Feb. 28, 1939. H. F. CAMPBELL 2,148,682

CRUSHER

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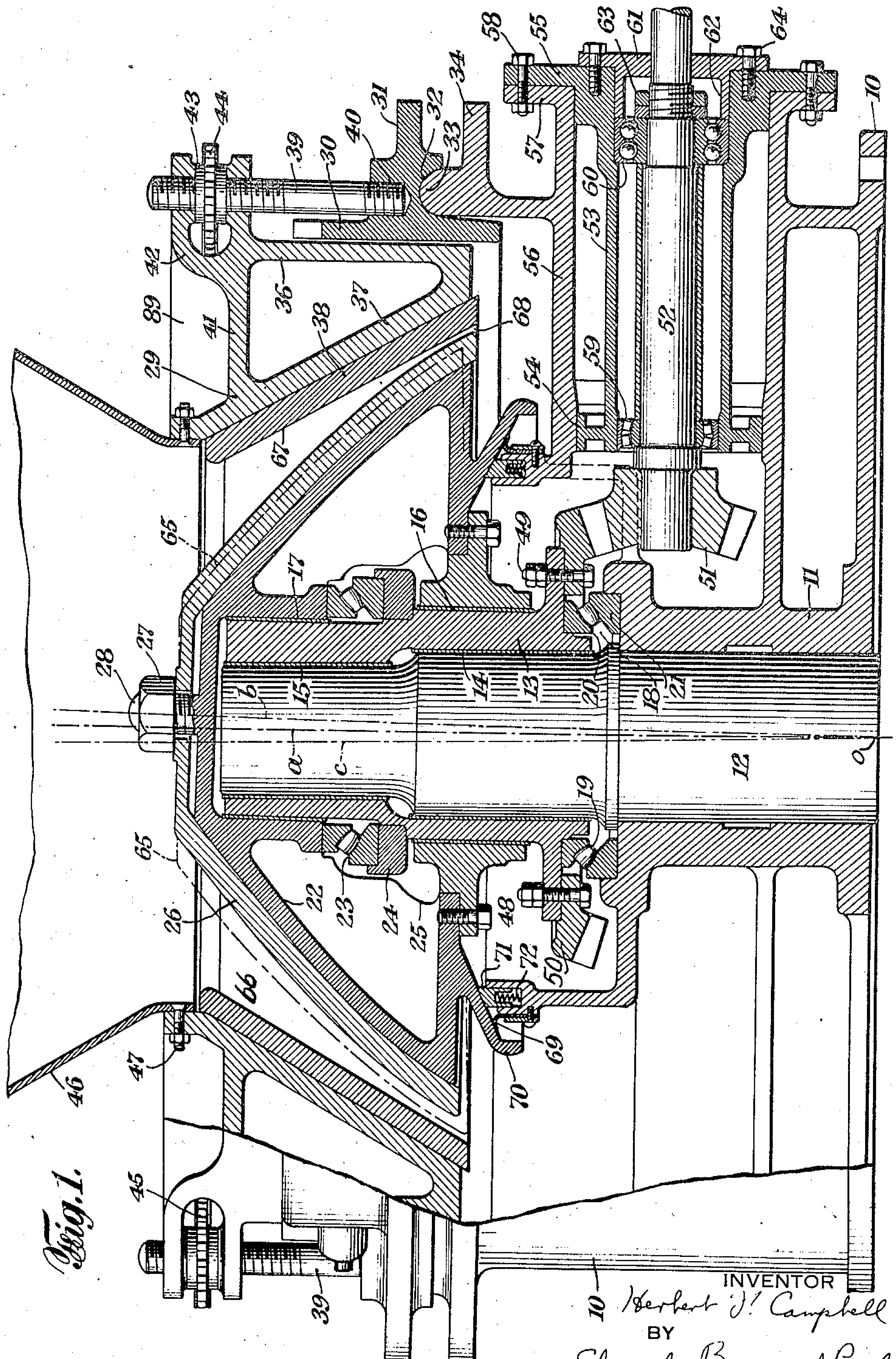

Fig. 1.

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Fig. 2.

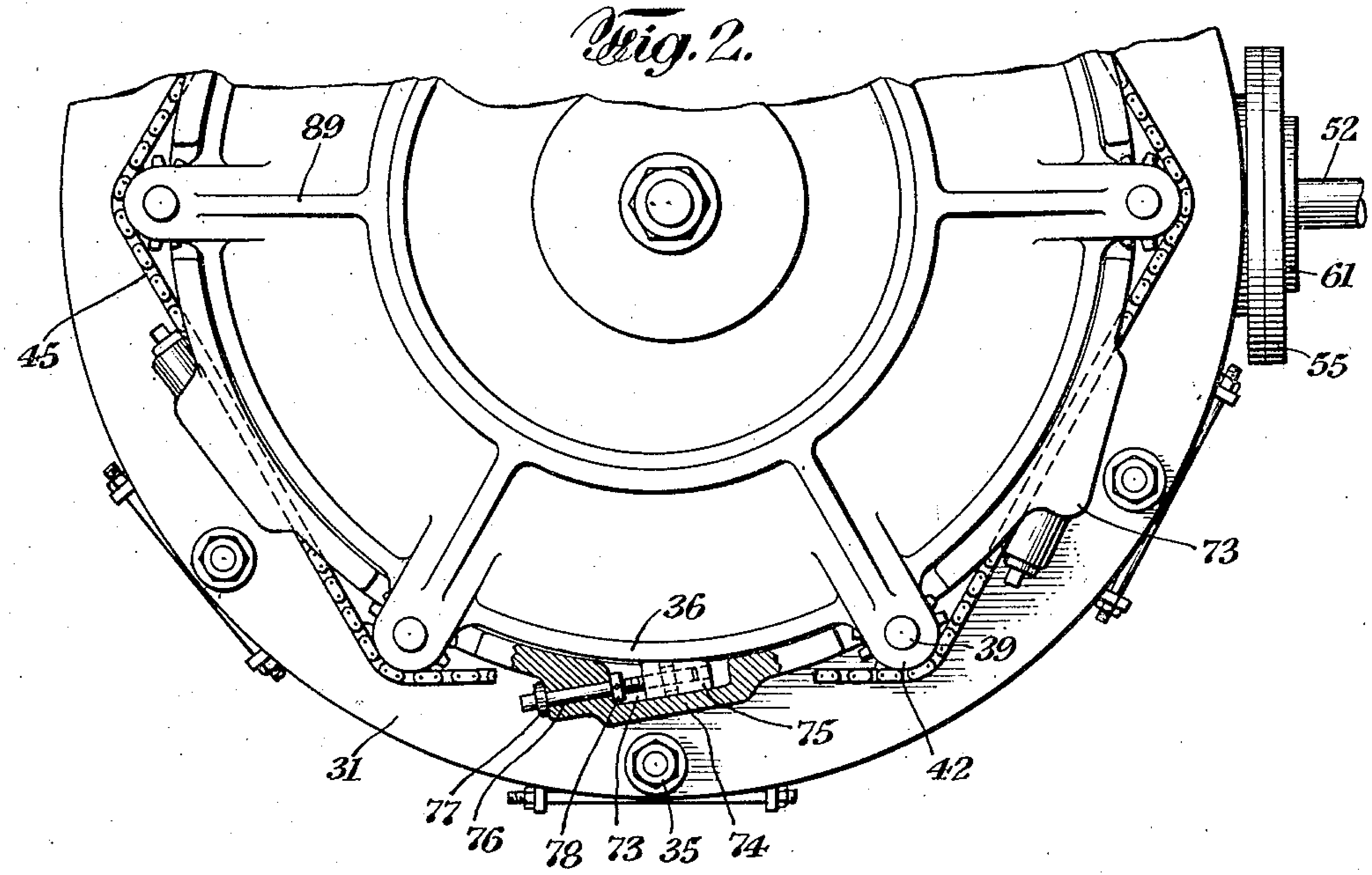
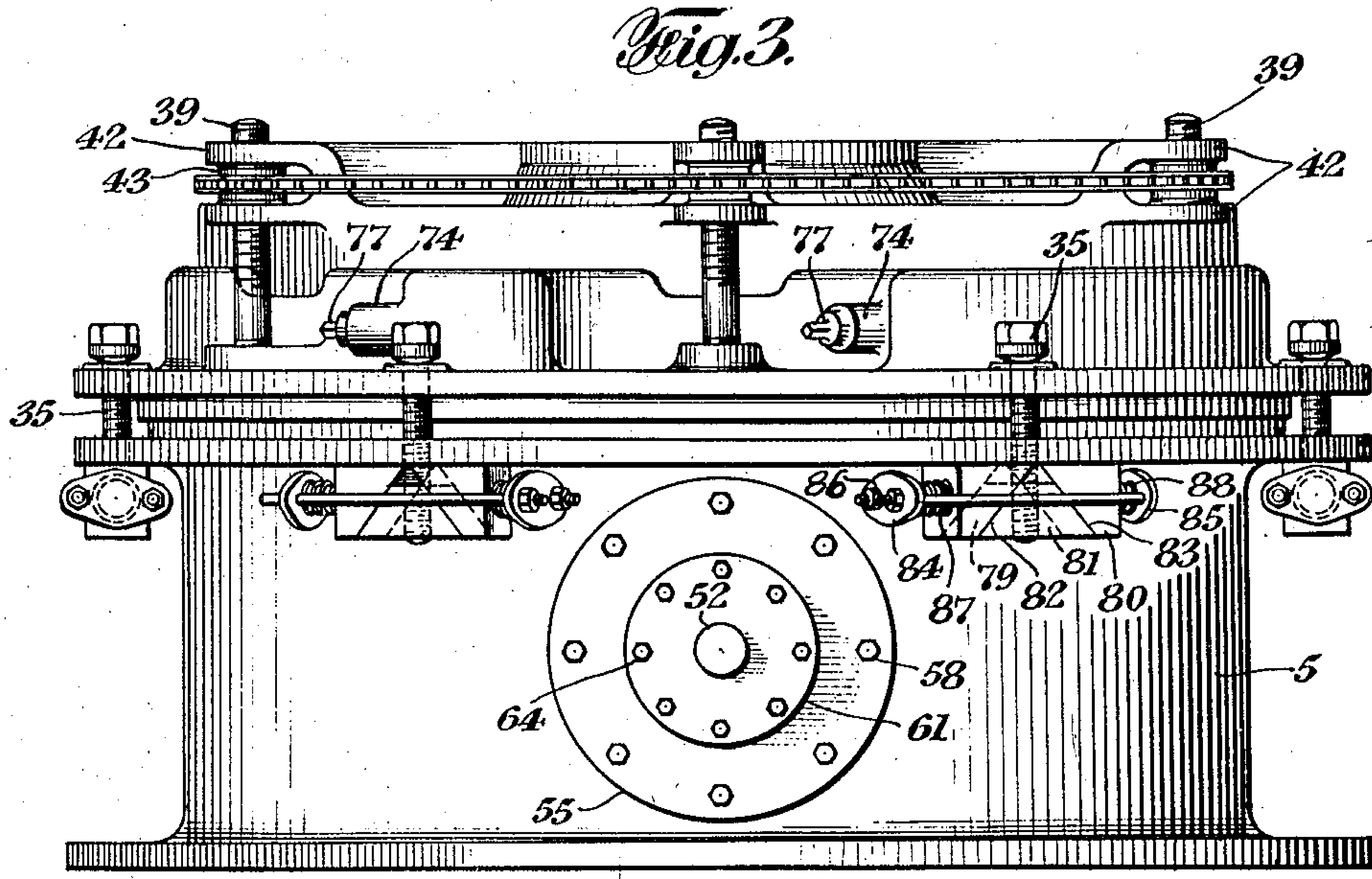


Fig. 3.



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CRUSHER

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7 Claims. (Cl. 83—10)

This invention relates to crushing equipment, and more particularly to machines adapted to crush such material as ore or stone.

The principal object of this invention is to provide relatively inexpensive crushing apparatus which is economical in operation and which produces a highly uniform crushed product.

The above objects are attained according to this invention by the provision of a crusher of the so-called cone gyratory type wherein a crushing member or head is caused to gyrate within a surrounding wall, and the material is crushed in a tapering cavity between the head and the wall by the gyration of the head. Gyratory crushers of this general type are well known in the art.

The crushers constructed according to this invention differ from those previously known, in the novel kind of gyratory motion imparted to the crushing member with respect to the surfaces between which the material is crushed and the direction in which the material is fed through. More particularly, the crushing member is caused to deliver a crushing impact in the direction of the surrounding wall with a component in the feeding direction of the material. When the crushing member is retracted from a crushing position, it is given a component of motion in the direction opposite the feeding direction of the material.

The material to be crushed is fed into the crushing cavity from a position above the crushing head and it slips along the outwardly and downwardly flaring wall of the head until it receives a crushing impact against the surrounding wall by the gyration of the head. The downward component of this impact tends to push and roll the crushed material further along its path of feed. Then when the crushing head is retracted from a crushing impact the crushed material resumes its downward slide between the walls of the crushing cavity. This crushing and sliding of the material is repeated until the crushed material completes its journey between the cavity walls and drops to a pit or receptacle below.

A feature of the invention resides in a novel arrangement for supporting the crushing head on a rotating eccentric for creating the peculiar gyrating motion.

The invention will be better understood from the following detailed description of a specific embodiment and the accompanying drawings, of which:

Fig. 1 illustrates a front elevation, mostly in section, of a crushing machine embodying this invention:

Fig. 2 illustrates a top view of the machine partially broken away; and

Fig. 3 is a side elevation of the same machine.

The machine is constructed on a frame 10, the outline of which is generally cylindrical in form. The frame will ordinarily be made of a tough metal and provided with webs at appropriate places, as shown in Fig. 1, to provide strength and rigidity. Centrally located within the frame and rigidly supported by radial webbing is a sleeve 11 into which is force-fitted the lower end of a vertical shaft 12. An eccentric sleeve 13 having inner bearing surfaces 14 and 15 and outer bearing surfaces 16 and 17, preferably of Babbitt metal, is mounted on the shaft 12. The use of double bearing surfaces on each circumference of the eccentric permits the use of greater total bearing surface than if single cylindrical bearing surfaces were used, because for any given size of crushing head (described hereinafter) the lower one of each double bearing may have a greater diameter than the upper one. The eccentric sleeve 13 is supported above the frame sleeve 11 by a roller step bearing 18, comprising rollers 19 and roller guides 20 and 21.

Mounted on the outer bearings 16 and 17 of the eccentric is a crushing head 22, approximately conical in shape. The head is supported vertically on a roller step bearing 23 which is supported by a collar 24 rested on a supporting ledge of the eccentric sleeve. The head is strengthened by a number of vertical radial webs 25. A jacket 26, providing the crushing surface, or wall, of the head, is placed snugly over the head 22 and firmly fastened by a nut 27 threaded on a stud 28 which projects from the head member 22 upward through a hole in the jacket. The diameter at the lower end, or skirt, of the head, including the jacket, may conveniently be about 60 inches.

Overhanging and surrounding the crushing head is a heavy mantle 29 supported by a solid ring 30 which is provided with a flange 31 having an annular recess 32 which registers with, and is supported by, an annular protuberance 33 of a flange 34 integral with the frame 10. The band 30 is clamped down to the flange 34 by a number of studs 35 (Figs. 2 and 3) extending through the flanges 31 and 34 at intervals. These studs are fastened below the flange 34 in a manner which will be described hereinafter. The outer circumferential wall 36 of the mantle is in the form of a cylinder which fits within the band 30. The inner wall 37 of the mantle is in the form of a frustrum of a cone of which the apex is at the top. A horizontal wall 41 joins walls 36 and 37 at the top. An inner jacket 38 is tightly fitted within the conical wall 37 and securely held by any suitable means such as screws (not shown).

Means is provided for adjusting the height of the mantle relative to the frame and to the crushing head 22. This means comprises a number of vertical studs 39 the lower ends of which are tightly threaded into tapped holes 40 provided at spaced intervals around the flange 31. Directly over each of the tapped holes 40 and integral with the walls 36 and 41 are a number of horizontally bifurcated lugs 42 provided with holes through which the upper ends of the studs 39 easily slide. These lugs are reinforced by means of radial webs 89. A regulating nut 43 is threaded on each stud between the bifurcated portions of the associated lug 42 for the purpose of regulating the vertical position of the mantle. For convenience in making the adjustment each of the nuts 43 is provided with sprocket teeth 44 which engage with a suitable endless sprocket chain 45. Movement of this chain turns all the regulating nuts 43 simultaneously in the same direction, thereby uniformly raising or lowering the entire periphery of the mantle.

To facilitate this adjustment the solid band 30 is provided, at its inner periphery adjacent the mantle walls 36, with a series of wedge shaped pockets 73 formed within pocket housings 74, spaced around the circumference of the band. Each of these pockets contains a wedge 75 positioned between the walls of the pocket and the mantle wall 36. A bolt 76, positioned by its outer head 77 and by a thrust collar 78 within the pocket, is threaded into a tapped hole in the wedge. The band 30 is locked to the mantle wall 36 by turning bolts 76 to force the wedge into closer contact between wall 36 and the wall of the pocket. When the height of the mantle is to be adjusted, the wedges 75 of the band 30 are first loosened, after which the mantle may be readily raised or lowered. When the proper adjustment is had the wedges are then tightened again.

A funnel-shaped feed hopper 46, into which is fed the material to be crushed, is fastened to the upper rim of the mantle by bolts 47.

For the purpose of gyrating the crushing head there is fastened to a lower flange 48 of the eccentric 13, by bolts 49, a bevel ring gear 50 adapted to be driven by a bevel pinion 51 fastened to a drive shaft 52. The drive shaft and pinion are carried by a housing member 53 having a webbed flange 54 at the inner end and a straight flange 55 at the outer end. The housing 53 is held within a larger housing 56 integral with the main frame 10 by forcing the flange 54 within a restricted portion of housing 56 and bolting flange 55 to a corresponding flange 57 by bolts 58.

The drive shaft 52 is mounted in the housing 53 by a roller bearing 59 near the inner end, and a ball thrust bearing 60 near the outer end. The outer portion of the roller casing of bearing 59 is driven within the end of housing 53 and the inner portion of the casing is forced onto the shaft 52. The ball race of bearing 60 is held in place by a cover plate 61 having a cylindrical portion 62 which holds the outer part of the ball race in a recess in the housing, and by lock nuts 63 which lock the inner part of the ball race in position. The cover plate 61 is provided with a central hole to permit the shaft to pass through, and is fastened over the open end of housing 53 by bolts 64.

This arrangement of the drive shaft housing keeps dust and grit away from the pinion and drive shaft bearing, and also permits the entire drive shaft assembly to be removed for repairs or inspection.

To aid in keeping dust away from the bearings and gears there is fastened to the under part of the frame an annular ring 69 of a tough flexible material, such as leather, which makes contact with an outwardly depending circular fin 70, attached to the under side of the head. The frame also carries an oil retaining ring 71 held against the fin 70 by spring 72. The oil system of the machine is not shown.

In operation, the drive shaft 52 is rotated by an external source of power (not shown), thereby causing the eccentric 13 to rotate on shaft 12. The rotation of the eccentric causes the crushing head 22 to gyrate; and the axis of the gyration is a point O (Fig. 1) which is below the crushing head and is at the intersection of the longitudinal axes of the shaft 12 and of the eccentric sleeve 13. In Fig. 1, line a is the center line, or axis, of shaft 12 and of the inner eccentric bearing; and line b is the axis of the outer eccentric bearing, and of the crushing head, in the position shown, wherein the head is nearest to the right hand side of the mantle. When the eccentric is rotated 180 degrees from the position shown in Fig. 1, however, the gyration causes the crushing head to assume the position indicated by the broken line 65, in which position the head is nearest the left side of the mantle. The axis of the head and of the eccentric in this latter position is indicated by the broken line c. It is evident that for each rotation of the eccentric the point of closest proximity of the head to the mantle jacket sweeps through the entire 360 degrees of the mantle circumference.

It is observed that the surface of jacket 26 curves downward slightly toward the lower portion or skirt thereof to become practically parallel with the inner wall of the mantle. The angle which the jacket surface makes with the axis of the cone is preferably approximately 45 degrees at the upper portion thereof, but at the lower 20 to 30% of the surface this angle decreases. This shape provides a very gradual downward taper of the crushing cavity walls; and the spacing between the balls of the crushing cavity for some distance from the lower end is substantially uniform. This distance of substantially parallel spacing at the bottom is preferably 20 to 30 per cent of the cavity depth; and parallel walls in this region cause the total cross section area to increase toward the bottom. In any event it is desirable that the total cross section area shall not decrease toward the bottom.

Let us consider, for the moment, the movement of the portion of the head adjacent some one part of the inner mantle wall, for example, that portion of the head adjacent the portion 67 of the mantle wall which is shown at the extreme right in Fig. 1. When the head is in the position indicated by the broken line 65 it is in its most retracted position, and is somewhat raised, with reference to the mantle wall portion 67. Then while the eccentric rotates 180 degrees the head approaches the wall portion 67 with a downward component of motion until it reaches the position shown in full lines, at which it is in closest proximity to the wall portion 67. Then, when the eccentric continues to rotate through another 180 degrees the head is retracted from wall portion 67 with an upward component of motion until the head returns again to the position shown by the broken line 65. The action just described takes place successively with reference to succeeding portions of the inner mantle wall, throughout its 360 degrees periphery.

The material to be crushed is fed into the hopper 46, from where it drops onto the crushing head and starts to slide down the outwardly slanting wall thereof. After the material has slid down a short distance, the larger lumps or masses of the material are crushed into smaller masses by the impact created when these lumps are caught between the crushing head wall and the inner wall of the mantle jacket, as the head approaches a portion of the mantle wall.

When the head retracts after having delivered the impact, the material continues to slip down and spread out on the flaring wall of the head along a course bounded by the adjacent head and mantle walls, until another impact is delivered by the head. After each succeeding impact the crushed material becomes smaller and slides along and spreads out into an area of the tapered cavity 66 having a smaller spacing between its walls.

The final size of the crushed product is determined by the spacing between the walls at the lower end of the crushing cavity at 68, when the head is in its position closest to the mantle. The substantially uniform spacing between the walls of the crushing cavity at and near 68 facilitates the ejection of the crushed material and tends to prevent clogging. The ejected material drops into a pit below the crushing head.

When the head is delivering a crushing impact its downward component of motion in approaching the mantle tends to push the material further downward in the direction in which it is being fed through the crushing cavity. But when the head retracts from the mantle the upward component of motion causes the sloping wall of the crushing head to lift somewhat and to become somewhat more horizontal, thereby tending to maintain it in more effective contact with the sliding material. This lifting effect is more pronounced the more gradual the slope of the head wall, and tends to prevent clogging by slowing down the rate of sliding in the upper region of the crushing cavity.

The downward component of the head in delivering the impact tends to crush the material so that the shape of the different crushed masses is more uniform. Such a crushing action accounts for the greater uniformity of the product of this machine relative to that of many prior crushing machines which deliver too sharp an impact or tend to roll the material upward away from the discharge.

Wherever the cone is gripping the material against the mantle or anvil it is at the same time moving its surface down in the direction of the outlet of discharge. As the cone recedes from the crushing action, its surface is moved progressively upward away from the outlet and preferably the relations are maintained such that while the material may move downward out of contact with the anvil during this retractive movement of the cone, the pieces of material will remain close to the cone surface and will slip or tumble downward thereon to new positions for crushing against other lower points of the anvil.

This gives a continuous downward feed of the material during both the crushing and the relief periods and there is no counter movement upward of the material at any part of the operation. Since the crushing head is not required to exert a lifting force on the material there is obtained a corresponding economy in required horsepower.

The location of the gyratory center O below the base of the cone gives a larger crushing movement to the surfaces which are further separated and are receiving the largest pieces of material. Consequently, the largest crushing forces are brought to bear on the larger pieces of material, and the relative component of movement between the cone and the anvil in the direction normal to the anvil surface becomes progressively less as the pieces of material decrease in size.

From the foregoing, it is apparent that one impact is delivered against each portion of the mantle for every revolution of the eccentric sleeve 13. It has been found that in the type of machine described an eccentric speed of about 350 revolutions per minute results in a smooth sliding and crushing action and delivers a very uniform product. The yield, at this speed is also very satisfactory.

The size of the crushed product can be regulated by raising or lowering the mantle by means of the sprocket nuts 43, thereby increasing or decreasing the cross section of the crushing cavity.

To take care of uncrushable material, such as iron, which might find its way into the crushing cavity there is provided means for permitting the mantle to be lifted when the crushing head strikes such material. This means is the arrangement for fastening bolts 35 under flange 34. The fastening arrangement comprises triangular prisms 79 and 80, (cut off somewhat at the lower edges) having a right angle, and a frustrum of a triangular prism 81. The prism 81 is centrally tapped to receive the bolt 35, as shown. The prisms 79 and 80 are positioned so that one side of each lies against the under surface of flange 34 and the hypotenuses register with the equal surfaces 82 and 83 respectively of prism 81. The prisms 79 and 80 are held in position by spring heads 84 and 85 held by stay-bolts 86, as shown. Springs 87 and 88 are held in compression, in recesses, between each spring head and the end face of the adjacent prism.

When a piece of uncrushable material enters the crushing cavity, the impact of the crushing head on it causes the mantle to rise. When the mantle rises the prism 81 is pulled upward by the bolt 35, and the surfaces 82 and 83 slide on the surfaces of prisms 79 and 80 and push these latter two prisms apart against the compression of springs 87 and 88. When the uncrushable material has passed through, the mantle is drawn down into position again by its own weight and by the action of the springs.

Although in the crusher described herein the axes of the inner and outer eccentric bearings are shown to intersect at point O below the head it will be understood that the point of intersection may be varied and may be shifted downward even to the extent of bringing the axes substantially parallel. The shaft and eccentric arrangement also permits the point of intersection to be brought above the cone, if desired.

The construction of the crusher is simple, rigid, durable, and inexpensive. The central stud shaft 12 is strongly supported and stiff against flexure in service. The crushing reaction is transmitted partly to the bearing surfaces of the eccentric, but the component of the various loads is delivered largely to the roller thrust bearing 18. Hence, the load is delivered to a relatively very low point on shaft 12. All of the parts are permanently dust-tight and accessible for thorough lubrication. The pinion drive is easily disconnected and removed for inspection, replacement and repair, without exposing any of the interior driving mechanism to the dust laden air of the discharge chamber.

I claim:

1. A gyratory crusher comprising a vertical shaft, an eccentric sleeve mounted on said shaft by a bearing, a substantially conical-shaped crushing head, mounted on said sleeve and having a wall flaring in an outward and downward direction at a wide angle from the axis of said sleeve, the axes of said shaft and of said sleeve intersecting at a point below said head, a substantially conical-shaped mantle, having its apex above, overhanging said head, said crushing head having an upper portion which approaches the mantle wall and having a lower skirt portion which curves downwardly, becoming parallel with said mantle wall, and means for rotating said eccentric sleeve, whereby said head gyrates and approaches points on said mantle with a downward component of motion every time said sleeve makes a revolution.

2. A gyratory crusher comprising a crushing head having a crushing wall which is approximately conical in shape and flares in a generally outward and downward direction at an angle of about 45 degrees with the vertical, a mantle overhanging said head having an inner wall which also flares in a generally outward and downward direction and is approached by said crushing wall toward the lower skirt of the latter, said walls becoming substantially parallel at said skirt, means for feeding material to be crushed between said walls and means for gyrating said head about a point below the latter so that said crushing wall successively approaches successive points around the circumference of said mantle wall, the distance of approach being less at the parallel region than at the converging region of said walls.

3. A gyratory crusher comprising a mantle in the shape of a conical frustum having its apex above and overhanging a crushing head, said crushing head having a crushing wall which is approximately conical in shape with the apex at the top and sloping for a substantial distance from the apex towards said mantle and making an angle of about 45 degrees with the axis of the head cone, and curving downward at the lower skirt thereof becoming substantially parallel with said mantle, means for feeding material to be crushed between said walls, and means for gyrating said head about a point below the head so that said crushing wall successively approaches successive points around the inner circumference of said mantle, the distance of approach being less at the parallel region than at the converging region of said walls, whereby material spreads out more thinly on said head as it proceeds in its direction of feeding and then is easily ejected by dropping downwardly past said skirt.

4. A gyratory crusher comprising a crusher head, means for supporting and gyrating the head, a cooperating mantle, means for maintaining the mantle in yieldable operative relationship to the head arranged to permit passage of uncrushable material between the mantle and the head comprising a fixed support, a movable support carrying the mantle, and a series of independent resilient connecting members between said fixed and movable supports, each member comprising a vertical movable wedge and cooperating relatively movable wedges yieldably maintained in engagement with said first named wedge.

5. A gyratory crusher comprising a crusher head provided with an outwardly and downwardly crushing face, means for supporting and gyrating the head comprising a central shaft member, an eccentric sleeve rotatably mounted thereon by upper and lower bearings, an upper radial bearing for the upper part of the crushing head carried by the sleeve, a spaced radial bearing for the lower part of the crushing head carried by the sleeve, and an intermediate thrust bearing between the sleeve and the crushing head and positioned between said spaced bearings.

6. A gyratory crusher as set forth in claim 5 in which the eccentric sleeve is supported by a thrust bearing around the central shaft.

7. A gyratory crusher as set forth in claim 5 in which the upper bearings of the eccentric sleeve are of smaller diameters than the corresponding lower bearings.

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