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Kueneman et al.

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[54] **GYRATORY CRUSHER ADJUSTING MECHANISMS**

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[22] Filed: **Aug. 14, 1970**

[21] Appl. No.: **63,934**

Related U.S. Application Data

[62] Division of Ser. No. 657,473, July 27, 1967, Pat. No. 3,539,118.

[52] **U.S. Cl.**.....**241/207,** 241/286
[51] **Int. Cl.**.....**B02c 2/00**
[58] **Field of Search**.....241/37, 207–216, 241/259, 286, 290

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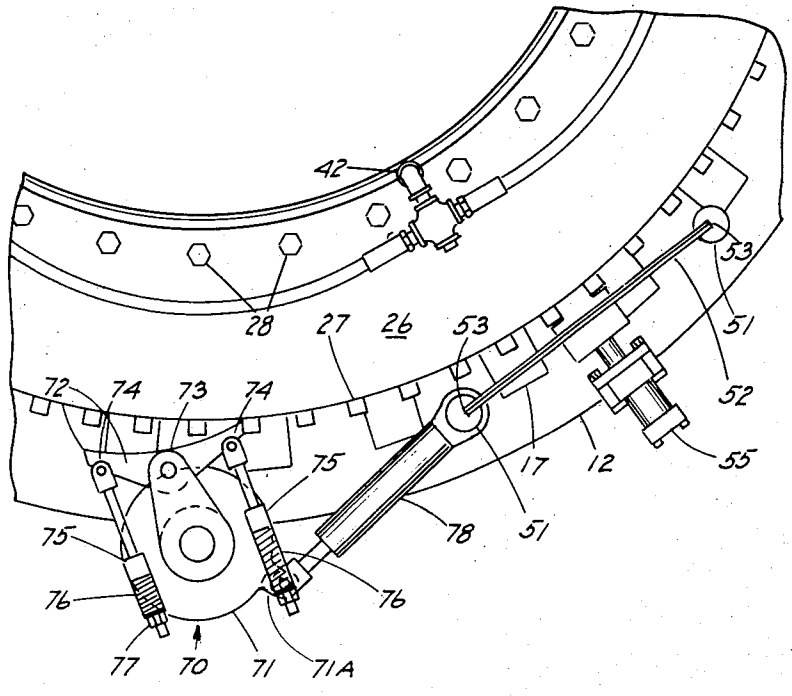
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[57] **ABSTRACT**

Gyratory crushers, sometimes referred to as cone type crushers, often have a threaded connection between the bowl and the main crusher frame for adjusting the crushing zone by rotation of the bowl relative to the frame. This invention includes a bowl rotating device for such a crusher in which a swingable arm mounted adjacent to the bowl structure is oscillated by an actuator and a double ended pawl pivoted on the end of the swingable arm is utilized to rotate the bowl in either direction depending on which end of the pawl is employed. A spring arrangement is employed to bias the pawl against the bowl structure and a reversing plate connected to the pawl through the spring arrangement sets the pawl for the desired direction of rotation.

8 Claims, 6 Drawing Figures



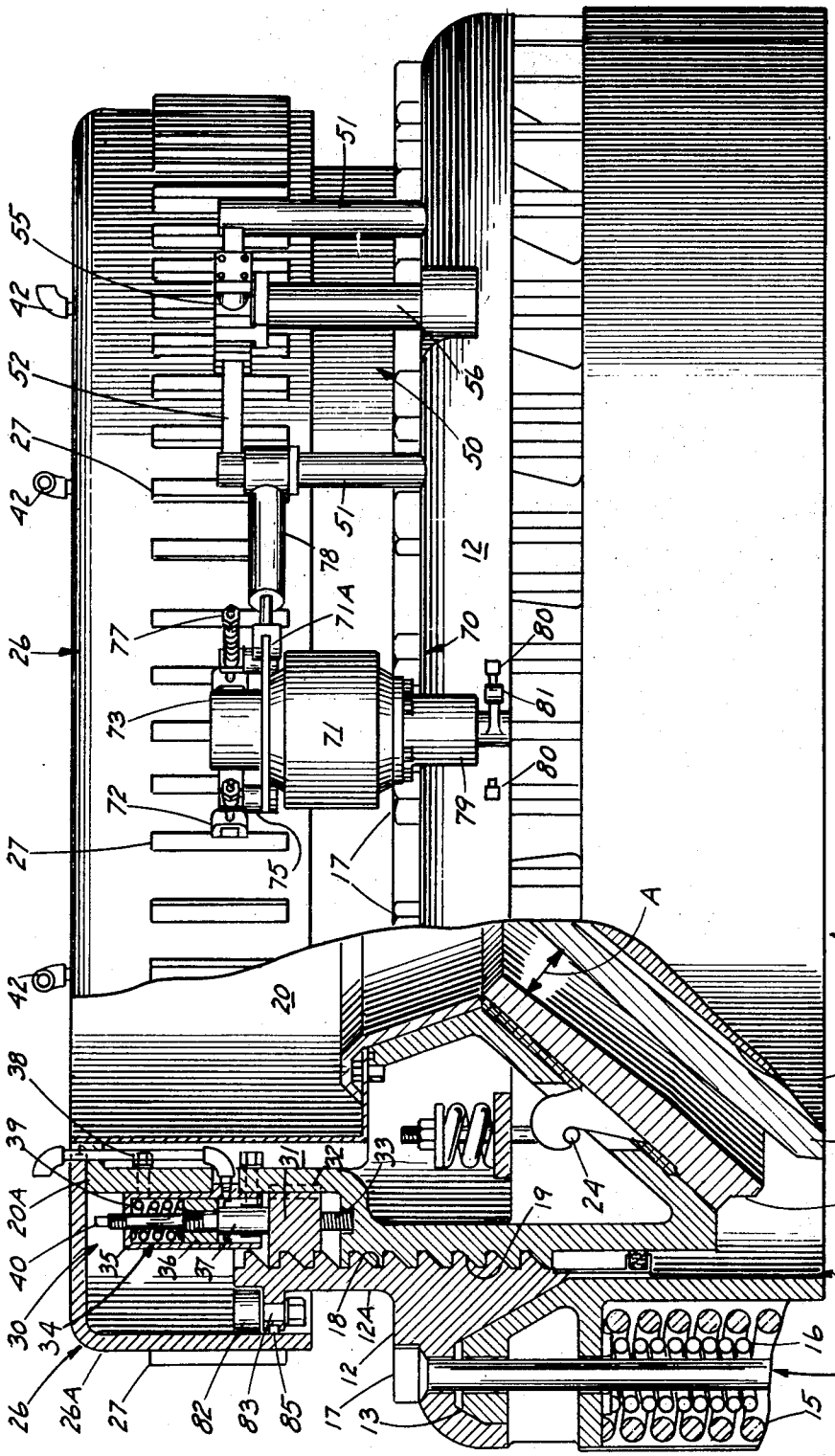


FIG. 1

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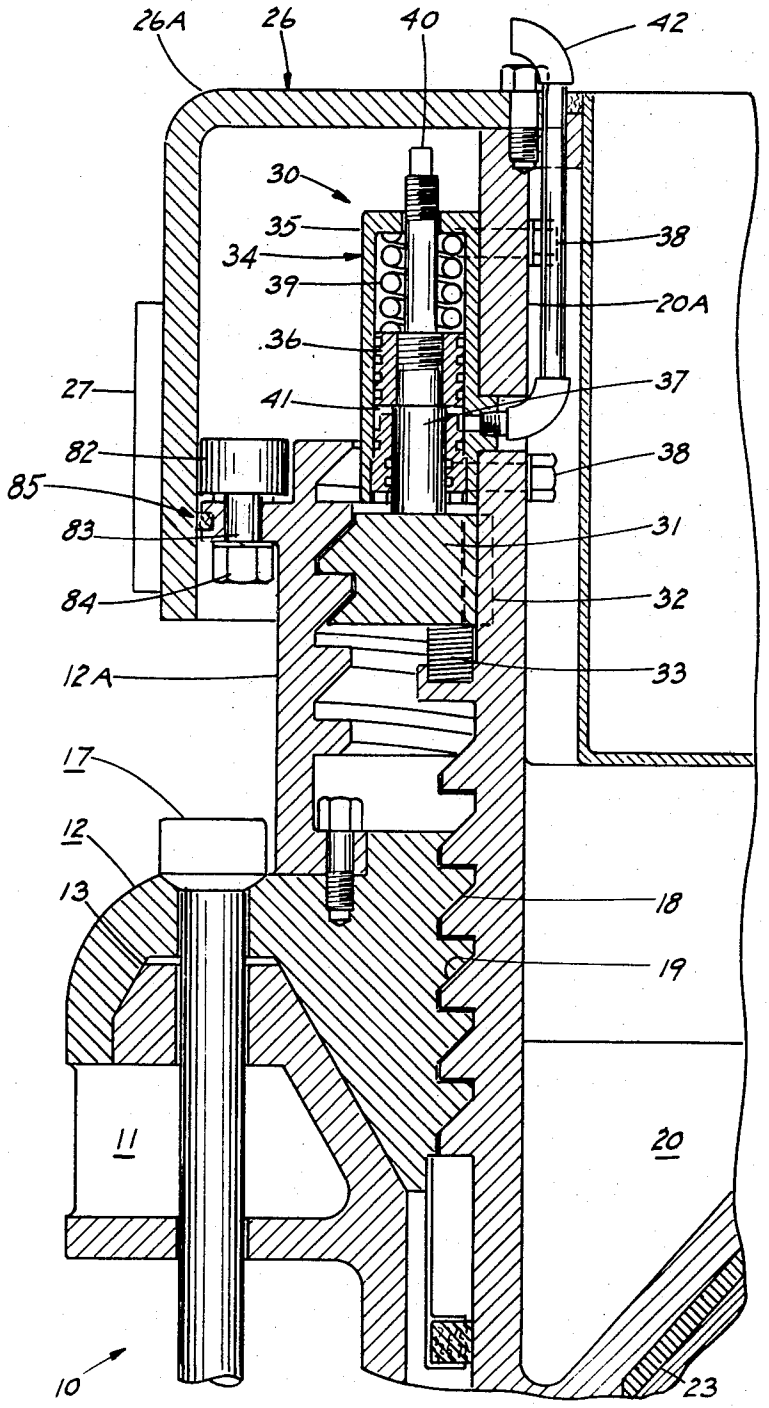


FIG. 2

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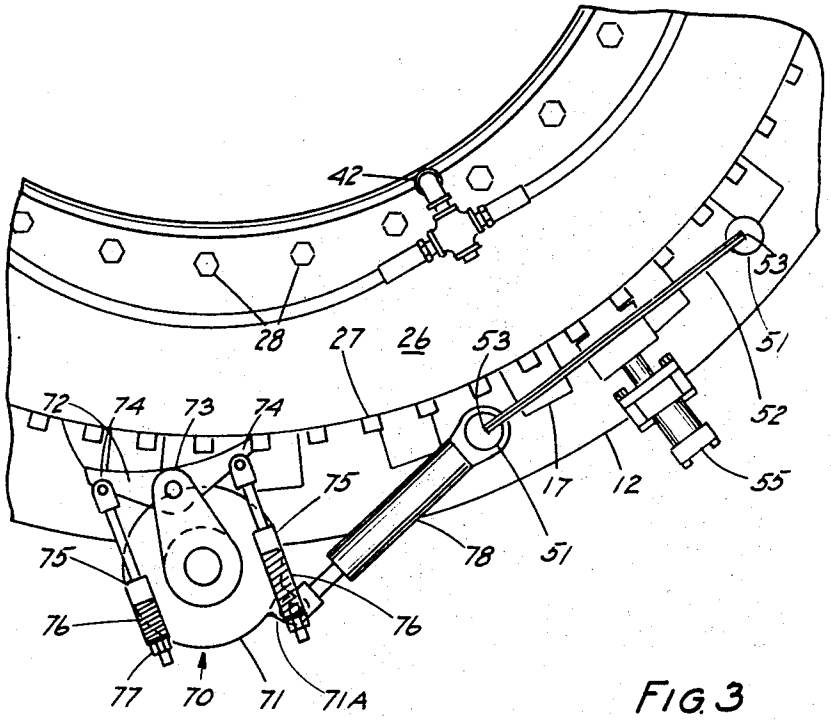


FIG. 3

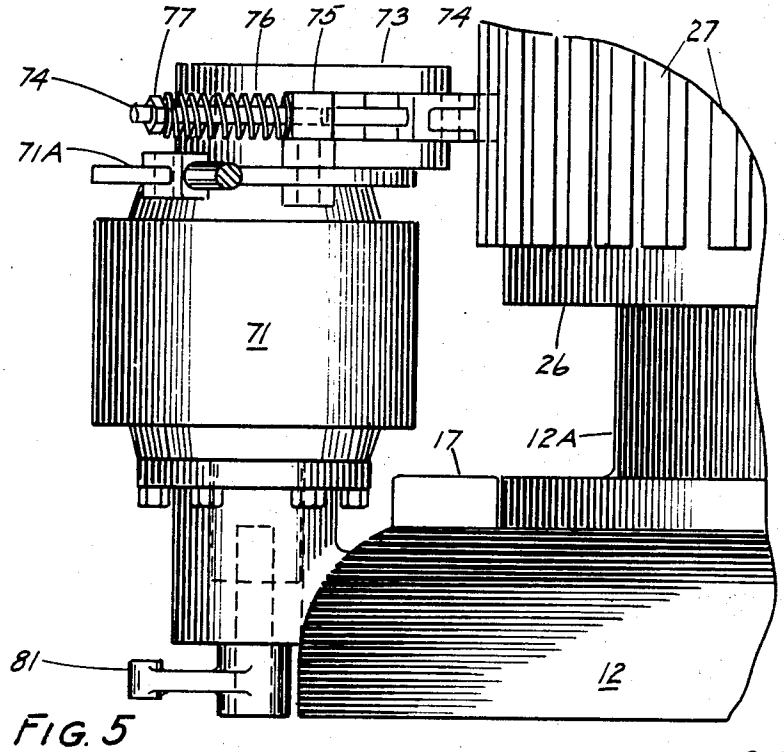


FIG. 5

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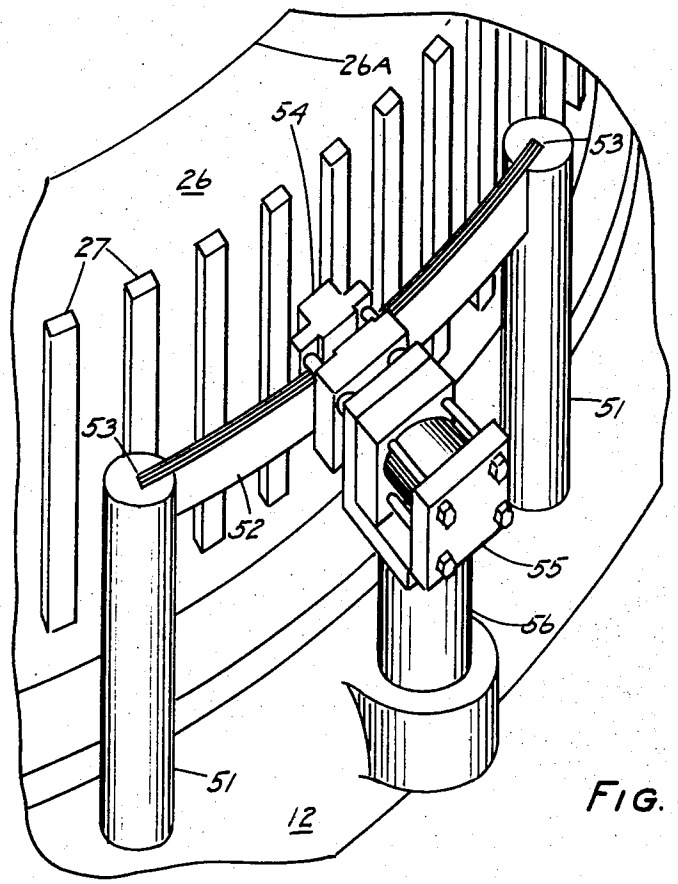


FIG. 4

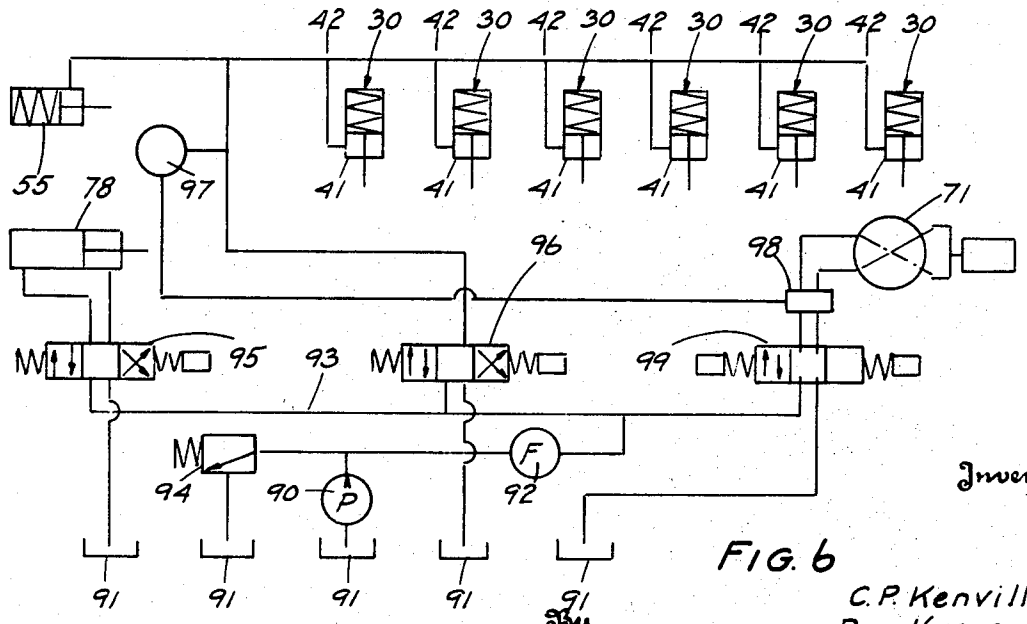


FIG. 6

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GYRATORY CRUSHER ADJUSTING MECHANISMS

CROSS-REFERENCES TO RELATED APPLICATIONS

This application is a division of application Ser. No. 657,473, filed July 27, 1967, now U.S. Pat. No. 3,539,118.

BACKGROUND OF THE INVENTION

Gyratory crushers have come into wide use since they are rotary machines as opposed to reciprocating machines, thereby providing better strain distribution. In addition, they have greater capacity per unit of discharge area and a more uniform power consumption than contemporary reciprocal machines. In the crushing and grinding fields, where these gyratory crushers are employed, they, like many others, are moving towards completely automated processes which require machines which can be adjusted automatically, rather than by the conventional arduous and laborious manual procedures. Thus, there is continued demand for mechanisms and apparatus by which the large commercial crushers can be more fully automated.

Large capacity commercial gyratory crushers generally have a main support frame in which a gyrating head is driven through an appropriate gear train. The upper surface of this gyrating head forms one of the crushing faces and a second crushing face is supported to the underside of a bowl structure positioned above the head and supported through the structures on the frame. Through this arrangement a crushing zone is defined between the crushing faces on the top of the head and the opposed faces supported directly above the head on the bowl structure. It has become quite conventional to thread the bowl into its contiguous supporting structure on the frame so that the bowl may be screwed into, or out of this structure for adjustment. Through this arrangement the distances between the crushing faces can be conveniently adjusted for wear or product size and also the bowl can be easily removed from the crusher to replace the crushing faces when they have worn through.

A threaded connection between the frame and bowl in gyratory crushers is well known in the art and is aptly disclosed in the drawings of U.S. Pat. No. 2,002,464 issued to Gruender. While the screw-threaded connection between the bowl and the frame facilitates convenient adjustment and replacement of the wear faces, it presents three basic problems. First, it requires suitable means to rotate the bowl relative to the frame, which have relatively large frictional drag due to their large circumferences and gritty environment. Secondly, it requires means to lock the bowl relative to the frame so that inadvertent rotation will not occur during operation of the crusher. Thirdly, it requires means to reduce the thread clearances in the threaded connection to prevent this connection from being battered during the operation of the crusher since fairly large thread clearance is provided during manufacture to make it easier to change settings by bowl rotation.

These particular problems have been recognized in the past and various devices have been used to solve them. For example, in the Gruender patent cited, threaded bolts supported on an upper cap structure are used to lift the bowl relative to the main frame to reduce the lost motion in the thread connection before the crusher is put in operation, a winch is used to rotate the bowl structure for adjustment and pins were dropped in registering holes to prevent inadvertent bowl rotation. More recently in U.S. Pat. No. 3,133,707 issued to Bond, a manually-operated mechanisms mentioned above were replaced by other devices, to increase automation capacity. The Bond mechanisms, however, have some disadvantages.

SUMMARY OF THE INVENTION

In a gyratory crusher wherein the bowl structure is mounted to the crusher frame through a threaded connection, an improved bowl rotating mechanism comprising a swingable arm pivotally mounted adjacent to the bowl structure which is oscillated by an actuator connected thereto, a double end pawl pivotally mounted on the end of the swingable arm arranged so either end can engage an outer surface of the bowl structure having notches thereon and an adjustable spring arrangement operable to bias one or the other end of the pawl against the outer surface of the bowl structure. The adjustment of direction of rotation of the bowl structure is controlled by a reversing plate forming part of the spring arrangement, which determines, by its position, the end of the pawl which engages the outer surface of the bowl structure. Thus the same oscillatory motion of the arm will drive the bowl structure in both directions, depending on the position of the reversing plate.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is an elevation with parts broken away of an upper portion of a gyratory crusher showing a thread clearance removal system, a lock system and a bowl rotation system;

FIG. 2 is an alternate construction of the thread clearance removal system of Fig. 1 in partial section;

FIG. 3 is a plan view of a portion of the top of a gyratory crusher showing several of the systems shown in Fig. 1 and depicting the relationship between the rotary actuator and bowl lock mechanisms;

FIG. 4 is a partial perspective of the leaf locking system employed in the automated crusher system according to this invention;

FIG. 5 is a partial elevation at one side of the crusher with parts broken away showing the rotary actuator for bowl rotation; and

FIG. 6 is a schematic of a hydraulic circuit used to control the automated system for a gyratory crusher according to this invention.

BRIEF DESCRIPTION OF AN EMBODIMENT

Gyratory crushers depicted in U.S. Pat. Nos. 3,133,708 and 2,002,464 issued to Bond and Gruender, respectively, generally show the threaded connection between the bowl of a gyratory crusher and its main frame through a tilting or adjusting ring. Since this invention is principally related to the automated control of this threaded connection, the other more-or-less conventional structures of gyratory crushers, such a drive trains, crusher head support and the like, will not be depicted or discussed. However, reference is made to the Gruender patent for clarification of the

relationship of crusher parts in a complete machine and their related operation, for a more complete understanding of the invention.

In FIG. 1 the upper portion of a gyratory crusher **10** is depicted with automating structures of this invention. Generally, it has a circular main frame **11** which supports a tilting or adjusting ring **12** on its top annular surface **13** through a spring overload yielding system **14**. The overload yielding system has a plurality of springs **15** and **16** disposed concentrically about bolts **17** which are, in turn, circumferentially disposed about the adjusting ring and operable between it and the main frame to resiliently hold the adjusting ring to the main frame. Such a connection allows the adjusting ring to rise relative to the frame if the crushing loads in the crusher exceed a safe value because of the presence of tramp iron or the like between the crushing faces.

The inner cylindrical surface **18** of the adjusting ring is provided with threads which cooperate with mating threads on the outer cylindrical surface **19** of the bowl **20** so that a rotation of the bowl will cause it to move axially relative to the adjusting ring, thereby adjusting the crusher for product size or wear in the crushing surfaces. A crushing cavity is formed between a mantle **21** supported on the gyrating crushing head **22** and a conically-shaped bowl liner **23** which is retained on the underside of the bowl with hook and bolt retainers **24**. As can be seen in FIG. **1**, the relative distance A between the crushing surfaces can be changed by rotation of the bowl either to facilitate product size or wear in the crusher.

Three cooperating systems in this invention automate the control of the threaded connection between the crusher and the bowl which are: a thread clearance removal system **30**; a leaf lock system **50**; and a bowl rotating system **70** which are all preferably hydraulically actuated from a common control system. For convenience, each of the systems will be discussed separately and their interrelated control functions noted.

Once the bowl of the crusher has been rotated to obtain the proper spacing "A" between the crushing surfaces, the thread clearance removal system is used to remove the "lost motion" or "play" in the threaded connection between the bowl and the adjusting ring. This lost motion or play is present to facilitate adjustment without binding or sticking, but once the adjustment has been completed its continued presence will allow damage to occur in the threaded connection during crusher operation. During manufacture the threaded surface of the bowl is machined to provide a fair amount of diametrical and axial clearance since otherwise the gritty environment in which the crusher operates may cause the bowl connection to freeze.

Damage will occur to the threaded connection, if the thread clearance or play is not removed, due to the intermittent crushing forces acting upwardly on the bowl driving it up, so that the upper surfaces of its threads will slam against the lower surfaces of the threads on the adjusting ring. Momentary interruption of these crushing forces will allow the bowl to drop, battering the opposite surfaces of the opposed threads in the connection. The inertia of the bowl moving up or down is considerable but, especially during down travel, since it is sometimes augmented by the action of the retaining springs **15** and **16** banging the adjusting ring down on the frame **11**. Further, diametrical clearance must be removed to prevent the bowl from radially shifting with sufficient force to damage the connection. Due to these factors, even a small amount of thread clearance or play can be very detrimental to the threaded connection and those conventionally present would, if not controlled, ruin the connection. In this invention the thread clearance or play removal system **30** is designed to act between a floating ring **31** and the bowl to lift the bowl upwards so that the forces lifting the bowl during machine operation will not be able to bang the threads together since the system will hold these surfaces in substantially continuous contact. Also the diametrical clearance will be eliminated as the bowl is lifted due to the wedging of the threads. Further, the system will also cushion the downtravel of the bowl when it occurs due to the inertia build-up caused by the retaining springs **15** and **16** pulling the adjusting ring sharply down on the crusher frame.

The above objectives and others are accomplished be fitting a floating ring **31** circumferentially over the upper cylindrical portion **20A** of the bowl **20** with a vertical key **32** preventing relative rotation between the floating ring and the bowl. A plurality of springs **33** spaced circumferentially around the floating ring support it from its underside at a selected axial position relative to the bowl. While the floating ring is so supported, it should be appreciated that it can move axially relative to the bowl on the resilient support of the springs. This spring support is merely for convenience during assembly of the bowl into the adjusting ring since it holds the floating ring in proper relationship to screw into its associated structures discussed below.

In FIG. **1** a wall **12A** of the adjusting ring **12** extends vertically upwards and has the inner threaded surface continued so that the outer threaded periphery of the floating ring **31** can be screwed into the upper wall as the bowl is screwed into the adjusting ring. Constructed in this manner, as the bowl is adjusted in the adjusting ring, the floating ring will maintain a constant axial position relative to the bowl. This feature is important since it maintains a constant throw or travel of a plurality of lift mechanisms**34**, mounted circumferentially about the top of the bowl and operable against the floating ring. This eliminates the "long to short" throw actuation, as is required for the hydraulic lift shown in the aforementioned Bond patent, or the long tap screws disclosed in Gruender, for removing the thread clearance in these types of bowl connections.

The lift mechanisms **34** consist of a vertical outer cylindrical shell **35** having a piston element **36** contained therein whose rod **37** extends from the base of the shell to the vicinity of the floating ring. A plurality of tap bolts **38** extend through the upper wall portion **20A** of the bowl to mount the cylindrical shells circumferentially about this upper vertical wall. Above the piston in each of the cylindrical shells is a heavy spring means **39** which acts between the top of its shell and its piston to extend its rod so it will push against the floating ring.

Since the floating ring **31** is free to move axially on the upper portion of the bowl, extension of the rods by the heavy spring means, assuming the proper adjustment, will lift the bowl upwardly since the floating ring

is screwthreaded into the upper wall **12A** of the adjusting ring. Further, the springs will pick up the play that develops due to the squeezing out of grit and grease in the threaded connection during crusher operation. In this manner the thread clearance is removed so that the crushing loads cannot batter the threads, as previously described. The proper adjustment of each rod is accomplished using the wrench flats **40** on a portion of the rod extending above the cylindrical shell of each unit to screw the rod up or down with respect to its piston. Also, the upper projecting portion of the rod is provided with a threaded periphery so a nut can be screwed thereon to compress spring **39** for emergency release and/or assembly of the system.

This particular thread clearance removal system **30** is advantageous since its operating parts are conveniently accessible by removing the cap structure **26** covering the top of the crusher for service and maintenance. Further, the constant relationship of the floating ring relative to the bowl eliminates the need for the longer throw devices such as those discussed in the aforementioned patents.

In the automated mode of operation of the thread clearance removal system springs **39** are compressed by simultaneously supplying hydraulic fluid to chambers **41** at the bottom of each cylindrical shell through hydraulic lines **42** connected to a circular fluid harness which interconnects all of the chambers. All the pistons **36** therefore will be simultaneously forced upwardly compressing their spring and completely release the floating ring. This allows bowl adjustment to be accomplished expeditiously.

In FIG. **2** a floating ring **31** having a larger outside diameter than the bowl is employed and the upper wall **12A** of the adjusting ring **12** is fabricated separately and stepped outwardly so that it is out of registry with the threaded connection between the bowl and the ring. Obviously, other similar alternate structures could be employed, using the features of this invention for connecting the floating ring and upper wall of the adjusting ring.

During operation of the machine, the rotary crushing action of the gyrating head **22** applies considerable torque to the bowl which, if not suitably locked, will rotate causing the crusher to drift from its setting. Since the torque applied to the bowl is substantial, the locking structure must be substantial to withstand the loading and yet release conveniently. The thread clearance removal does restrain the bowl somewhat but will not eliminate its movement.

These features, among others, are achieved in the lock system **50** of the automated control system for crushers according to this invention, and is best seen in FIGS. **3** and **4**.

Basically, the lock system includes two vertical support posts **51** which are mounted on the adjusting ring **12** in spaced relationship with a plurality of leaf means **52** supported in slots in the upper ends of the posts. The posts are arranged so that the leaf means is oriented generally tangentially to the periphery of the cap **26** of the crusher. Centrally located on the leaf springs is a lock lug **54** which extends radially to engage the vertical side **26A** of the cap between vertical ribs **27** spaced circumferentially about the vertical outside wall of the cap. When the lug is between two vertical ribs of the cap, which in turn is secured with bolts **28** on the top of the bowl, the latter is prevented from rotating relative to the adjusting ring. The particular structure allows most of the load to be carried axially of the leaf means and when the leaf means is composed of leaf springs the springs provide a certain resiliency between the locking parts which tends to prevent jamming and yet holds the bowl securely. Further, it should be appreciated that the symmetry of the construction allows the lug to lock the bowl against both clockwise or counter-clockwise rotation.

As noted above, the leaf means carry the locking loads and therefore only a small, non-load carrying hydraulic cylinder **55** need be used to release the lock. This cylinder is supported on a separate vertical post **56** centrally located between the two support posts **51**. The rod of the hydraulic cylinder is connected to locking lug **54**. If the leaf means is composed of leaf springs the lug fixedly mounted thereon is pulled radially outwardly when the cylinder is actuated by hydraulic pressure so that the lug will clear the vertical ribs of the bowl, as can be seen in FIG. **4**. The leaf springs have adequate resiliency to allow this radial movement of the lug, and the slots **53** in the upper portion of each vertical support post are deep enough so that the radial travel of the lug will not cause the leaf springs to disengage from the upper portion of these posts. Alternatively the leaf means can be rigid and the lug itself reciprocated to lock and unlock the bowl.

Use of the leaf springs is preferred since it provides a positive lock powered by the springs. If the lug is not in registry between the vertical ribs, the lug will snap against the cap when registry first occurs. Thus, alignment is not critical when the operator makes an adjustment.

The last system in the automation of the connection between the bowl and adjusting ring according to this invention is the bowl rotation system **70** which is only actuated after the lift mechanism in the thread clearance removal system and the lock system have been released. Due to the dusty and gritty environment in which crushers operate, the conventional ram system employed to rotate bowl structures are highly unsatisfactory since the grit will lead to the failure of the seals around the reciprocating rods with high maintenance costs, plus downtime on the crusher. In the instant invention, the use of reciprocating exposed cylinder rod is eliminated by employing a rotary actuator **71** with a double ended pawl means **72** connected to its oscillating arm **73**. The actuator is mounted on adjusting ring **12**.

The pawl means pivoted at its midpoint on the oscillating arm includes clevis connecting spring bolts **74** attached to the outboard ends of the pawl as can be seen in FIG. **3**. These spring bolts extend through pivoted eyes **75** on the reversing plate on top of the actuator body and are provided with coaxial springs **76** which are retained between the eye and a nut **77** on the end of each bolt. The nuts are adjusted so that the pawl axis will be generally normal to radial axis of the oscillating arm when the pawl is free of contact with the cap structure **26** so the actuator can be simply and easily reversed.

Reversal of the rotational direction of the bowl is accomplished by means of a hydraulic cylinder **78** which

extends between one of the vertical support posts **51** and a lug **71A** on the reversing plate. This cylinder swings the reversing plate about the top of the actuator so that one or the other end of the pawl **72** will be spring-biased against the vertical wall **26A** of the cap. The inner surface of the pawl is arcuate so that its ends are able to drop against the vertical wall of the cap behind the vertical ribs **27** for transmitting rotational force to the bowl without interfering with the next adjacent rib.

Through the arrangement depicted in the drawings it is only necessary that hydraulic cylinder **78** swing the actuator about 30° to reverse its operable direction. The exposed rod of the cylinder can be equipped with an expandable boot if desired, but it is not reciprocated frequently. Further, ram systems cannot be so conveniently reversed.

The particular arrangement described provides a very convenient rotational mechanism for rotating the bowl of a gyrator crusher relative to the adjusting ring which can be simply and automatically reversed through a simple two-position hydraulic cylinder. These rotary actuators are available commercially and can rotate and counter-rotate their oscillating arms through any angle within 270°. In the instant invention angular arm swing is limited to an angle of less than 120° with limiters **80** mounted on the adjusting ring so they will engage limit arm **81** of the actuator. These limitors reverse the flow of hydraulic fluid when contacted thereby reversing the swing of the arm of the actuator.

To reduce frictional loading when using the rotary actuators, the upper wall **12A** of the adjusting ring **12** is equipped with a plurality of bearings **82** each having its journal boss **83** secured with nuts **84** in holes provided in the wall for this purpose. In general, these bearings are located in the same plane in which the pawl engages the cap **26** of the crusher. Thus, as the bowl is rotated the cap will move up or down relative to the plane of the bearings and the pawl. A circumferential seal **85** is positioned directly below the bearing journals to seal out some of the dust and grime from the machine's surrounding dusty environment. Utilizing the bearing structures, it is possible to use a single actuator provided the vertical ribs **27** are of a sufficient length since there is a considerable reduction of friction drag in the threaded connection from diametrical loading. Single rotary actuator systems, of course, are more economical and more easily maintained, and further do not require a complex control system.

In FIG. **6** a schematic hydraulic circuit is shown for operating and sequencing the systems described above. As can be appreciated, the crusher operation is normally carried out with the hydraulic circuits inactivated with the heavy springs **39** and the leaf spring **52** providing the necessary bowl lifting and locking features. A simple hydraulic circuit is employed which includes a pump **90**, which draws fluid from reservoir **91**, which pressurizes, through filter **92**, a manifold **93**. A relief valve **94** is connected to the output of the pump to control the maximum pressure in the manifold and drains to reservoir. A simple reversing valve **95** is connected to the manifold and controls pressurized fluid flow to cylinder **78** for setting the reversing plate for a clockwise or counter-clockwise rotational mode. Since this operation is merely a two-position operation, the actuation merely consists of supplying hydraulic fluid to the proper end of the cylinder through the valve.

Also, connected to the manifold through a non-directional valve **96** used to control is the lock release cylinder **55** and the fluid pressure chambers **41** of each of the lift mechanisms **34** through a common line or hydraulic harness. These units have spring elements which re-engage them when hydraulic pressure is released. By the common connection the lock mechanism and the lift mechanisms are released simultaneously, so the bowl will be free for rotation by rotary actuator **71**.

Also included in the common line connecting the above system is a pressure responsive switch **97** which is coupled to a cut-off unit **98** in the lines leading to the rotary actuator. Thus, when the valve **99** is actuated for actuator operation, it will not be possible to supply pressurized hydraulic fluid to the rotary actuator unless the pressure-sensitive switch **97** has sensed a preset pressure level which will insure that the lift mechanism and the lock mechanism have been hydraulically released. In this way damage to the actuator can be prevented since the actuator is inoperable until the bowl is free for rotation.

Valve **96** can thereafter be employed to operate the actuator which cycles automatically, to rotate the bowl for adjustment.

We claim:

1. In a gyratory crusher having a main frame, a crushing head mounted therein for oscillation and a bowl structure threadedly supported in said main frame for vertical adjustment through its rotation whereby a bowl supported crushing surface cooperates with said crushing head to form an adjustable crushing zone, a bowl rotating mechanism comprising:

a swingable arm pivotally mounted on said main frame adjacent to said bowl structure;

an actuator means connected to said swingable arm and said main frame operable to oscillate said swingable arm;

a double-ended pawl means pivotally mounted on the outboard end of said swingable arm so it can be oriented in alternate positions whereby only one end or the other end of said double-ended pawl means will engage an outer notched surface of said bowl structure;

a reversing plate means associated with said swingable arm and independently movable relative thereto; and

spring means connecting said reversing plate with said double-ended pawl means operable to bias one end of said double-ended pawl means against said outer notched surface of said bowl structure in one position of said reversing plate means and the other end of said double-ended pawl means against said outer notched surface of said bowl structure in another position of said reversing plate means whereby the same oscillation of said swingable arm by said actuator will drive the bowl structure in either direction depending on the position of said reversing plate.

2. The bowl rotating mechanism as defined in claim **1** wherein the main frame includes an adjusting ring and said rotating mechanism is mounted on the main frame

through its attachment to said adjusting ring and the actuator is connected between the swingable arm and said adjusting ring.

3. The bowl rotating mechanism as defined in claim 1 wherein the bowl structure includes a cap secured thereto and the pawl means is arranged to engage lugs on the outer surface of said cap.

4. The bowl rotating mechanism as defined in claim 2 wherein the cap is supported against diametrical shift through a plurality of bearings circumferentially supported from the adjusting ring.

5. The bowl rotating mechanism defined in claim 1 wherein the swingable arm is connected to a vertical shaft which is pivotally mounted on the main frame.

6. The bowl rotating mechanism defined in claim 5 wherein the vertical shaft is part of a rotary actuator which forms the actuator means.

7. The bowl rotating mechanism defined in claim 1 wherein a positioning means is connected to the reversing plate means and includes remote operating means whereby the direction of rotation can be controlled from a remote location.

8. The bowl rotating mechanism as defined in claim 1 wherein the actuator means is a hydraulic means capable of oscillating the swingable arm and the hydraulic means includes conduits, a source of fluid pressure, and control means remote of the bowl rotating mechanism for controlling it.

* * * * *