July 8, 1969 W. R. ALLEN 3,454,230

COMBINED CRUSHING AND ATTRITION APPARATUS AND METHOD

Filed Sept. 29, 1966 Sheet 1 of 2

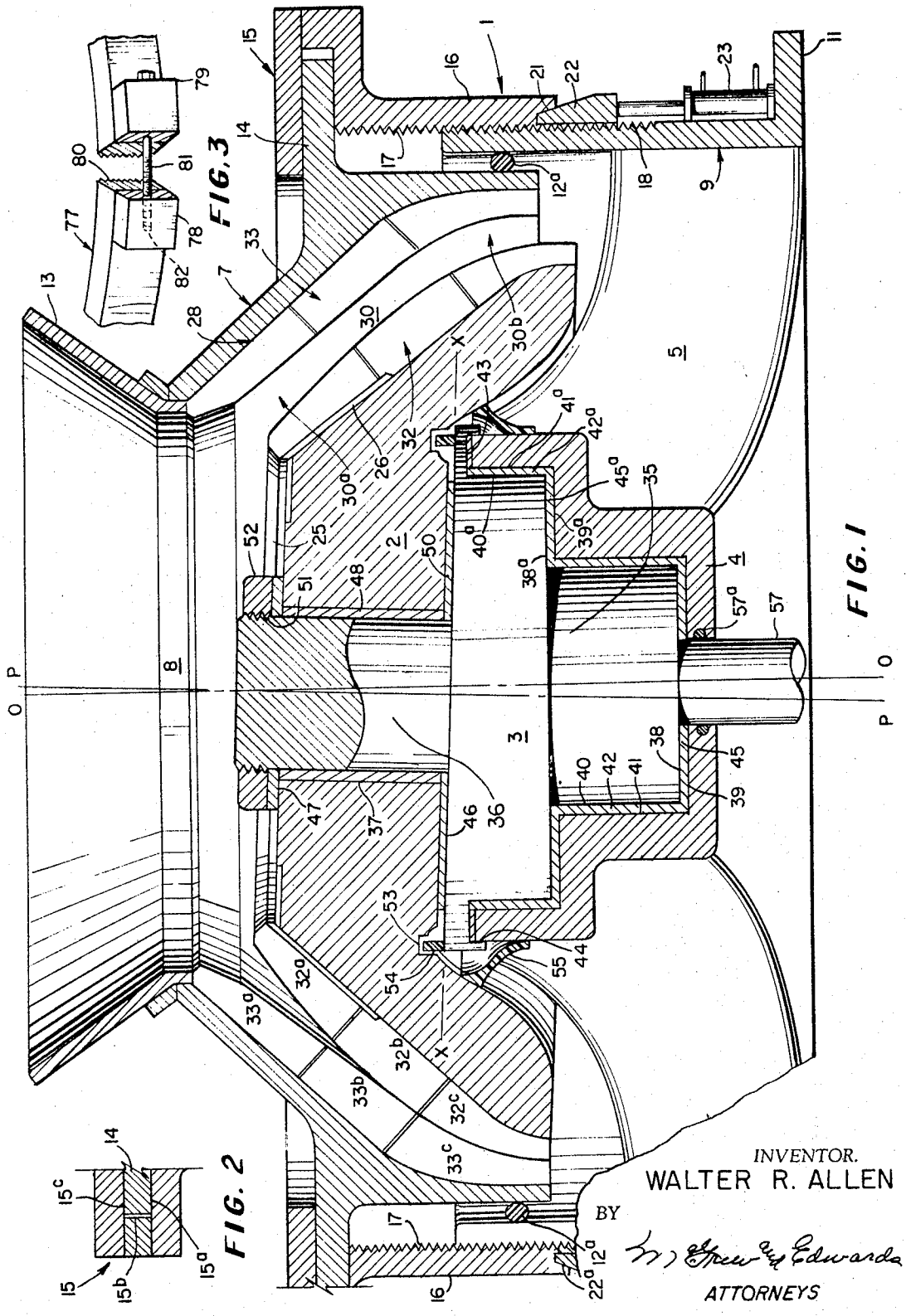


FIG. 1

FIG. 3

FIG. 2

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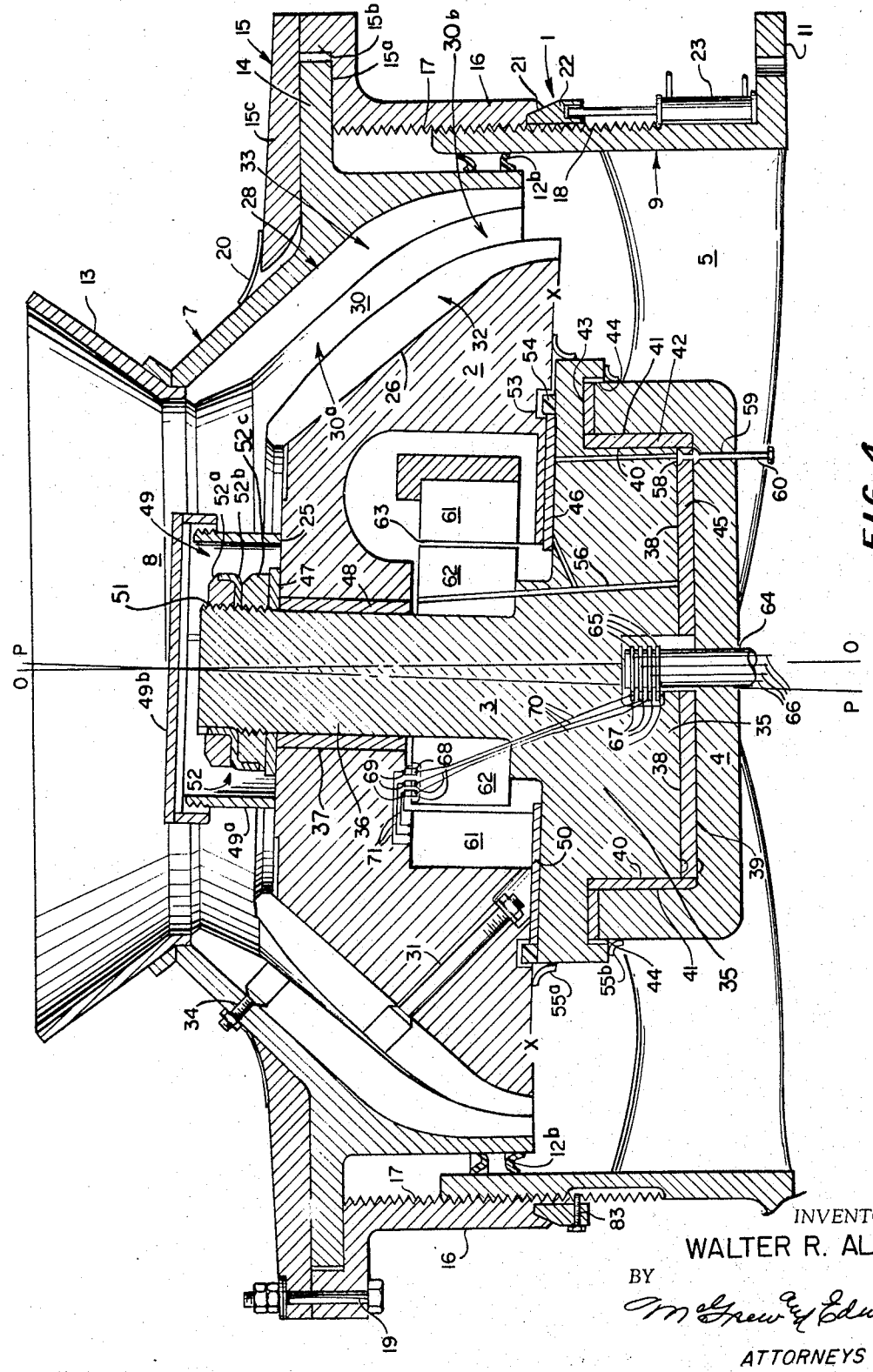


FIG. 4

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COMBINED CRUSHING AND ATTRITION APPARATUS AND METHOD

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U.S. Cl. 241—30 19 Claims

ABSTRACT OF THE DISCLOSURE

A gyratory crusher for the reduction of solid material wherein a stationary, upright housing for progressively passing a flow of solid material includes an inverted bowl having a generally central inlet portion forming an intake of the housing and lower side walls for confining material flow. The bowl is supported for both rotary and lateral movement on the housing, and a crusher rotor is disposed within the housing and mounted for gyratory rotation therein, the rotor and bowl member having outwardly and downwardly inclined facing surface portions defining a material treatment zone with the inclined surface portions of the rotor disposed in underlying relation to the inclined surface portions of the bowl member. A rotor liner assembly and a bowl liner assembly are provided whereby the outer surfaces of the rotor liner assembly move in close clearance with the facing surfaces of the bowl liner assembly at points in each cycle of revolution and material introduced through the central inlet is subjected to a progression of impacts in the upper portion of the treatment zone and substantially continuous attrition in the lower portion of the treatment zone during the graviational and mechanically assisted descent of the material to a point of discharge at the lower end of the treatment zone.

This invention relates to gyratory crushers suitable for the treatment of dry or wet feeds of the type disclosed in my copending application Ser. No. 353,056 filed Mar. 19, 1964, which issued Apr. 4, 1967, as U.S. Patent No. 3,312,404.

Gyratory crushers have been used primarily for the size reduction of various types of solid materials and particularly for the size reduction of ores and the like. In my earlier above referred to application there was described method and apparatus which among other things provided first an impact action and then an attrition action in the upper and lower portions of the crushing zone, respectively, to produce substantial size reduction in a single-pass crushing treatment zone. In addition there was described the support of various portions of the crusher assembly and particularly the overhanging inverted bowl member for free idling movement during the crushing action. The present invention is directed to related crusher apparatus and the method disclosed therein providing benefits in the size reduction of various types of solid materials.

Accordingly it is an object of this invention to provide a simple, compact, durable, and efficient crushing and attrition grinding apparatus which has a high capacity and high reduction ratio for materials being treated and suitable for either attrition grinding or a combination of crushing and attrition in varying degrees.

Another object of this invention is to provide a single-pass treatment for the size reduction of various types of solid materials within a size range usually attained by a fine crushing stage such as a tertiary stage followed by further size reduction to the flotation size range, for example as in a rod mill stage or the like.

It is a further object of this invention to provide an improved crusher and grinding assembly having free movement between the supporting structure for the crusher surfaces to reduce friction and wear during the crushing and grinding and permit control of the product over a wide range of sizes.

Still another object of this invention is to provide a novel combination crushing and grinding method which produces an extra fine and very uniform size product.

It is still a further object of this invention to provide a novel crusher apparatus having an internal drive for driving the crusher directly without the necessity of gearing and the like.

Other objects, advantages, and capabilities reside in novel details of construction and novel combinations and arrangements of parts all of which will be set forth in the course of the following description. In the accompanying drawings in which like numerals are employed to designate like parts throughout;

FIG. 1 is a developed sectional view of a crusher embodying my invention having an external drive and which is generally symmetrical about a vertical axis of the housing and shown with a portion of one side of the assembly broken away;

FIG. 2 is a fragmentary section of the flange and flange encompassing member which is broken away from FIG. 1, showing one limit of lateral movement of the bowl flange;

FIG. 3 is a perspective view of a portion of an alternative form of ring for rigidly securing the flange member to the side wall member; and

FIG. 4 is a vertical sectional view of another form of crusher embodying my invention having an internal drive and which is generally symmetrical about a vertical axis of the housing.

Referring now to the drawings there is shown two forms of gyratory crushers in FIG. 1 and FIG. 4 each of which is general comprise an upright stationary housing **1** through which solid material being treated is passed. A movable rotor or gyratory head member **2** is disposed within the housing **1** and is mounted on a movable drive member **3** which seats on a stationary base or pedestal member **4**. Base member **4** is secured across the bottom of the housing by a plurality of radially extending webs **5** which provide spaces for passing the treated material from the housing **1**. Rotor **2** may be actuated by various types of motor drive means, herein illustrated as an external drive arrangement (FIG. 1) and an internal drive arrangement formed in rotor **2** (FIG. 4), each of which drives the rotor **2** in a gyratory path in a manner described more fully hereinafter.

More specifically, housing **1** includes an inverted bowl member **7** having a central inlet aperture **8** forming an intake at the top of the housing through which material to be treated is initially passed and a lower side wall member **9** for confining material flow after crushing which terminates in a flanged end portion **11** at the bottom for seating the crusher asssembly in an upright position on suitable support structure (not shown). An O-ring type seat **12***a* (FIG. 1) or flap type seal **12***b* (FIG. 4) is provided between adjoining surfaces of the lower end of the bowl member **7** and the upper end of the side wall member **9** to provide a seal during relative movement therebetween. A conical feed member **13** is secured to the bowl member **7** which extends upwardly from its intake aperture for directing an incoming feed of material into the housing.

The bowl member **7** is supported from the side wall member **9** by the combination of a circumferential flange **14** on the exterior surface of the bowl member **7** and a flange-encompassing member **15**. The flange-encompassing member **15** is provided with a depending lower portion

16 of greater diameter than the side wall member 9 which is supported from the upper portion of the side wall member 9 by a threaded coupling herein illustrated as machined threads 17 on the interior surface of portion 16 which thread onto machined threads 18 on the upper exterior surface of the side wall member 9 so that the elevation of the bowl member may be adjusted by threading the flange-encompassing member 15 up and down on the side wall member 9. Other threaded couplings are also suitable such as a ball bearing screw substituted for the machined threads.

The flange-encompassing member 15 includes an interior underlying surface portion 15*a* on which the flange 14 seats, an upright surface portion 15*b* in spaced relation to the end of the flange which limits the lateral movement of the flange and an overhanging surface portion 15*c* in closely spaced or in a close clearance relation to the top surface of the flange so as to substantially encompass the flange 14 and permit free rotary and limited vertical and lateral movement of the bowl member. A suitable lubricant may be provided on these wear surfaces. The overhanging surface portion 15*c* is preferably detachable from the upright surface portion 15*b* by a plurality of circumferentially spaced fasteners such as a bolt 19 (FIG. 4) or the like which permit removal of the bowl member 7 for inspection or repair of the liner members and may be used for the passage of tramp iron as hereinafter described. During the crushing treatment gyratory movement of the rotor and the impact of the material against the bowl member oscillates the flange 14 within the flange-encompassing member 15 so as to support the bowl member in an essentially free floating manner. A seal member 20 (FIG. 4) is preferably provided between the upper part of the bowl member 7 and the top surface of portion 15*c* to protect the interior surfaces of the flange from the deleterious effects of foreign matter.

The depending lower portion 16 has notched surfaces 21 at its bottom end to receive a wedge-shaped continuous ring 22 which encompasses the side wall member 9 and has inclined or tapered outer surfaces for engaging the notched surfaces 21. A force-applying member 23, preferably a double acting hydraulic cylinder, is supported on the lower flanged end 11 and moves upwardly to force the wedge ring 22 into engagement with the notched surface 21 for locking the flange-encompassing member 15 and the bowl member 7 at a selected elevation to maintain the treatment zone at a preselected gap setting.

Rotor head member 2 includes a generally flat top surface portion 25 disposed below and adjacent the central inlet portion 8 and an upper surface portion 26 which inclines outwardly and downwardly from the top surface portion 25 and the upper surface portion 26 is covered with wear members or a liner assembly 32 having wear surfaces corresponding in shape to surface portion 26. Surface portion 26 is disposed in underlying relation to an outwardly and downwardly inclining facing under surface portion 28 of the bowl member which is covered with wear members or a liner assembly 33 having an inner surface which conforms in general to surface portion 28 to define a restricted crushing treatment zone 30 bounded by adjacent or facing surfaces of the liner assemblies 32 and 33.

The spacing between these facing surfaces of liner assemblies 32 and 33 decreases from the intake to the discharge end of the zone to a minimum spacing at the discharge end. As is shown in FIG. 1, at one point in the cycle of revolution of the rotor the surfaces of the liner assemblies and the periphery of flange 14 move in close clearance relationship while at 180° therefrom there is a maximum spacing therebetween. The treatment zone 30 is generally divided into an upper portion 30*a* which is formed of generally linear or flat facing surface portions which are essentially surfaces of a frustum of a right circular cone and provide an impact action for initially reducing the larger material sizes and a lower portion 30*b* which is formed of arcuate or curved facing portions which provide an attrition action for further reducing the sizes resulting from the prior impact action.

The liner assemblies 32 and 33 are preferably split or comprise segmental portions which circumferentially span approximately 180 degrees of the associated rotor or bowl member. These segmental portions may be fastened together into an interlocking arrangement and are preferably detachably connected to the rotor 2 and bowl member 7 by circumferentially spaced fasteners 31 and 34, respectively (FIG. 4). For convenience of illustration, only one of each fastener has been illustrated in FIG. 4. The segmental portions of the liner assemblies are preferably arranged in tiers extending from top to bottom herein illustrated in FIG. 1 as 32*a*, 32*b* and 32*c* on the rotor 2 and 33*a*, 33*b* and 33*c* on the bowl member 7. These tiers of the segmental liners preferably are of materials of differing wear characteristics with the upper tiers having wear characteristics suitable for impact crushing and the lower tiers suitable for attrition or abrasion grinding. The lower tiers may be rubber or a rubber cover on a backing member or a plastic to provide the attrition or scoring action with a minimum of size reduction. In addition, the liner surfaces may be provided with a corrosion resistant surface such as porcelain or the like.

The rotor 2 is mounted for rotation on drive member 3 and associated support base member 4. Drive member 3 includes a lower base portion 35 and an upright shaft portion 36 which fits within a central aperture 37 in the rotor 2. The undersurface of the rotor is disposed in superposed relation to the upper surface of the base portion 35. The undersurface of the base portion 35 is disposed in superposed relation to the upper surface of base member 4. The base member 4 is generally cylindrical in shape and includes a flat bottom having an upper surface 39 and upright side walls having inner surfaces 41 and top and outer surfaces 44. The undersurface of the drive member base portion 35 includes a flat bottom surface 38 in superposed relation to the flat upper surface 39 of the support base member 4, upright side wall surfaces 40 which fit within the upstanding wall surfaces 41, and an upper portion having surfaces 43 which extend outwardly and downwardly in overhanging relation to the top and outer wall surfaces 44 of the base member 4. In the arrangement shown in FIG. 1 the base portion 35 is provided between its top and bottom with an intermediate step-like portion including a flat bottom surface 38*a* and side wall surface 40*a* in superposed relation to an intermediate flat upper surface 39*a* and upstanding intermediate wall surfaces 41*a* for added support of the drive member 3 within the base member 4. The undersurface of base portion 35 and upper surface of the base member may be made arcuate or spherical as shown in the above referred to copending application instead of cylindrical as shown with an associated spherical shaped bearing to more uniformly distribute the pressure on the bearing surfaces.

The flat upper surface 39 of the base member 4 is in a horizontal plane perpendicular to a vertical axis designated O—O which is the central axis for the housing and the axis about which the drive member 3 rotates. The upper surface 46 of the drive member base portion 35 is disposed in a plane inclined at an angle with the horizontal indicated along line X—X and the upright shaft portion 36 has an axis designated P—P perpendicular to the plane of line X—X and is rotatable about axis O—O. The under surface of rotor 2 is flat and is in superposed relation to the inclined upper surface 46. The upper part of the shaft portion 36 is threaded at 51 and receives a locking nut assembly 52 for securing the rotor 2 to the drive member 3 and permits relative rotation therebetween. In the form shown in FIG. 4 there is provided for the locking nut assembly an upper nut 52*a*, an inter-

mediate locking washer **52***b* and a lower lock nut **52***c*. A bearing **47** is provided between the locking nut assembly **52** and the top of the rotor **2** to decrease friction therebetween. A suitable seal (not shown) may be provided at the outer end of bearing **47**. With this arrangement the head member **2** will rotate about axis P—P in a gyratory action with respect to the vertical axis O—O with the liner assemblies moving between the two extremes of contacting and maximum spaced positions illustrated in FIGS. 1, 2 and 4.

The superposed surfaces of the rotor **2**, drive member **3** and pedestal or base member **4** having relative rotation therebetween are preferably provided with bearings therebetween herein illustrated as of the bushing type having friction reducing surfaces for protection against excessive wear of mechanical parts, and provide for less drag in the movement therebetween. The rotor aperture **37** preferably supports a bearing **48** having friction reducing surfaces engaging the machined surfaces of upright shaft portion **36**. The upper surface **46** of the drive member base portion **35** supports a bearing **50** having friction reducing surfaces engaging the undersurface of the rotor and the upper surface **46** of the base portion **35**. The upper surface **39** of the base member supports a bearing **45** having a friction reducting surface engaging the undersurface **38** of the base portion **35** and a bearing **42** is suitably pressed into and lines the side wall surfaces **41** and extends over the top and along the side surfaces **44** of the base member and has friction reducing surfaces engaging the side wall surfaces **40** and **43** of the drive member base portion **35**. In the form shown in FIG. 1 an intermediate bearing portion **42***a* is provided between the surfaces **38***a*, **40***a* and **39***a*, **41***a*, respectively.

Various lubrication systems may be provided for lubricating friction reducing wear surfaces of the bearings **42**, **42***a*, **45**, **47** and **50** as hereinabove described, as for example the lubricating oil may be introduced through the center of shaft **36** and fed radially outwardly at selected elevations on the shaft. In the form shown in FIG. 4 a reservoir **49** is disposed on the top of the rotor inclusive of upright side walls **49***a* and a detachable cap **49***b* for storing a quantity of lubricant such as oil for feeding these bearing surfaces. An oil discharge aperture **56** passes the oil from the bearing **48** to the upper surface of bearing **45** and **50** and an oil discharge aperture **58** in bearing **45** in communication with an aperture **59** in the base member **4** passes oil through a discharge line **60** (FIG. 4).

The undersurface of the rotor **2** is provided with a circumferential notched or grooved portion **53** which receives a circumferential seal **54**, preferably of the labyrinth type, supported on the upper surface of the drive member base portion **35**. More than one labyrinth type seal may be used. An additional seal **55** preferably of the flap type extends downwardly from the undersurface of the rotor and engages a peripheral side of the base member (FIG. 1) and two flap type seals **55***a* and **55***b* separately engaging the peripheral surface of the drive member from the rotor and base member to seal the bearing surfaces and drive motor (FIG. 4) from the abrasive effect of the materials passing from the treatment zone **30**.

The external drive arrangement for driving the drive member **3** and rotor **2** as shown in FIG. 1 includes a stub shaft **57** which extends from the bottom of the drive member **3** through a central aperture in the base member **4** to a point below the housing where it may be suitably coupled to an external drive motor such as an electric gearmotor or the like. Shaft **57** has an axis of rotation about vertical axis O—O above described and is provided with a suitable seal member **57***a* illustrated as of the O-ring type. An alternative external drive arrangement may be provided by extending the stub shaft portion upwardly outside the housing and coupling a portion of this shaft to an external drive motor.

The internal drive arrangement as shown in FIG. 4 in general includes an outer motor member **61** disposed within a chamber in the rotor **2** and is rigidly secured thereto. An inner motor member **62** is disposed within the outer motor member **61** and is rigidly secured to the drive member **3** illustrated as fitted on and rigidly secured to stub shaft portion **36**. A concentric air gap **63** separates the outer motor member **61** and the inner motor member **62**. Motor members **61** and **62** may have power input to one or both which will effect relative rotation or motion therebetween and these motor members may take various known forms having hydraulic fluid, air or electric power sources. A preferred form of power and motor is electric, in which case the motor members **61** and **62** would be the components of an electric motor, and as illustrated in FIG. 4 electric power is applied to the outer motor member **61**.

An electric connector **64** extends through the central portion of the base member **4** and drive member **3** and has plural slip rings **65** of electric conductive material supported at the upper end thereof, each of which is electrically connected to one of a plurality of input power lines **66**. Plural brushes or electric contactors **67** are secured on the drive member **3** adjoining and in engaging contact with one of the rings **65**. Similarly, plural brushes or electric contactors **68** are secured on the drive member **3** adjoining and in engaging contact with one of a plurality of electric conductive slip rings **69** secured on the rotor **2**. Electric conductive lines **70** electrically connect one of corresponding or associated contactors **67** and **68** and plural electric conductive lines **71** electrically connect one of each rings **69** to the electric windings (not shown) disposed in the outer motor member **61**. The electric power preferably three-phase and standard voltage from input line **66** may thus be applied to either electric windings in the outer member **61** or the inner member **62** or both during relative rotation between the drive member **3** and the rotor **2**. By way of example, the outer member **61** may be the stator or field windings of a three-phase squirrel cage induction motor and the inner member **62** may be the squirrel cage rotor or armature into which current is induced to eliminate the necessity of applying external excitation to the inner member **62** from the power line **66**.

In any case, with both the drive member **3** and the rotor member **2** which are supported so as to be free to rotate and by applying the power input to either the inner motor member or the outer motor member of both, the drive member **3** will rotate in one direction and the rotor **2** will rotate in the opposite direction.

An alternative arrangement for locking the flange-encompassing member **15** to the side wall member **9** is illustrated in FIG. 3 wherein there is shown a split ring member **77** suitable for encompassing the side wall **9** having blocks **78** and **79** at each end. The internal surface of ring member **77** includes a threaded portion **80** extending circumferentially thereof. Each block has an aperture for receiving a fastener such as a bolt **81** which may extend through block **79** and then into a threaded portion **82** of the other block **78** to draw the ring **77** into a rigid engagement with the side wall. The pitch diameter of the threaded portion **80** is preferably slightly smaller than the pitch diameter of mating threads **18** of the side wall so that tightening bolt **81** has the effect of raising depending lower portion **16** and effects a frictioned contact between threaded portions **17** and **18**. This results in locking the depending lower portion **16** to side wall member **9** for setting the spacing between the liner assemblies of the treatment zone. A powered screw could be substituted for bolt **81** to remotely and automatically control the setting of ring **77**. In the form shown in FIG. 1 one or a plurality of set screw **83** extends through ring **22** and assists in locking the ring **22** to the side wall.

The action in the above described crusher will now be described beginning with the rotation of the drive member **3** either externally through shaft **57** or internally by exciting the internally mounted motor members

61 and 62. Reference is now made to the drive arrangement of FIG. 4 and its motor for providing the power for the complete cycle of operation and the sequence is equally applicable to FIG. 1. A suitable electric power from an external source is applied to line 66 which energizes the windings in the outer motor member 61 through rings 65, brushes 67, line 70, brushes 68, rings 69 and lines 70. Assuming a squirrel cage type rotor for inner member 62 an electric current is induced therein and a magnetic repulsion or motor effect between the outer member 61 and the inner member 62 causes the rotor or head member 2 to rotate in one direction about axis P—P and the drive member 3 attached to outer member 62 in the opposite direction about axis O—O thus producing the gyratory action of the head with respect to the bowl member 7.

The feed material passing through the conical member 13 is discharged onto the top surface of the head or rotor 2 and is then moved toward the treatment zone 30 by the centrifugal action of the rotating surfaces. The gap or spacing between the facing liner assembly surfaces of zone 30 is widest at the top and narrows progressively toward the discharge end as previously described. After the material enters the top of zone portion 30*a*, the gyratory action of the head 2 moves the liner assembly surfaces together to narrow the gap thereby producing essentially a "pinching effect" or impact crushing to reduce the larger sizes to smaller sizes. As the gyratory action continues the resulting smaller sizes fall into the lower zone 30*b* which, due to the smaller gap spacing, the continuous twisting action and the size of the particle, produce a "wiping effect" or shearing of the particles against each other or attrition grinding to reduce the smaller sizes still further prior to discharge through the openings in the web member 5.

The driving forces produced between the inner and outer motor members 61 and 62 and the reaction forces produced between the bowl member and rotor produced by the material being crushed in zone 30 may impart motion in the bowl member which is oppositely of that of the rotor 2 and will also result in action wherein the bowl member 7 is supported in a substantially free floating idling action during lateral and circumferential movement of the bowl member in response to the gyratory action of the rotor. The lateral movement of the bowl member imparts a downward movement to the material in the treatment zone which in combination with the effect of gravity moves the treated material through treatment zone 30. This movement of the bowl member is significant in reducing the wear on the crusher in that it will spread the incoming material to provide more uniform distribution of forces on both the bowl member and the liner members. The provision of the support of the rotor 2, the drive member 3, and the base or pedestal member 4 for independent rotation therebetween as above described permits a variation in the type of grinding which may be produced and by adjusting the crusher "setting" or treatment zone gap through the threaded coupling a variation in the speeds of the drive member 3 and rotor 2 may be effected. In a preferred direct drive arrangement in accordance with the practice of the present invention the bowl member 7 may be positively driven by suitable exterior drive means in a direction oppositely of the direction of rotation of rotor 2. For some applications it may be desirable to control or restrict the rotation of bowl member 7 as for example by providing gear teeth in the outer periphery of flange 14 which will mate with gear teeth cut into upright portion 15*b*.

As an illustration or example of the size reduction obtained in a single pass treatment in a test apparatus similar to that shown in FIG. 1 utilizing a Climax Molybdenum ore feed of −½ inch +6 mesh, the screen analysis results in standard Tyler mesh sizes are as follows and establish a reduction ratio of approximately 18 to 1.

SCREEN ANALYSIS SCREEN ANALYSIS
[Feed, 200 grams of solids]

Sample	Mesh												
	+10	+14	+20	+28	+35	+48	+65	+100	+150	+200	+270	+400	−400
Grams retained	0.3	3.0	15.2	22.4	26.8	18.0	16.0	14.5	11.1	12.0	8.7	8.8	41.4
Percent retained	0.15	1.5	7.6	11.2	13.2	9.0	8.0	7.2	5.5	6.0	4.3	4.4	20.7
Percent passing	99.8	98.3	91.7	79.5	66.3	57.3	49.3	42.0	36.5	30.5	26.2	11.8	
Percent accumulated	0.15	1.6	9.2	20.5	33.6	42.7	50.7	58.0	63.5	69.5	73.8	78.2	98.9

Various types of arrangements may be provided in the practice of the present invention for feeding material into the crusher hereinabove described to facilitate more rapid movement of the material therethrough. A standpipe member of substantial height may be used in place of the conical member 13 which in the case of a wet feed will provide a hydrostatic head above the treatment zone to assist the mechanical head. In dry grinding passage of material through the crushing zone may be assisted by providing an air or gas pressure differential between the feed inlet and discharge. These crusher machines may also be stacked vertically and driven at different speeds to provide two or more stages of crushing, grinding and attrition in one passage through a series of machines.

The crushing apparatus as above described is arranged for the passage of tramp iron or the like through the crushing zone. By selecting the right combination of direction of rotation of the rotor 2 and the direction of screw thread portion 17 the torque on rotor 2 will be transmitted through the piece of tramp iron to the flange encompassing member 15 to unscrew this member and thereby widen the gap of the treatment zone to pass the tramp iron. The bowl member 7 may be returned to its setting by rotating the bowl member 7 either manually or automatically. The tramp iron may also be released by raising the top portion 15*c* of the flange-encompassing member which may be accomplished manually by removing bolts 19 or automatically by a force applying member such as a hydraulic cylinder connected to portion 15*c* or bolt 19 and through suitable control responsive to the locking of the rotor raising the portion 15*c* to pass the tramp iron with return of the portion 15*c* by the hydraulic cylinder or the like.

Various modifications may be made in the invention without departing from the spirit and scope thereof and only such limitations shall be placed thereon as are set forth in the appended claims.

I claim:

1. A gyratory crusher for wet or dry size reduction of solid material comprising a stationary upright housing for progressively passing a flow of solid material, inclusive of an inverted bowl member having a central inlet portion forming an intake of the housing and lower side walls for confining material flow, means inclusive of a circumferential flange on the exterior surface of the bowl member and flange-encompassing means for supporting the bowl member for rotary and lateral movement, a rotor disposed within the housing and mounted for gyratory rotation on a drive member and associated base support means, said drive member having an upper surface inclined to the horizontal for engaging a superposed undersurface of the rotor, said base support means extending inwardly from the lower side walls of the housing and having at least one substantially horizontal up-

per surface portion for engaging a superposed undersurface of the drive member for supporting the drive member for rotary movement thereon, said rotor having its top surface below and adjacent said central inlet portion for distributing the material delivered into the inlet opening, said rotor and bowl member having outwardly and downwardly inclined facing surface portions defining a material treatment zone with the inclined surface portions of the rotor disposed in underlying relation to the inclined surface portions of the bowl member, a circumferentially disposed liner assembly secured on the inclined surface portion of the rotor, a circumferentially disposed liner assembly secured on the inclined surface portion of the bowl member, means for rotating the drive member so as to impart gyratory movement to said rotor during contact between said upper inclined surface of the drive member and said superposed undersurface of the rotor so as to impel movement of the bowl member laterally and circumferentially to provide mechanically impelling forces in a downward direction on the material in the treatment zone, whereby the outer surfaces of the rotor liner assembly move in close clearance with the facing surfaces of the bowl liner assembly at points in each cycle of revolution, and material introduced through the central inlet is subjected to a progression of impacts in the upper portion of the treatment zone and substantially continuous attrition in the lower portion of the treatment zone during the gravitational and mechanically assisted descent of the material to a point of discharge at the lower end of the treatment zone.

2. A gyratory crusher as set forth in claim 1 including means associated with said flange-encompassing means for locking said bowl member at selected elevations to establish a selected spacing between the material-contacting surface portions in the treatment zone.

3. A gyratory crusher as set forth in claim 2 wherein said locking means for the bowl includes a wedge shaped member encompassing at least a portion of the side wall member for engaging the lower end of the flange-encompassing means, and a force-applying member for moving the wedge shaped member between said side wall and flange-encompassing means.

4. A gyratory crusher as set forth in claim 2 wherein said locking means for the bowl member includes a split ring member encompassing the side wall member below the lower end of the flange-encompassing means having coupling means adjoining its ends for securing the ring member at selected elevations on the bowl member so that the lower end of the flange-encompassing means engages the upper surface of said ring member.

5. A gyratory crusher as set forth in claim 1 wherein said liner assemblies comprise segmental portions arranged in tiers from top to bottom of said facing portions of the rotor and bowl members.

6. A gyratory crusher as set forth in claim 5 wherein the material of one of said tiers of segmental liners differs in wearing characteristics from the material of another of said tiers.

7. A gyratory crusher as set forth in claim 1 wherein bearing means having friction reducing surfaces are provided between the superposed surfaces of the rotor and drive member and between the superposed surfaces of the drive member and the base support means.

8. A gyratory crusher as set forth in claim 7 wherein the under surface of said rotor is provided with a notched portion in receiving relation with a seal member disposed on an upper surface of said drive member to seal the bearing surfaces from the material passing through the treatment zone.

9. A gyratory crusher as set forth in claim 7 wherein seal means are disposed between a surface of the rotor member and a surface of the drive member and between a surface of the drive member and a surface of the base support means to seals said bearing surfaces from material passing through said treatment zone.

10. A gyratory crusher as set forth in claim 1 wherein said rotating means is externally driven.

11. A gyratory crusher for wet or dry size reduction of solid material comprising a stationary upright housing for progressively passing a flow of solid material, inclusive of an inverted bowl member having a central inlet portion forming an intake of the housing and lower side walls for confining material flow, means inclusive of a circumferential flange on the exterior surface of the bowl member and flange-encompassing means for supporting the bowl member for rotary and lateral movement, a rotor disposed within the housing and mounted for gyratory rotation on a rotor support means disposed within the housing, said rotor having its top surface below and adjacent said central inlet portion, said rotor and bowl member having outwardly and downwardly inclined facing surface portions defining a material treatment zone with the inclined surface portion of the rotor disposed in underlying relation to the inclined surface portions of the bowl member, a circumferentially disposed liner assembly attached to the inclined surface portion of the rotor, a circumferentially disposed liner assembly attached to the inclined surface portion of the bowl member, motor drive means including an outer motor member disposed within and attached to the rotor and an inner motor member attached to the drive member and disposed within said outer motor member, one of said motor members having power input means for inducing motion in the other of said motor members for imparting rotation to the rotor, whereby the outer surfaces of the rotor liner assembly move in close clearance with the facing surfaces of the bowl liner assembly at points in each cycle of revolution, and solids introduced through the central inlet are subjected to a progression of impacts in the upper portion of the treatment zone and substantially continuous attrition in the lower portion of the treatment zone during the gravitational descent of the material to a point of discharge at the lower end of the treatment zone.

12. A gyratory crusher as set forth in claim 11 wherein said inner and outer motor members impart rotation to said rotor and said drive member in opposite directions.

13. A gyratory crusher as set forth in claim 11 wherein said inner and outer motor members comprise the field and armature portions of an electric motor.

14. A gyratory crusher as set forth in claim 13 wherein the power input means includes slip rings supported by said support member adapted for connection to an external electric power line and plural electric conductive contactors supported on said drive member, each said contactor engaging one of said slip rings, and slip rings on one of said motor members for applying electric power to said one motor member.

15. A gyratory crusher for wet or dry size reduction of solid material comprising a stationary upright housing for progressively passing a flow of solid material, inclusive of an inverted bowl member having a central inlet portion forming an intake of the housing and lower side walls for confining material flow, means inclusive of a circumferential flange on the exterior surface of the bowl member and flange-encompassing means for supporting the bowl member for rotary and lateral movement, a threaded coupling means adjustably connecting a portion of the flange-encompassing means to the lower side walls of the housing for varying the elevation of the bowl member, a rotor disposed within the housing and mounted for gyratory rotation on a rotor support means disposed within the housing, said rotor having its top surface below and adjacent said central inlet portion for distributing the material delivered into the inlet opening, said rotor and bowl member having outwardly and downwardly inclined facing surface portions defining a material treatment zone with the inclined surface portion of the rotor disposed in underlying relation to the inclined surface portions of the bowl member, a circumferentially disposed liner assembly attached to the inclined surface

portion of the rotor, a circumferentially disposed liner assembly attached to the inclined surface portion of the bowl member, means for imparting rotation to the rotor, whereby the outer surfaces of the rotor liner assembly move in close clearance with the facing surfaces of the bowl liner assembly at points in each cycle of revolution, and solids introduced through the central inlet are subjected to a progression of impacts in the upper portion of the treatment zone and substantially continuous attrition in the lower portion of the treatment zone by the gyratory movement of said rotor portion during the gravitational descent of the material to a point of discharge at the lower end of the treatment zone.

16. The method of crushing and grinding divided solids, which comprises directing divided solids in continuous gravitational flow into a treatment course of progressively narrowing width in a downward direction, said course being defined by wear surfaces of an outer member supported for laterally floating rotation about a vertical axis, and wear surfaces of an inner member disposed within the vertical plane of the outer member and supported for gyratory movement about a central axis inclined at a few degrees to the vertical, whereby the space between points on the inner and outer members alternately increases and decreases in the cycle of revolution of the inner member so as to impart impact forces to descending solids in the narrowing portion, and reciprocating the floating surfaces in a vertical plane during the cycle of rotation of the inner member to selectively vary the gap between the members and impart additional impact forces to solids descending through the treatment zone.

17. The method of crushing and grinding divided solids, which comprises directing divided solids in continuous gravitational flow into a treatment course of progressively narrowing width in a downward direction, said course being defined by wear surfaces of an outer member supported for laterally floating rotation about a vertical axis, and wear surfaces of an inner member disposed within the vertical plane of the outer member and supported for gyratory movement about a central axis inclined at a few degrees to the vertical, whereby the space between points on the inner and outer members alternately increases and decreases in the cycle of revolution of the inner member so as to impart impact forces to descending solids in the narrowing portion, and directing the flow of material introduced into the space between the inner and outer members along separated helical courses in which additional impact forces are directed against confined solids by rotation of the members.

18. A gyratory crusher for wet or dry size reduction of solid material comprising a stationary upright housing for progressively passing a flow of solid material, inclusive of an inverted bowl member having a generally central inlet portion forming an intake of the housing and lower side walls for confining material flow, means supporting the bowl member for rotary and lateral movement, a rotor disposed within the housing and mounted for gyratory rotation on a drive member, one of said drive member and rotor having a surface inclined to the horizontal for engaging a dissimilarly disposed surface of the other, said rotor having its top surface below and adjacent said central inlet portion for distributing the material delivered into the inlet opening, said rotor and bowl member having outwardly and downwardly inclined facing surface portions defining a material treatment zone with the inclined surface portions of the rotor disposed in underlying relation to the inclined surface portions of the bowl member, and means for rotating the drive member so as to impart gyratory rotational movement to said rotor during contact between said upper inclined surface of the drive member and said superposed undersurface of the rotor so as to impel movement of the bowl member laterally and circumferentially to provide mechanically impelling forces in a downward direction on the material in the treatment zone, whereby the outer surfaces of the rotor move in close clearance with the facing surfaces of the bowl at points in each cycle of revolution, and material introduced through the central inlet is subjected to a progression of impacts in the upper portion of the treatment zone and substantially continuous attrition in the lower portion of the treatment zone during the gravitational and mechanically assisted descent of the material to a point of discharge at the lower end of the treatment zone.

19. A gyratory crusher for wet or dry size reduction of solid material comprising a stationary upright housing for progressively passing a flow of solid material, inclusive of an inverted bowl member having a central inlet portion forming an intake of the housing and lower side walls for confining material flow, means supporting the bowl member for rotary and lateral movement, a rotor disposed within the housing and mounted for gyratory rotation on a rotor support means disposed within the housing, said rotor having its top surface below and adjacent said central inlet portion, said rotor and bowl member having outwardly and downwardly inclined facing surface portions defining a material treatment zone with the inclined surface portion of the rotor disposed in underlying relation to the inclined surface portions of the bowl member, and motor drive means including an outer motor member disposed within and attached to the rotor and an inner motor member attached to the drive member and disposed within said outer motor member, one of said motor members having power input means for inducing motion in the other of said motor members for imparting rotation to the rotor, whereby the outer surfaces of the rotor move in close clearance with the facing surfaces of the bowl at points in each cycle of revolution, and solids introduced through the central inlet are subjected to a progression of impacts in the upper portion of the treatment zone and substantially continuous attrition in the lower portion of the treatment zone during the gravitational descent of the material to a point of discharge at the lower end of the treatment zone.

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