flow of material through the flow passage 34.

The shaft 28 extends from the outer end of the housing 29 through a suitable lubricant seal 35, whereby it may be connected to a suitable means (not shown) for rotating it. As particularly shown, the shaft 28 provides a spur gear 36 mounted intermediately thereon within the housing space, and the latter gear constantly engages a gear 37 disposed in a depending housing portion 29''' provided outwardly of the mounting flange 33 of the housing, and carried on the operating shaft 38 of a pump (not shown) for the lubricant to be used in the crusher. It will be understood that the closed housing 29 may provide an oil bath for the gears 36 and 37 and for the bearing for the pump shaft 38.

The stem 24 for the working head 25 has a cylindrical upper portion 24' connected with a smaller cylindrical lower portion 24'' by means of a conically tapered intermediate portion 24''', and the sleeve 23 extends for the major portion of the length of the stem and is provided with a stem-receiving bore 39 which is complementary to the stem exterior and is preferably lined with bushings 39' and 39'' of bearing metal at the straight portions thereof which correspond to the portions 24' and 24'' of the stem. A bushing 41 of bearing metal is interposed between the cup wall 22'' and the opposed exterior portion of the sleeve 23, and the latter sleeve rests upon a suitable bearing ring 42 which supports it from the bottom of the cup 21.

The bore 39 of the sleeve 23 which complementarily receives the stem 24 has its axis angularly related to the axis of the sleeve exterior, the relation preferably being such that said axes intersect at a gyration point P which is above the apex of the cone of the working face of the head 25, the relation being brought out in Figure 2. The stem 24 is independently rotatable within the bore 39 of the eccentric sleeve 23 whereby a rotation of said sleeve does not necessarily cause a rotation of the stem and the working head 25 which it carries.

A foot plate 43 having a relatively frictionless upper face 43' is mounted in the bottom of the cup 21, carries the sleeve-supporting anti-friction bearing ring 42 upon its upper face adjacent its edge, and intermediately mounts a slide block 44 which provides a spherical upper face and a flat under face which slidably bears on the upper plate face 43'. The lower end of the stem 24 is spherically cupped to complementarily receive the spherically convex top of the slide block 44, the opposed block and cup faces being relatively frictionless. The center of curvature of the spherical cup lies in the longitudinal axis of the stem whereby, as the sleeve 23 is rotated, the block 44 is moved in a circle about the common axis of the sleeve exterior and the cup.

It will be understood that a rotation of the sleeve 23 from the shaft 28 is arranged to gyrate the stem and head assembly 24—25 about the point of intersection of the axes of the stem and the cup, whereby a given point of the working face of the conical working head 25 may be caused to approach and leave the opposed working face of a concave which is cooperative with the working face of the head to define a downwardly tapering annular working zone about the head. The arrangement is such that the point of maximum crushing progresses around the working zone in the direction of rotation of the sleeve as the head is gyrated about its point of swing, the action being independent of any rotation of the head which has its supporting stem 24 rotatable within the sleeve bore which it engages.

It will now be noted that the intermediate frame section 16 comprises axially separable parts or portions 45 and 46, the part 45 resting upon and being attached to the top of the bottom frame section 15. The lower part 45 comprises an external tubular wall 47 which is arranged for alignment with the exterior wall 18 of the bottom frame section 15, and is provided at its bottom with a radial flange 47' disposed opposite the top flange 18'' of the wall 18 for attachment to the latter as by bolts 48 engaged through the flanges at spaced points therearound.

Webs 51 extend radially inwardly from spaced points about the bore of the wall 47 to a collar member 52 which rotatably receives the portion of the sleeve 23 above the ring gear 26 thereon, a bearing bushing 53 being preferably interposed between the bore of the collar 52 and the opposed exterior of the sleeve 23 in fixed position in said bore. The webs 51 are arranged as the webs 19 of the section 15 for disposal in overlying and mutually coplanar relation to the latter whereby the webs 51 and 19 cooperatively partition the portion of the flow passage 34 thereat. Externally, the collar member 52 is of generally frusto-conical outline, and has the outer edge portion of its lower bottom face seated upon the top of the cup wall 22' of the bottom section 15, the member being formed with an annular bottom recess 54 extending thereinto above the top level of the hub of the ring gear 26, the collar 52 is understood to provide a continuation or extension in the frame section 16 of the cup 21 at the top of the space 21' about the mounted sleeve 23. An annular bearing ring 49 of bronze or the like freely encircles the sleeve 23 between the top of the hub of the gear 26 and the bottom of the bushing 53 and of the portion of the collar 52 thereat, said bearing ring normally resting upon the top of the hub 26' for rotation therewith and being operative to prevent any appreciable raising of the sleeve 23 against the action of gravity by reason of the reaction of the gear 26 with the drive gear 27 under heavy-duty operating conditions for the crusher head.

In the present structure, the collar 52 and wall 47 of the frame part 45 extend approximately to the same level slightly beneath the bottom of the working head 25, and an upward extension 55 of the wall 47 of said part flares outwardly to a semi-torical bead 56 at its top and from beneath which a radial flange 57 extends. The upper part 46 of the intermediate section 16 generally comprises a ring having its under face complementary to and seated upon the upper wall portion 55 and top bead 56 of the part 45. An upper outer portion of the part 46 is formed to provide a flange 58 opposite the flange 57 of the part 45, and the lower face 57′ and the upper face 58′ of the flanges 57 and 58 respectively are mutually spaced and parallel in perpendicular relation to the frame axis.

It will now be noted that the frame part 46 carries the concave-carrying top section 17 of the present frame assembly in fixed and axially adjusted relation to it, and that the normal seating of this part upon the lower part 45 of the section 16 is arranged to permit an axial raising of the section for releasing a piece of non-fracturable material which may become engaged between the gyratory working head 25 and the concave, the arrangement generally comprising an overload release. At symmetrically spaced points therearound, the flanges 57 and 58 are provided with aligned transverse openings 57″ and 58″ respectively through which bolts 59 extend, the bolt heads 59′ being uppermost. Annular spring seat members 61 are mounted on the bolts 59 in engagement with the bolt heads 59′ and with nuts 59″ threadedly engaging the lower bolt ends, and helical compression springs 62 are reactive between the flanges 57 and 58 and the seat members 61 to normally hold the latter against the bolt heads and nuts; the arrangement is such that the compression springs 62 resiliently and yieldingly resist an unseating of the frame part 46. The present crusher structure has been particularly designed for use in spaces having relatively low ceilings, and the present divided spring assemblies at the bolts 59 permit the present arrangement in which the upper spring seat members 61 are disposed below the level of the top of the gyratory working head 25, preferably in a common plane below the highest head point.

Since the temporarily raised part 46 may tend to shift circumferentially with respect to the part 45 on which it is normally seated, means are preferably provided for positively preventing any such shifting of the part 46. As shown, said anti-rotation means comprises pins 63 depending fixedly from the flange 58 of the member 46 and slidable in mutually aligned holes 63′ in the flange 57 of the part 45; the present arrangement prevents any accumulation of dust or other foreign matter from the crushing operation in the holes 63′. This device permits any required mutual separation of the parts 45 and 46, with or without tilting of the part 46, against the resistance of the springs 62 while the parts are restrained against mutual rotation which would bind the bolts 59 in and between the aligned flange openings 57″ and 58″.

The upper frame section 17 comprises a tubular wall portion 64 which is slidably adjustable in the bore of the part 46 and is provided at its top with a radial flange 65 extending over the top of the part 46. At spaced points therearound, and adjacent its bore, the part 46 mounts stud bolts 66 which extend freely through bolt holes provided in the flange 65 and carry nuts 66′ above said flange, and spacing members are engaged between the flange and part 46 for determining the height of the flange above the part; as shown, the spacing members comprise U-shaped shim members 67 assembled upon a split or sectional clamp ring 67′ of wedge form which is complementarily fitted between the outer face of the wall 64 and an upwardly and outwardly sloping portion of the top of the bore of the part 46. The individual spacers 67 may be of different thicknesses for installation upon the ring 67′ to variously space the clamped-down flange 65 of the section 17 from the part 46 of the section 16 which carries it, it being noted that the tightening of the bolts 66 provides for a centered and releasable connection of the frame section 17 to the upper member 46 of the frame section 16.

The inner face 68′ of the member 17 is conically tapered upwardly and is provided by a wall 68 which extends obliquely from the bottom of the wall 64 of the section 17 and terminates in an out-turned flange 68″ at its top. The concave 69 of the present structure comprises an axially tapered ring member having its outer face 69′ complementarily fitting the inner face 68′ of the wall 68 and secured in place by bolts 70 connecting it with the flange 68″; the top face of the flange 68″ is shown as coplanar with the top face of the flange 65 of the wall 64. As particularly shown, ears 71 extend outwardly and integrally from the concave 69 near its top, and are provided with radial notches 71′ at their outer ends for receiving the head end portions of the bolts 70 which extend freely through the flange 68″ and have helical compression springs 70′ engaged about them between the flange and their nuts 70″. Suitable openings 72 are provided through the oblique wall 68 to permit the insertion of the concave 69 within the space of the wall 68 for its mounting in place thereagainst by means of the bolts 70, it being noted that the V space between the walls provides the required room for the installation of the bolts 70.

The gyratory cone or head assembly 25, it will now be noted, comprises a central core 74 which is integral with the stem 24, and has its outer face conically tapered from its bottom toward a point in the stem axis adjacent and below the gyration point of the head. At its upper end, the head core 74 provides a threaded stud 74′, and a skirt portion 74″ of the core depends below the plane of joining of the core and stem 24 to provide an inverted V-shaped channel space 75 between it and the stem. A facing member or mantle 76 is mounted on the head core 74, a soft metal cushion layer 77 of zinc or the like being preferably engaged by and between the opposed outer and inner faces of the core and the mantle. The outer face of the core 74 is stepped outwardly adjacent its bottom edge for the thickness of the cushioning layer 77 to provide a spacing annulus on which the face member 76 may be supported in spaced relation from the rest of the core 74; the cushioning layer 77 is preferably cast in place while the member 76 is wedgedly mounted on the core 74 in coaxial relation thereto. Having the mantle 76 mounted in the described manner upon the head core 74, a helical spring 78 is mounted upon the top end of the mantle in encircling relation to the stud 74′, and a nut 78′ is screwed down on said stud to forcibly and resiliently seat the mantle on the head core.

The conically tapered working face of the present concave 69 has a relatively narrow lower portion 81 having the apex of its cone at, or substantially at, the gyration point P of the head 25, while the remaining upper portion 81′ of said face is conically tapered toward an apex above the gyration point P. A lower portion 82 of the working face of the present mantle 76 which is opposite the working face portion 81 of the concave 69 also has the apex of its cone at, or substantially at, the gyration point P, while the remaining upper portion 82′ of said working face is conically tapered toward an apex well below the point P. The working zone 79 defined between the opposed concave and mantle faces is such that the upper face portions 81′ and 82′ of the concave and mantle cooperate to provide a downwardly tapering upper portion of the crushing zone portion above the substantially untapered lower zone portion defined between the mutually opposed lower working face portions 81 and 82 of the concave and mantle. By reference to Figure 2, it will be particularly noted that lines comprising elements of the cone of the concave face 81 pass through the gyration point P, and that points on said lines are substantially equidistant from the working faces of the concave and head, whereby they generally bisect the angle of said faces, while the cone of said lines generally bisects the V-shaped crushing zone as primarily defined between the angularly related upper working face portions 81′ and 82′.

The concave 69 and mantle 76 are preferably formed of a hard and wear-resistant metal such as manganese steel whereby they may have a maximum life for the crushing of material in the crushing zone 79. Furthermore, the described devices for mounting the concave and mantle on the frame and head respectively are understood to be such that adjustment of their spacing may be made for wear on their working faces and/or any flattening-out action by the material being crushed between them. Also, any radial spreading of the mantle 76 is arranged to be automatically taken up by the seating action of the spring 78 upon the mantle. While the elements of the cones of the concave and mantle are shown as straight, it will be understood that they might be curved in or out with respect to their axes. The maximum delivered size for particles of the rock being crushed is determined by the maximum spacing of the faces 81 and 82, and the latter faces do not contact at any time. Furthermore, the height adjustment of the concave provided for at the bolts 66 through the selected use of different thicknesses of spacers 67 thereat provides for an adjustment of the maximum gap provided between the working faces 81 and 82 at the bottom of the crushing zone 79; as the concave is raised, the spacing of said faces increases.

The permitted rotation of the head in its bearings, while not very rapid on account of the holding action of material in the crushing zone, assures that any wear on the working faces of the concave and mantle will be uniform whereby to provide a maximum useful life for the replaceable concave and mantle. Since the central cone of the working zone 79 has its apex at, or substantially at, the gyration point P, the working motion of any particular point of the mantle face toward the concave face is generally perpendicular to the latter whereby a rock piece engaged between the faces at any point of the zone may be diametrically crushed without rolling or friction effects on the piece; in this manner, wear on said faces is a minimum, the production of an undue amount of rock dust is avoided, and the life of the concave and mantle members is particularly long because of the minimized abrasive effects with the rock being crushed in the zone 79.

Preferably, and as shown, the top of the inwardly sloping wall 68 of the top frame section 17 mounts a cylindrical collar member 83 which defines a fixed mouth for the crushing zone 79 about the upper head portion at the mantle-retaining nut 78′. In the present structure, the top of the collar 83 is lower than the nut 78″ whereby the latter determines the overall height of the crusher assembly which is appreciably lower than the crusher would otherwise be if a bearing were provided at the gyration point P above said plane.

Understanding that the crushed rock falling from the crushing zone 79 is arranged to be discharged through the annular flow space 34 provided through the intermediate and bottom frame sections 16 and 15, and that such material includes more or less dust which must be kept out of the bearings for the head-carrying stem 24 and the eccentric sleeve 23, means are provided for sealing-in said bearings in a manner to prevent the admission of dust thereto from the space 34 without interfering with the required movements of the stem and sleeve with respect to the frame and each other. As particularly brought out in Figure 4, said dust sealing means is provided in and immediately below the space 75 beneath the head core 74, and includes a ring member 84 encircling the stem 24 and sealedly engaged between the frame member 52 and the head core.

The member 84 is of general Z-section circumferentially thereof and comprises a flat radial web portion 84′ having a tubular flange 84″ extending upwardly from its inner edge and complementarily receiving the stem 24, and a tubular flange 84‴ depending from its outer edge in spaced enclosing relation to the top portion of the collar 52 of the frame part 45; the web portion 84′ overlies the tops of the eccentric sleeve 23 and the collar 52 and may supportedly rest upon the top end of the sleeve or upon the top of the collar 52, the former being particularly shown.

A circumferentially fluted or pleated flexible sleeve 85 connects the flange portion 84‴ with a circumferential seat 86 provided on the outer side of the collar 52 between its top and the tops of the web 51 thereat, with the ends of the sleeve sealedly engaging the seat 86 and the cylindrical exterior face of the flange 84; the sleeve 85 may be of an oil-proofed and dust-tight fabric or the like. Clamp rings 85′ may be provided for fixedly and sealedly securing the different sleeve ends against the seat 86 and flange 84‴. Because the upper flange 84″ of the member 84 rotatably receives the stem 24, the member 84 will be gyrated with the stem as permitted by the flexible connection provided by the sleeve 85, it being noted that the portions 84′ and 84‴ of the member 84, and the flexible sleeve 85 cooperatively define an encircling closed space 87 about the upper end portions of the rotatable eccentric sleeve 23 and the fixed collar 52, with the sleeve 85 functioning positively to exclude dust at the bottom portion of the space 87.

Means are provided for preventing dust from the flow space 34 reaching the exterior of the stem 24 above the flange portion 84′ of the member 84 whereby to dust-seal the space 87 at its top.

As particularly shown, a ring member 88 is fixed to and beneath the skirt portion 74'' of the head body 74, rotatably receives the flange 84'' of the member 84, and is provided with a stepped inner edge which is cooperative with the opposed outer wall of the flange 84'' to define an upwardly-opening space 89 in which a dust-sealing means may be provided. As particularly shown, a flexible sealing ring 90 of general C-section is disposed in the space 89 and has its inner edge sealedly engaged with the outer surface of the flange 84'' by the action of a longitudinally tensed band 91; said band 91 may comprise a closed ring of helically wound wire.

Figures 9 and 10 disclose a crusher structure which differs primarily from the embodiment of Figures 1 to 8 in omitting any overload release device and in providing a bearing for the head at its gyration point. The present structure otherwise provides the same mounting and bearing and lubrication arrangements as those found in the first embodiment, and is provided on and within frame sections 115 and 116 and 117 corresponding to the respective sections 15 and 16 and 17 of the first embodiment. The section 115 may be identical with the section 15, and only the top portion thereof at and below its top flange 118'' has been shown. The section 116 is of one-piece construction, and the outer wall 147 is provided with bottom and top flanges 147' and 158 corresponding to the flanges 47' and 58 of the two-part frame section 16 of the first embodiment. The upper frame section 117 is formed as the section 17, includes a tubular wall portion 164 having a radial flange 165 at its top, and mounts a concave 169 as in the other embodiment. Stud bolts 166 extend from the flange 158 and through the flange 165 for engaging spacing members 167 and a wedge ring 167' between said flanges for releasably and fixedly attaching the section 117 to the section 116 in the manner taught for the first embodiment.

The head 125 of the embodiment of Figures 9 and 10 is the same as in the first embodiment except above its mantle 176. In the present structure, an axially extending stud 174' of the head core 174 intermediately and threadedly mounts a collar 178' for action against a compression spring 178 for seating the mantle 176 on the head core 174. The stud portion above the collar 178 has its end portion extended radially into a complementary socket 192 provided in a spherical bearing member 193 having its center coincident with the center of gyration of the head 125. The ball member 193 is engaged in a complementary supporting socket which is provided by an assembly 194 mounted on the top flange 158 of the frame section 116, and including a head block 195 integrally carried on three spider legs 196 which have bottom foot portions 196' secured by bolts 196'' to extensions 158' of the flange 158.

The present block 195 is provided with a cylindrical recess 195' extending from its top to the level of the gyration point P', and has a central bore which is arranged to complementarily receive the ball 193 below the level of the gyration point P' while freely receiving the upper portion of the stud 174' for a required oscillation of the ball in its seat. A bearing block 197 is fittedly engaged in the cylindrical recess of the block 795 and provides a semicircular socket 197' for complementarily receiving the upper half of the ball 193. A member 198 complementarily fits the top of the block 195 in centered position thereon, and has an annular depending portion 198' thereof arranged for bearing upon the top of the block 197 to secure the latter in place to provide its portion of the socket for the ball 193. The member 198 preferably provides a more or less domed hollow cap for the block 195, and is secured to the rim portion of the block 195 by screw bolts 199; the cavity of the member 198 may contain a lubricant grease for feeding to the main bearing surface of the ball 193 through registering axial ducts of the block 197 and the ball 193.

It will be understood that the ball and socket arrangment provided at the gyration point P' of the head 125 provides part of the support for the head, while steadying the head action under heavy duty conditions. Since rock to be crushed must enter the crushing zone 179 around the socket assembly 194 and the legs 196 which support it, a guided feeding of rock thereat with appropriate radial clearance is provided by a funicular collar 183 mounted upon the top of the upper frame member 117 and extending below the assembly to the top of the crushing zone.

Lubrication of the various sleeve and stem and shaft bearings for both disclosed embodiments of the present crusher is arranged to be effected by a positive feeding of a lubricant through a lubricant distribution system which assures ample lubrication at all points, the lubricant being supplied under pressure, as by a pump (not shown) actuated by the jack shaft 38 which is driven from the sleeve-rotating shaft 28 of the assembly. As particularly brought out in Figure 2, the liquid lubricant from a said, or other, pump is arranged to be introduced under pressure at an axial inlet passage 92 through the bottom of the cup 21 and a registering axial hole 93 through the footplate 43.

A riser passage 94 is provided in the bottom stem portion 24'' axially thereof and is arranged for constant registration with a radial passage 95 provided through the slide block 44, the passage 95 being of such size at its top and bottom as to constantly connect the passage 94 with the hole 93 as the stem is oscillated upon the block. A passage 94' extends from the upper end of the passage 94 through the stem 24 to exterior stem points at the juncture of the lower and intermediate stem portions 24'' and 24''' for discharging lubricant into the open annular space 97 provided between the bore of the sleeve 23 and the stem portion 24''.

A slot 98 is provided longitudinally along the inner face of the lower stem bushing 39'' which is fixed in the sleeve bore, said slot preferably being opposite the thickest part of the eccentric sleeve 23, as is illustrated. The slot 98 is arranged to discharge lubricant into the cup space defined between the sleeve-supporting bearing ring 42 and the slide block 44 for insuring a supply of lubricant upon the footplate 43 thereat as well as in the bushing 39''. For insuring a flow of the lubricant through said space, a radial duct 99 is provided in the ring 42 in constant communication with an axial slot 100 provided in the bushing 41 which journals the lower sleeve end, said slot being arranged to discharge lubricant into the upper portion of the cup 21; in this manner, the flow of lubricant under pressure is assured for all bearing surfaces below the plane of the radial passages 96.

The upper stem bushing 39', which is carried by the eccentric sleeve 23, is provided with an axial slot 102 extending from the space 97 to the top of the bushing for lubricating the opposed stem face, said slot being provided along the thin side of the sleeve where there is substantially no working pressure as the sleeve rotates about the stem. A duct 103 extends radially through the bushing 39' and the sleeve 23 just below the top of the collar 52 which mounts the sleeve-receiving bushing 53, and a slot 104 is provided in the sleeve exterior longitudinally thereof for connecting the outer end of the duct 103 with the space between the gear hub 26' and the opposed bottom portion of the collar 52 in which the thrust ring 49 which is carried by the gear hub 26', is disposed. The upper face of the thrust ring 49 is preferably provided with a radial slot 49' to provide for the discharge of lubricant into the space 54 within the collar. Any lubricant escaping into the space 87 having its bottom defined between the upper portion of the collar 52 and the flexible sealing sleeve 85 is arranged to drain from said space into the space 54 through a duct 105 extending axially from the bottom of the space 87 to the space 54. It will be understood that the descending flow of lubricant through and from the ducts 104 and 105 will be effected by gravity and any residual pressure in the lubricant.

A major portion of the lubricant which is discharged into the space 54 will fall upon the gears 26 and 27 for lubricating the same, and means are provided for delivering a minor portion of said lubricant within the shaft housing 29 for a lubrication of the various bearings and gears therein. As particularly shown, a duct 106 extends from an upper point of the exposed inner end face of the housing 29 to the housing interior at a point inwardly of the constricted housing portion 29', said duct being arranged to receive lubricant which is thrown centrifugally from the rotating gear 26 on the sleeve 23. The shaft housing space outwardly of the housing portion 29' is arranged to retain the lubricant at a level determined by the bottom point of the housing bore at the reduced housing portion 29', whereby said portion acts as a dam over which excess lubricant may escape through the inner shaft bearing 30 into the cup space.

As particularly shown, the lower cup wall portion 22'' of the cup 21 extends above the bottom of the cup space defined within the upper wall portion 22' to provide a horizontal annular cup space 21' in which the radial outer portion of the bevel gear 27 extends for picking up lubricant from said space as it rotates therein. At the opposite side of the cup from the gear 27, the cup is formed to provide a downwardly directed discharge passage 21'' through which used lubricant may escape from the space 21' for cleaning and re-circulation.

It will be noted that the present crusher structures provide bearings of maximum area for their duties whereby to avoid the possibility of unduly concentrated bearing areas which may result in a failure of the lubrication system to provide sufficient lubricant at all bearing surfaces.

From the foregoing description taken in connection with the accompanying drawings, the advantages of the present crusher features will be readily understood by those skilled in the art to which the invention appertains. While we have described the principle of operation, together with arrangements which we now consider to be the preferred embodiments thereof, we desire to have it understood that the showings are primarily illustrative, and that such changes and developments may be made, when desired, as fall within the scope of the following claims.

We claim:

1. In a gyratory crusher, a head member providing a conical working face having the apex of its cone above it, an annular concave receiving the head and having a conically concave working face opposite said head face and having its apex above said apex of the working face of the cone whereby said working faces define a downwardly contracting working zone between them, and means operative for effecting a relative gyration of the head and concave members about a fixed intersection point of the axes of their cones which lies between the apexes of their cones in such a position that all lines therefrom to the bottom of the working zone are effectively equidistant from the working faces of the head and concave.

2. In a gyratory crusher, a conical head member having the apex of the cone of its working face uppermost, an annular concave receiving the head and having a conically concave working face in opposition to said working face of the head, with its apex appreciably above said apex of the working face of the head whereby said working faces cooperatively define a downwardly contracting working zone between them, and means operative for effecting a relative gyration of the head and concave members about a fixed intersection point of the axes of their cones which lies between and in appreciably spaced relation from the apexes of their cones in such a position that all straight lines therefrom to the bottom of the working zone effectively bisect the angle of the working faces thereat.

3. In a gyratory crusher, a conically tapered head having upper and lower working face portions coterminous and conically tapering to different degrees with respect to a common axis, the apex of the cone of the lower face portion being above the apex of the cone of the upper face portion, a concave overlying and generally enclosing the head and having upper and lower working face portions of its bore conically tapering to different degrees with respect to a common axis and respectively cooperative with said upper and lower working faces of the head to define a downwardly contracting working zone between the head and concave, the cone of the upper face portion of the concave having its apex at a point appreciably above the apex of the cone of the upper face portion of the head, and means operative for effecting a relative gyration of the head and concave members about a fixed intersection point of the axes of their cones which lies between and in appreciably spaced relation from the apexes of the cones of their upper face portions in such a position that all straight lines therefrom to the bottom of the working zone effectively bisect the angle of the upper working face portions thereat, the cone of said lower face portion of the concave effectively having its apex at said gyration point.

4. In a mount for an upright gyrating stem, an externally cylindrical bearing sleeve providing a bore closely journalling the bottom portion of said stem as the sole positioning means for the stem and eccentric to the sleeve exterior in fixed angular relation to the stem axis and having its axis intersecting the stem axis above the bearing sleeve at a fixed gyration point for the stem, a frame providing a socket having its side closely journalling the bottom portion of said sleeve, a bearing ring at the socket bottom pro-

viding a foot-bearing for the sleeve, a bearing block having a flat under face engaging the socket bottom and having its upper face complementarily engaging the stem bottom to provide a sliding foot bearing beneath the stem, and a drive gear mounted on said sleeve intermediately thereof.

5. In a mount for an upright gyrating stem, an externally cylindrical bearing sleeve providing a bore closely journalling the bottom portion of said stem as the sole positioning means therefor and eccentric to the sleeve exterior in fixed angular relation to the stem axis and having its axis intersecting the stem axis above the bearing sleeve at a fixed gyration point for the stem, a frame providing a socket rotatably receiving said sleeve, means providing a support ring bearing for the sleeve on the socket bottom, the socket bottom being provided with a coaxial duct therethrough, and a bearing block having its upper face complementarily engaging the stem bottom within the ring bearing and having a bottom face slidably engaging the socket bottom to provide a sliding foot bearing for and beneath the stem, said bearing block being provided with a passage for lubricant extending upwardly therethrough from its bottom and arranged for constant registration with said duct of the socket bottom, and said duct in the socket bottom being arranged for connection with a source of liquid lubricant under pressure for effecting a pressure distribution of lubricant to the bearing faces of the block and thence to the ring bearing.

6. In a gyratory crusher, a conically tapered head having the apex of its cone above it, a cylindrical stem carrying the head in coaxial relation thereto, an externally cylindrical bearing sleeve providing a bore rotatively receiving said stem and having its axis oblique to the axis of the sleeve exterior, a frame having a fixed tubular part providing a bore rotatably receiving said sleeve, means on the frame providing mutually independent foot bearings beneath the stem and sleeve, means for rotating said sleeve, a sealing ring directly cooperative between the head and said sleeve to provide a dust seal above the bearing between the stem and the sleeve bore for permitting a relative rotation of the stem and sleeve, and a flexible sealing tube cooperative between the sleeve exterior and said tubular part of the frame to provide a laterally flexible dust seal over the top of the bearing between the sleeve exterior and said tubular frame part for permitting a relative rocking of the stem and said tubular part of the frame.

7. In a mount for an upright gyratory stem, an externally cylindrical bearing sleeve providing a bearing bore closely journalling the bottom portion of said stem and eccentric to the sleeve exterior, a frame providing a socket closely journalling the bottom portion of said sleeve, a bearing ring at the socket bottom supportedly carrying said sleeve as a foot bearing thereat, and a bearing block having a flat under face slidably engaging the socket bottom and having its upper face complementarily engaging the stem bottom to provide a sliding foot bearing beneath the stem, the bottom portion of the socket at said bearing ring and bearing block comprising a well for containing a lubricant for the lubricating immersion of both the sleeve and block bearing therein.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
464,463	McCully	Dec. 1, 1891
650,097	Rotter	May 22, 1900
799,647	Hart	Sept. 19, 1905
1,132,984	Smith	Mar. 23, 1915
1,553,202	Symons	Sept. 8, 1925
1,575,874	Symons	Mar. 9, 1926
1,691,553	Rumpel	Nov. 13, 1928
1,780,459	Bernhard	Nov. 4, 1930
1,863,529	Symons	June 14, 1932
1,873,671	Symons	Aug. 23, 1932
2,014,588	Rumpel	Sept. 17, 1935
2,052,706	Guest	Sept. 1, 1936
2,134,903	Young et al.	Nov. 1, 1938
2,135,324	Brown	Nov. 1, 1938
2,147,833	Fahrenwald	Feb. 21, 1939
2,223,956	Gruender	Dec. 3, 1940
2,224,542	Gruender	Dec. 10, 1940
2,310,737	Gruender	Feb. 9, 1943
2,390,048	Farfan	Feb. 5, 1946