Feb. 14, 1933. F. C. PEREW 1,897,176

APPARATUS FOR PULVERIZING AND CLASSIFYING ORE AND THE LIKE

Filed Dec. 31, 1928 3 Sheets-Sheet 1

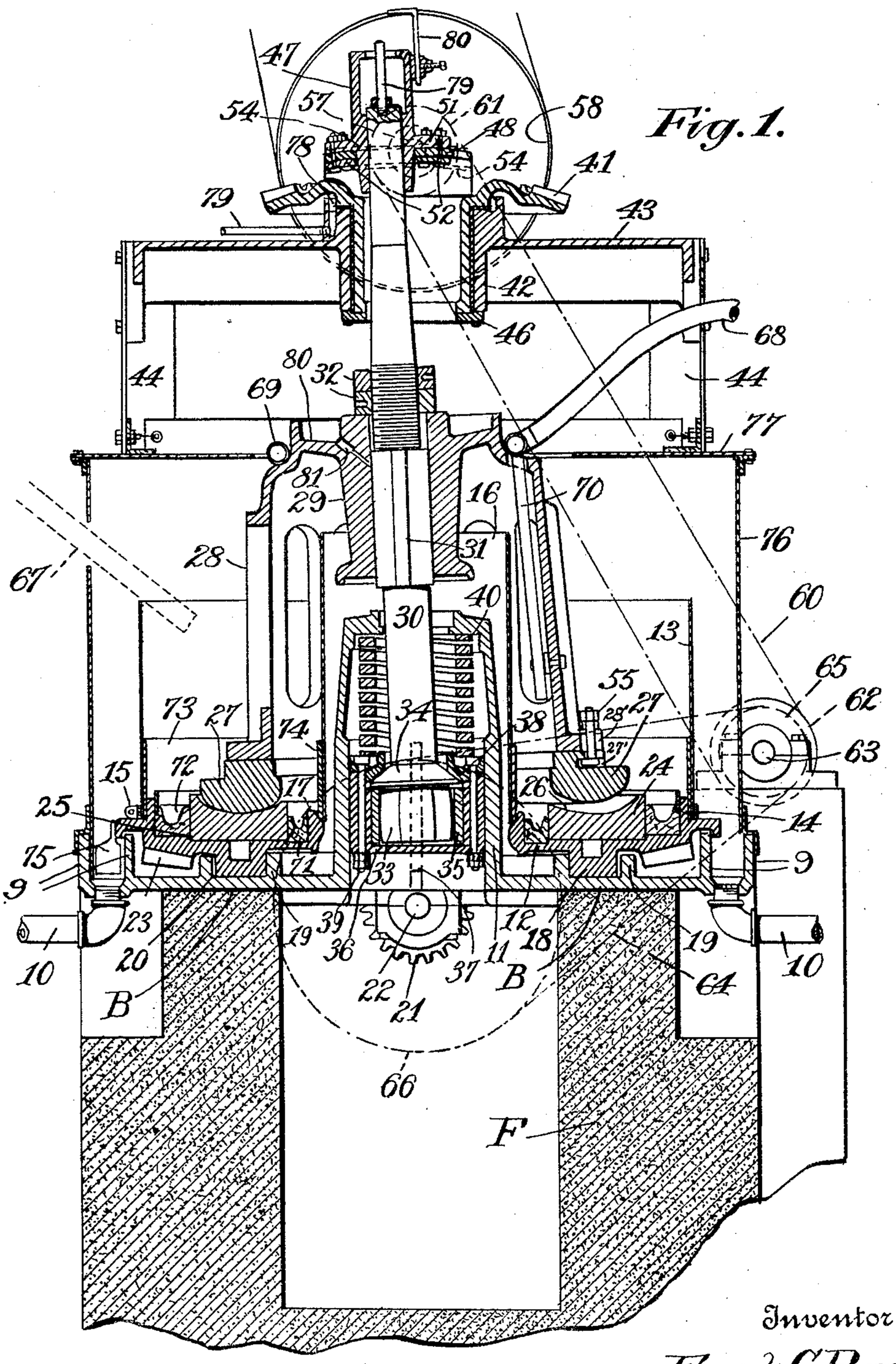

Fig. 1.

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Filed Dec. 31, 1928 3 Sheets-Sheet 2

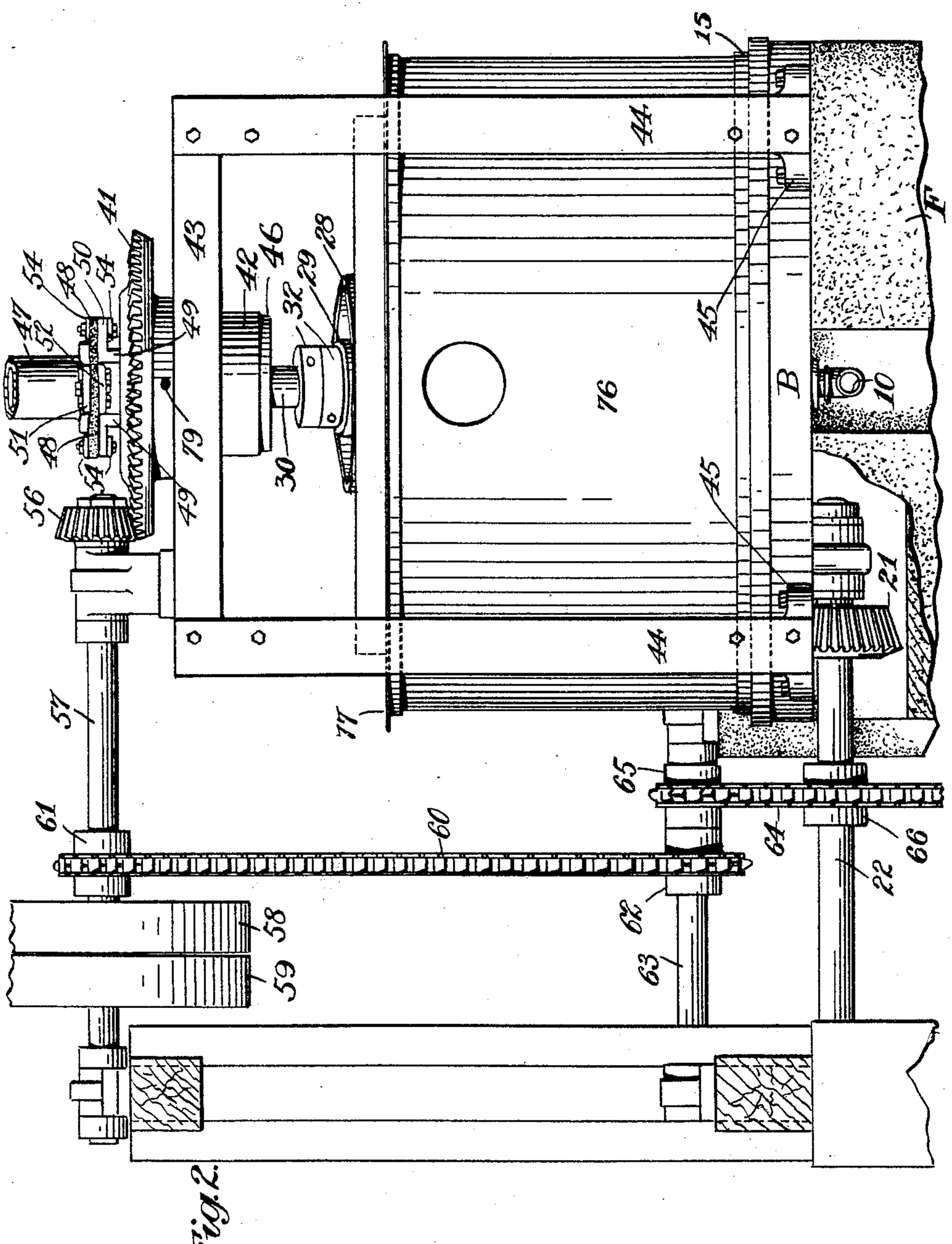

Fig. 2.

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Filed Dec. 31, 1928 3 Sheets-Sheet 3

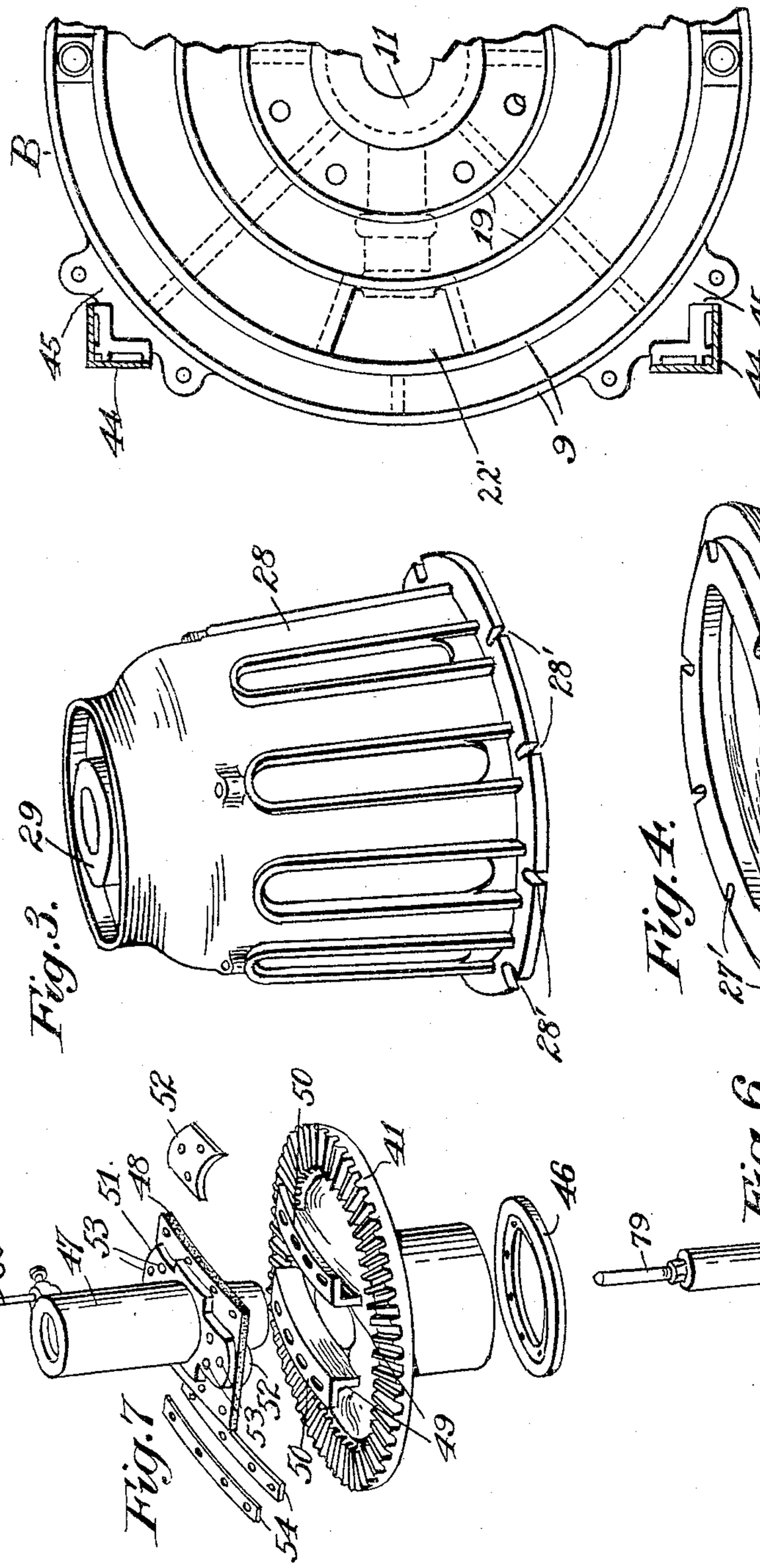

Fig. 8.

Fig. 3.

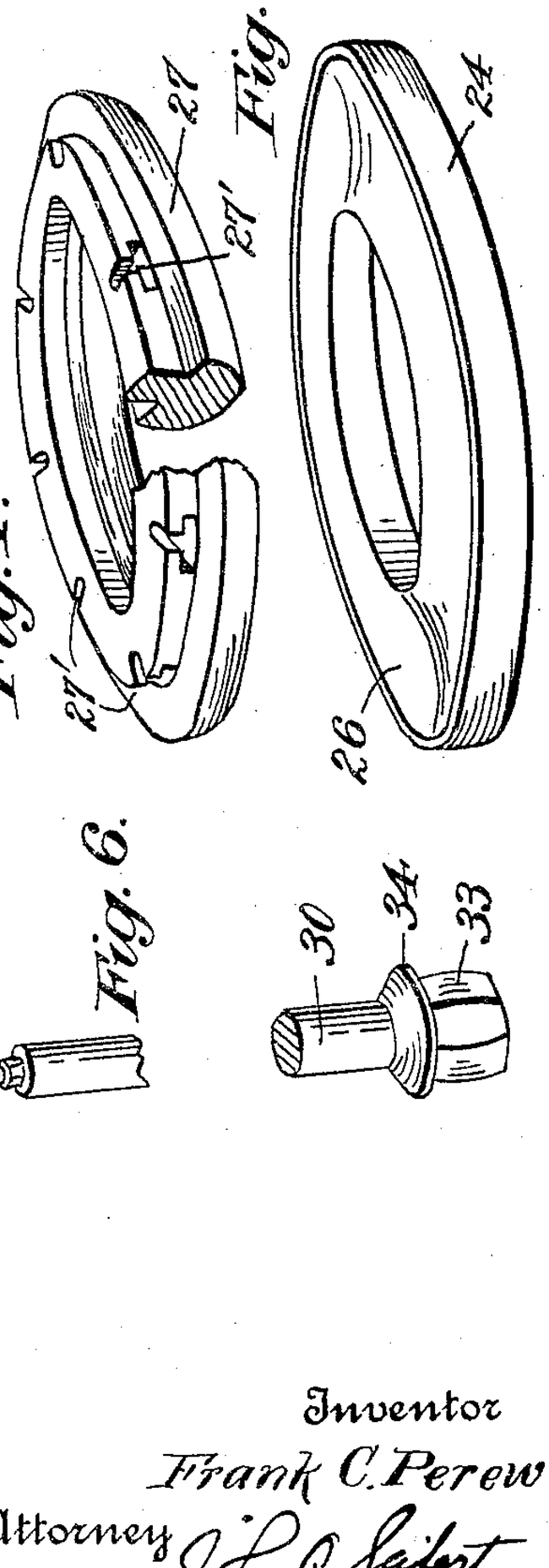

Fig. 4. Fig. 5.

Fig. 7.

Fig. 6.

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UNITED STATES PATENT OFFICE

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APPARATUS FOR PULVERIZING AND CLASSIFYING ORE AND THE LIKE

Application filed December 31, 1928. Serial No. 329,511.

This invention relates to the comminuting or pulverizing of ore and like materials, and it is an object of the invention to provide an improved method of and apparatus for subjecting the ore or other material to be comminuted simultaneously to a crushing pressure and attrition action to render the material into a pulverulent condition.

It is a further object of the invention to provide an improved method of and apparatus for rendering ore and like materials to a comminuted or pulverized condition and classify the pulverized material.

The invention furthermore relates to apparatus of this character embodying a pair of opposed crushing members, one of which comprises a muller including a head carrying an annular crushing member or shoe, said muller being supported to have gyratory movement to progressively move successive portions of the shoe toward and away from the other crushing member in the form of an annular die, and it is a further object of the invention to provide improved means for mounting the shoe carrying head of the muller to hold the same against rotation while permitting of gyratory and axial movement thereof and yieldingly urged with a predetermined crushing pressure in a direction toward the die.

It is another object of the invention to provide pulverizing apparatus of this character embodying a gyratory muller wherein the die is rotated in a direction reverse to the gyratory movement of the shoe carrying head of the muller whereby the material as it is subjected to the crushing force of the muller is simultaneously subjected to an attrition or rubbing action to triturate and render the material to a pulverulent condition.

Another object of the invention is to provide in apparatus of this character means wherein the ore is rendered pulverulent in the presence of a liquid and the lighter or non-metallic and more buoyant content of the ore is floated off, and means is provided in which to collect the heavier or metallic content of the ore and said means adapted to carry material therein to form an amalgam with such collected metallic content of the pulverized ore.

Other objects and advantages will hereinafter appear.

In the drawings accompanying and forming part of this application there is illustrated an embodiment of apparatus for carrying out the improved method of rendering ore and like materials to a pulverulent condition and classifying the pulverized material wherein Figure 1 is a longitudinal sectional view.

Figure 2 is a side elevation looking at the right of Figure 1.

Figure 3 is a perspective view of a head forming a part of the muller member.

Figure 4 is a perspective view of an annular shoe carried by the muller head and comprising one of the crushing members.

Figure 5 is a perspective view of the annular die or crushing member with which the muller shoe co-operates to effect a crushing and triturating of the ore.

Figure 6 is a perspective view of one end of a shaft upon which the muller head is mounted and carried to show the arrangement of the shaft to mount the same concentrically of the die and hold it against rotation while permitting of gyratory movement of the shaft.

Figure 7 is a perspective view of means for mounting the muller head carrying shaft eccentrically to the axis of the die and the operative means for effecting gyratory movement of the shaft, the parts being shown in dissembled relation; and

Figure 8 is a fragmentary plan view of a support in which a carrier for the die, and comprising the bottom of the pan, is rotatably mounted and in which the one end of the muller head carrying shaft is mounted concentrically of the die.

In the embodiment of the apparatus illustrated in the drawings for carrying out the method of subjecting ore and like material to a crushing force and attrition action to render the same pulverulent and the classifying of the pulverulent material, there is provided a circular supporting or base member B upon which the operative mechanism

and supporting structure therefor of the apparatus is mounted, and whereby the same is supported upon a foundation F of suitable material, in the present instance concrete. This base member is arranged at the peripheral portion with concentrically arranged flanges 9 to extend from one face and constituting the top of the base to form a trough, for a purpose to be hereinafter described, having an outlet pipe or pipes 10 connected to and leading from the bottom thereof. The base member is also arranged centrally thereof with a hollow pillar or pedestal 11 extending laterally or upwardly from the base in the direction of the trough forming flanges 9, said pillar having an opening in the top and opening through the bottom of the base member.

An annular pan in which the ore or other material is to be pulverized is rotatably carried by the base member B, said pan comprising an annular head 12 to constitute the bottom of the pan, with a cylinder or drum 13 to constitute the side wall of the pan engaged upon said head to extend about an annular flange projected from the top or face of the head, as at 14, and secured thereto by a draw band or hoop 15. The inner wall of the pan comprises a cylinder 16 of greater length than the cylinder 13 seated in a recess in the surface of the inner wall of the opening through the head, as at 17. The pan head is arranged on the bottom surface with an annular rib 18 whereby it is rotatably supported upon the base member B between a pair of annular flanges or ribs 19, the space between the flanges is preferably slidably greater than the width of the rib thereby providing a lubricant carrying pocket between said rib and one of the flanges, as at 20. While this rib is shown as having a slip surface connection with the base member it will be obvious that an anti-friction bearing may be provided between the pan and base member by interposing rollers or the like betwen the pan rib 18 and the base member. The pan head is constructed and arranged whereby the peripheral portion will extend beyond and overlap the inner trough forming flange 9. The pan is rotated by a bevel pinion 21 fixed to a shaft 22 journaled in bearings below the base member, a peripheral portion of said opinion being extended into a recess 22′ in the base member and meshing with gear teeth 23 on the lower surface of the pan head.

One of the material crushing and triturating members, herein termed a die, is carried by and rotatable with said pan, and comprises an annular member 24, said die being mounted upon the pan head and positioned therein with the peripheral wall engaging a shoulder 25, and have a recess 26 in the upper surface of arcuate form in cross section and constituting the crushing surface of said die.

The other material crushing and triturating member is in the form of a muller and comprises an annular shoe 27 carried at one end of a head in the form of a hood 28 with the crushing surface of the shoe in opposed relation to the crushing face of the die, and said crushing face being shaped to convex or arcuate form in cross section to correspond substantially with the crushing surface of the die. The muller head 28 has a hub 29 extended centrally inward from the end opposite to the shoe whereby the head is mounted on a shaft 30 to extend over and about the inner wall 16 of the pan. The muller head is mounted on the shaft to permit of longitudinal movement thereof relative to the shaft and held against rotation on the shaft by keying the muller head to the shaft, in the present instance shown as comprising diametrically opposite ribs or keys 31 on the shaft adapted to engage in correspondingly formed keyways in the hub 29, the muller head being held against longitudinal movement on the shaft in one direction by nuts 32 on a threaded portion of the shaft above and against which the hub of the muller head abuts.

The shaft 30 is mounted concentrically-eccentrically of the axis of the pan and die member 24 whereby the shaft with the shoe carrying head is adapted to have gyratory movement to progressively move successive portions of the shoe toward and away from the die and ride upon and off from the material interposed between the shoe and die. To effect this gyratory movement of the shaft and permit of movement thereof in an axial direction the lower end of the shaft is slightly enlarged and made of hexagonal form in cross section and the hexagonal surface shaped to arcuate form in longitudinal section, as clearly shown at 33 in Figures 1 and 6. At the inner end of said hexagonal portion the shaft is arranged with an annular enlargement 34 (Figure 6) having the surface adjacent the hexagonal end arranged in a plane to extend at a right angle to the axis of the shaft and the opposite surface of spherical or arcuate form. The shaft is extended through the opening in the top of the pillar 11 with the hexagonal end of the shaft mounted concentrically of the die in a bearing 35 the bore of which is of hexagonal shape in cross section and the cross sectional area of which bore is equal to the greatest cross sectional area of the hexagonal portion of the shaft. The bearing 35 is fixedly mounted in a bearing box in the form of a cup member 36 mounted in the pillar 11 to have axial sliding movement and held against rotation by feather keys diametrically oppositely disposed and engaging in keyways in the bearing box and pillar 11, as shown at 37 in Figure 1. To retain the shaft in the bearing box and permit of lateral movement of the shaft as it is gyrated a perforate cap 38 is engaged upon the shaft above the annular

enlargement 34 having an arcuate surface to conform to and engage the arcuate surface of the shaft enlargement and secured to the bearing box by tie bolts 39. The shaft is urged in an axial downward direction by a spring 40 coiled about the shaft and confined between the top of the pillar 11 and the cap 38.

The shaft 30 is mounted at the opposite end eccentrically to the axis of the pan and die in an enlarged opening in a hub extended laterally from a bevel gear 41 rotatably mounted in a bearing portion 42 of a plate 43 supported above the muller head 28 by uprights 44 fixed to lugs 45 extended laterally from the base member B and by means of which lugs the base member is secured to the foundation F by tie rods extended through perforations in said lugs and embedded in the concrete of the foundation. (Figures 2 and 8). The gear is supported in the plate bearing 42 by a shoulder formed at the juncture of the hub with the gear seating against the top of the plate bearing and a ring 46 fixed to the lower end of said plate bearing. The shaft is flexibly connected with the gear eccentrically to the axis thereof to participate in the rotative movement of the gear to impart gyratory movement to the shaft and muller head by a bearing member 47 in which the shaft is loosely engaged and the bearing member connected with the gear by a diaphragm 48 of suitable material, such as leather preferably of multiple ply. To secure the bearing member to the gear the gear is arranged on the face opposite to that from which the hub extends with a pair of ribs 49 of angle shape in cross section, (Figure 7), said ribs extending in parallel relation at diametrically opposite sides of the opening through the gear with the one angle portion spaced from the gear and projecting laterally and having a series of elongated perforations therein, as shown at 50. The bearing member 47 is loosely engaged in the central opening in the diaphragm with a flange 51 on the bearing in abutting relation to the diaphragm, said flange having a portion of a width substantially equal to the space between the gear ribs 49 and elongated at right angles to said portion, the diaphragm being secured to said flange by clamping plates 52 engaged at the opposite side of the diaphragm in opposed relation to the elongated portions of the flange of the bearing member and riveted thereto, as shown at 53. The bearing member 47 with the diaphragm is then secured to the gear ribs 49 by engaging the opposite perforated marginal portions of the diaphragm extended beyond the flange of the bearing member upon the perforated portions of the gear ribs and secured thereto by perforated clamping bars 54 engaged upon said perforated marginal portions of the diaphragm and below the perforated angle portion of the gear ribs and secured thereto by bolts passed through the perforations in said clamping bars, the gear ribs and diaphragm. It will be obvious that by the elongating of the perforations in the gear ribs that the bearing member may be adjusted to vary the eccentric movement of the bearing member and thereby of the muller shaft relative to the axis of the gear and to the concentric mounting of said shaft.

The gear 41 is rotated and thereby the muller gyrated in a direction reverse to the rotation of the die carrying pan by a pinion 56 (Figure 2) fixed to the shaft 57 and meshing with the gear 41. The gear 41 and the die carrying pan are actuated from a suitable source of power by a belt passed around a pulley 58 fixed to the pinion carrying shaft 57, a pulley 59 juxtaposed to the pulley 58 being loosely mounted on the shaft to which the belt may shift to render the apparatus inactive. The shaft 57 is operatively connected with the shaft 22 carrying the pinion 21 meshing with the gear teeth of the pan by a sprocket chain 60 passing around a sprocket wheel 61 on shaft 57 and a sprocket wheel 62 fixed to an intermediate shaft 63, and the latter shaft connected with the shaft 22 carrying pinion 21 by a sprocket chain 64 passing around a sprocket wheel 65 on shaft 63 and a sprocket wheel 66 on shaft 22. The ratio of the gearing is such that the muller shoe is gyrated at a greater speed than the rotation of the pan and die. By this arrangement as the muller shoe rides upon and off the material between the shoe and die, due to the gyratory movement of the shoe the material will not only be subjected to a crushing pressure but also to an attrition or rubbing action by the slippage of the die relative to the shoe and thereby also triturate the material and more readily render it into a pulverulent condition.

The crushing member or shoe 27 is made of wear resisting material, such as manganese steel or the like, and while it may be constructed integral with the muller head 28, it is preferably made as a separate member and releasably secured to the muller head, whereby the head may be made of a cheap material, such as ordinary grey iron casting. To secure the shoe to the muller head the head is arranged at the end with a laterally extending annular flange having slots circumferentially disposed about the same and extended radially inward from the periphery, as at 28′. The shoe 27 at the side opposite to the crushing face is arranged with an annular rib having inverted T-slots extended radially inward from the peripheral wall, as at 27′, said slots being circumferentially disposed about the shoe rib and spaced to correspond with the spacing of the slots 28′ in the flange of the muller head. Headed bolts are entered into

the T-slots of the shoe with the threaded ends extended through the slots in the muller head and having nuts threaded thereon at the upper side of the flange of the muller head, as at 55 in Figure 1.

The material to be treated is delivered to the pan by suitable means, such as a chute 67, which may lead from the outlet of a hopper (not shown) or from proportional feeding means to which the material is delivered from a hopper.

The apparatus is also adapted to classify the pulverized ore for which purpose the ore is rendered pulverulent in a liquid, such as water. The water is supplied in a constant stream to the pan from a suitable source by a flexible conduit 68 connected to a circular pipe 69 extended about the top and carried by the muller head 28, pipes 70 being connected to said pipe 69 and extended through openings in and arranged within the muller head with the outlets above and adjacent to the muller shoe 27. By this arrangement as the pan is filled with water the admission or flow of water from the outlet pipes into the pan sets up an upward flowing current of the water in the pan, which upward flow is further augmented by the gyratory movement of the muller shoe. The ore as it is pulverized mixes with the water forming a pulp and this induced upwardly flowing current of water will float the pulp causing the spilling of the same from the pan in the overflow of the water therefrom, this overflow of the pulp from the pan being to the trough formed by the flanges 9 of the base member B from which it is drained by the pipes 10, the material in the trough being directed to the outlet pipes by paddles 75 fixed to the portion of the pan overhanging the inner trough forming flange 9, said paddles extending into the trough and being rotatable with the pan.

The die 24 is of less width then the pan and is retained in position in the pan relative to the muller shoe by spaced members 71, 72 of suitable material, such as wood, interposed between the die and flanges of the pan head 12, said spacing members being arranged with recesses in the top to form channels at opposite sides of the die. As is well known the metallic content of ore is of greater specific gravity than the rock content with the result that the metallic content will gravitate to the bottom of the pan and the more buoyant or lighter and non-metallic content will readily mix with the water to form a pulp, and the force of the flow of water into the pan may be so regulated that the more buoyant and lighter particles are floated off from the pan and the heavier metallic content gravitates to the bottom and collects in the channels in the spacing members, and said channels may carry a suitable material therein, such as mercury, to form an amalgam with said metallic content.

To prevent wear of the pan cylinders 13, 16 and a consequent frequent renewal thereof, a wear resisting surface is provided for said cylinders, comprising sheet metal bands 73, 74 arranged in contiguous relation to said cylinders adjacent the bottom of the pan.

The pan with the muller may be enclosed in a suitable housing, shown as consisting of a drum 76 mounted upon and extending upward from the base member B and a plate 77 secured upon said drum having a central opening for the passage of the muller head.

To lubricate the operative parts an annular chamber 78 is arranged in the top of the hub 42 of the gear supporting plate 43 to extend about the bearing of the gear hub therein, a pipe 79 connected with a source of lubricating supply being connected to said chamber. The surplus lubricant will drip from the gear bearing and be collected in an annular recess 80 in the top of the hub of the muller head, a duct 81 leading from said recess to the bore of the hub and the bearing of the shaft 30 therein, the lubricant flowing from said bearing to the bearing 33 of the shaft in the bearing box 36. If desired, the latter bearing of the shaft may be packed with grease not only assuring the lubricant of said bearing members but also obviating the necessity of frequent lubricant of said bearing.

Means are provided to indicate the quantity of material confined between the crushing members, comprising a gauge member 79 secured in the upper end of the shaft 30 and extended through an opening in an extension of the bearing member 47, said gauge member being moved by the longitudinal movement of the muller shaft relative to a pointer 80 adjustably mounted on said extension of the bearing 47.

It will be obvious that various modifications may be made in construction and arrangement of parts, and that portions of the invention may be used without others, and come within the scope of the invention.

Having thus described my invention I claim:

1. In comminuting apparatus, a pair of superposed annular crushing members one supported from the other, and actuating means therefor operative to gyrate one member and progressively move successive portions of said member into and out of engagement with the other member and simultaneously rotate the other member in a direction opposite to the gyratory movement of the gyratory member to simultaneously exert crushing and attrition forces on material between the crushing members.

2. In comminuting apparatus, a pair of superposed crushing members one of which members is arranged with an annular crushing face and rotatable in a horizontal plane and the other member having an annular

crushing face opposed to the crushing face of and supported by the rotatable member and gyratory in a direction opposite to the direction of rotation of the rotatable member, and means to gyrate the gyratory member to progressively move successive portions of the gyratory member toward and away from the rotary member during the rotation of the latter and exert a crushing force on material between the crushing faces of the members and rotate the rotary member to simultaneously exert an attrition force on such material.

3. In comminuting apparatus an annular die rotatable in a horizontal plane, a head arranged with an annular shoe, means to support said head concentrically-eccentrically of and to have movement toward and away from the die with the shoe in opposed relation to the die, means to rotate the die in one direction and gyrate the head with the shoe in a direction opposite to the rotation of the die, and means to yieldingly urge the gyratory crushing member in a direction toward the rotary crushing member.

4. In comminuting apparatus, a rotary annular crushing member, a second annular crushing member located above the first crushing member, a pair of bearing members arranged concentric of the first crushing member, the second crushing member being concentrically mounted in one of said bearing members and eccentrically mounted in the other bearing member, and means to rotate the eccentric bearing to impart gyratory movement to the second crushing member in one direction and rotate the first crushing member in the opposite direction.

5. In comminuting and classifying apparatus for ore and the like, a rotatable pan, a die mounted in and rotatable with the pan, an annular shoe located above the die in the pan, a pair of bearing members arranged coaxially of the pan and die, a shaft mounted concentrically in one of the bearing members and eccentrically in the other bearing member, means to mount the shoe upon the shaft, and means to rotate the pan with the die in one direction and the eccentric bearing member in the opposite direction to gyrate the shaft and shoe carried thereby in a direction opposite to the rotation of the die with the pan.

6. In comminuting and classifying apparatus as claimed in claim 5, means for supplying liquid to the pan to effect an upward current of liquid with comminuted material in the pan and overflow thereof from the pan.

7. Comminuting and classifying apparatus as claimed in claim 5, wherein the shoe carrying shaft is eccentrically mounted in the one bearing member by a diaphragm to effect gyratory movement of the shaft with the shoe through the rotation of said bearing member.

8. Comminuting and classifying apparatus as claimed in claim 5, wherein the pan is of annular form, a fixed support in which the pan is rotatably mounted, said support having a pillar extending axially through the pan and in which the concentric bearing member for the shoe carrying shaft is mounted.

9. In comminuting and classifying apparatus as claimed in claim 5, a fixed support in which the pan is rotatably mounted and in which the concentric bearing member for the shoe carrying shaft is mounted to have axial movement, and a spring confined between said bearing member and a fixed part of the support to yieldingly urge the shaft with the shoe axially in a direction toward the die.

10. In comminuting and classifying apparatus as claimed in claim 5, a fixed support in which the pan and concentric bearing member for the shoe carrying shaft is mounted, said support being arranged with an annular trough extended about and to receive the overflow from the pan and having outlet means.

11. Comminuting and classifying apparatus as claimed in claim 5, wherein the pan is arranged with channels in a plane below the die to receive the metallic contents of the comminuted ore and adapted to carry a material to form an amalgam with said metallic contents.

12. In comminuting apparatus, an annular crushing member supported for rotation in a horizontal plane, an annular crushing member arranged above and supported by a portion thereof from the rotary member to have gyratory movement relative to said rotary member, means to gyrate the gyratory member about the axis of the rotary member to progressively move successive portions of said member out of and into engagement with the rotary member and simultaneously rotate the rotary member in a direction opposite to the direction of the movement of the gyratory member to simultaneously exert crushing and attrition forces on material between the crushing members.

13. In comminuting apparatus, an annular crushing member rotatable in a horizontal plane and having a crushing face of concave form in cross section in the upper face, an annular gyratory crushing member superposed to the rotatable crushing member having a crushing face of convex form in cross section opposed to the concave crushing face of the rotatable member and gyratory in a direction opposite to the direction of rotation of the rotatable member, and means to simultaneously rotate the one member and gyrate the other member.

14. In comminuting apparatus, a pair of superposed crushing members, one of which members has an annular crushing face and rotatable in a horizontal plane and the other

member having an annular crushing face opposed to and supported by the crushing face of the rotatable member, means to mount said latter member concentrically-eccentrically of the rotary member, and means to rotate the eccentric mounting of said latter member to gyrate said member about its concentric mounting and progressively move successive portions of the crushing face thereof into and out of engagement with successive portions of the crushing face of the rotatable member and rotate the rotary member in the opposite direction and at a lower speed than the gyratory movement of the other member.

15. In ore reducing and classifying apparatus, a pan rotatable in a horizontal plane arranged with an annular crushing member of a width less than the width of the pan and with the crushing face above the bottom of the pan and having a channel concentric of and contiguous to the crushing member and below the crushing face thereof, a crushing member having an annular crushing face superposed to the crushing face of the crushing member in the pan and mounted concentrically-eccentrically of the pan, and means to rotate the pan with the crushing member carried thereby in one direction and gyrate the other crushing member in the opposite direction.

Signed at Los Angeles, in the county of Los Angeles and State of California, this 18th day of December, 1928.

FRANK C. PEREW.