Aug. 13, 1968 F. M. ALLEN 3,396,915

BOWL ADJUSTMENT FOR CRUSHERS

Filed March 16, 1965 2 Sheets-Sheet 1

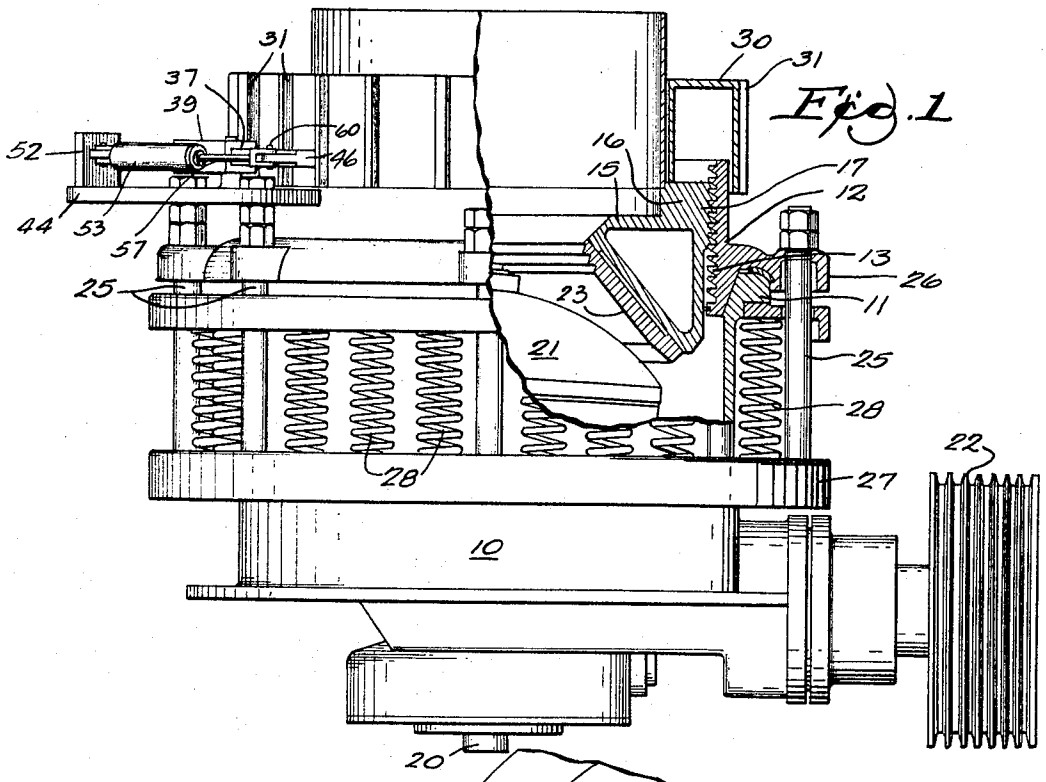


Fig. 1

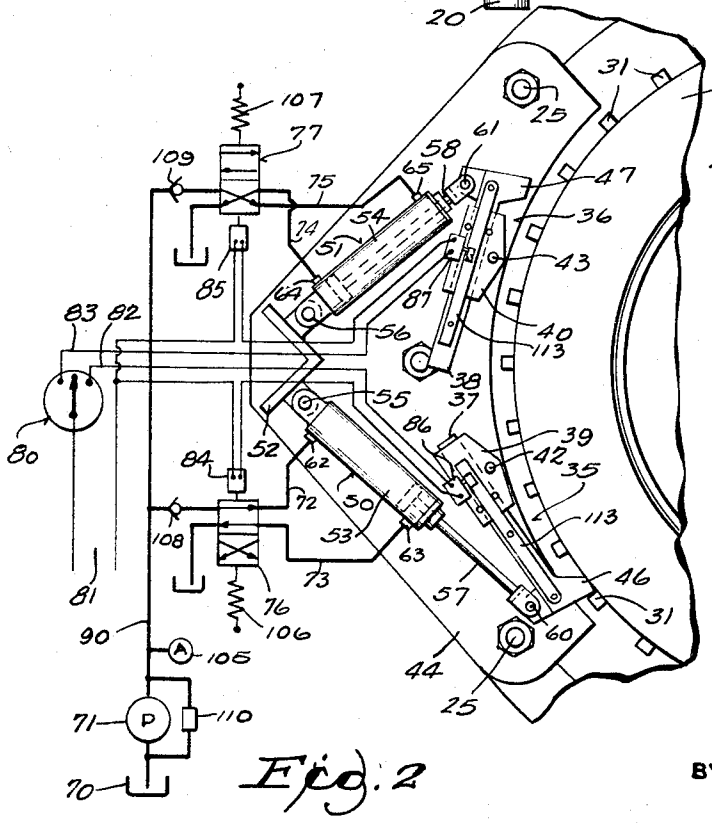


Fig. 2

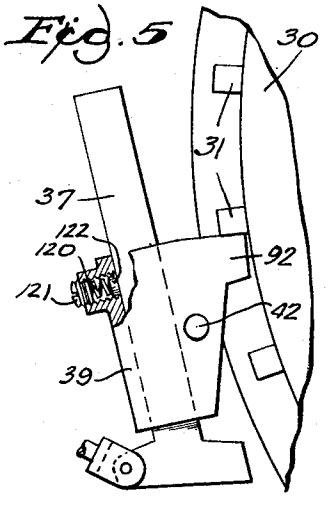


Fig. 5

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BOWL ADJUSTMENT FOR CRUSHERS

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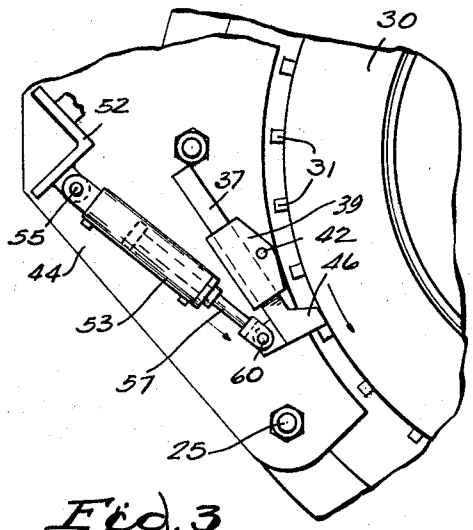


Fig. 3

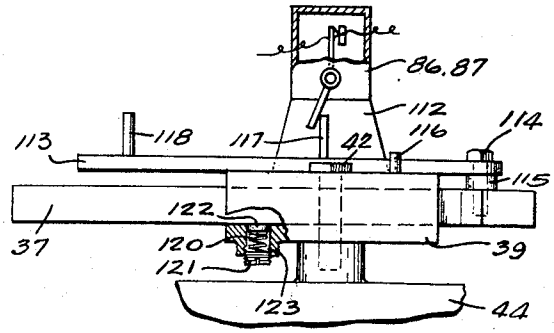


Fig. 4

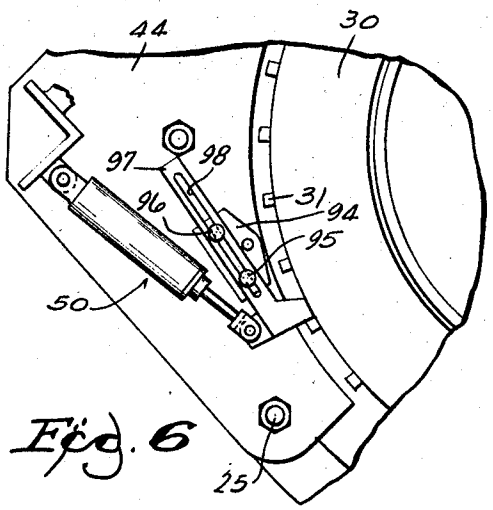


Fig. 6

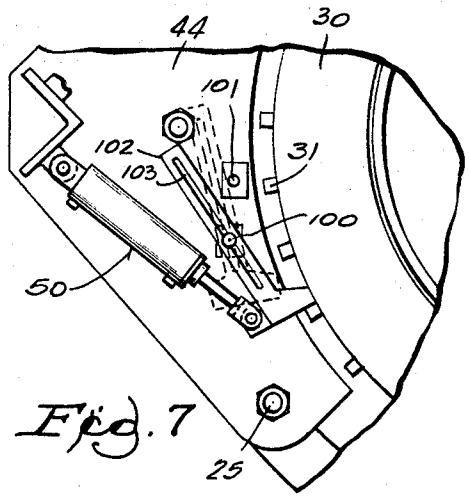


Fig. 7

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BOWL ADJUSTMENT FOR CRUSHERS

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18 Claims. (Cl. 241—290)

ABSTRACT OF THE DISCLOSURE

The present invention relates generally to improvements in the art of crushing rock and ore, and relates more particularly to the provision of an improved device for rotating the bowl or concave of a gyratory or cone type crusher to effect adjustments in the position of the bowl relative to the crushing head.

Background of the invention

Various types of crushing machines for the reduction of rock and ore have been heretofore proposed and are in common use. One of the most popular types of such crushing machines is the gyratory crusher. Briefly, a gyratory crusher embodies a rotary member or shaft carrying a crushing head mounted off center or eccentrically with respect to the axis of shaft rotation so that the head wobbles or gyrates within a surrounding concave bowl during crusher operation. Accordingly, the crushing action takes place in the gap between the gyrating crushing head and the bowl or concave.

In these machines, the particle size of the final product as produced by the crusher is dependent upon the size of the gap in the crushing zone which is defined by the space between the bowl and the head. Therefore, whenever it is desired to vary the particle size, it is necessary to change the dimension of the gap. In order to accomplish this, it is common practice to mount the crushing bowl or concave on the frame of the crusher in a manner which permits movement of the bowl relative to the crushing head.

While diverse means have been employed to permit adjustments to be effected in the position of the bowl, one of the most common expedients is to provide a threaded adjustment ring on the crusher frame and to form the crushing bowl or concave with a threaded flange engageable with the threads of the ring. Thus, the bowl is movable toward the crushing head to decrease the gap and particle size by rotating it in one direction within the threaded adjustment ring, and it is movable away from the crushing head to increase the gap and product size by rotating it in the opposite direction.

In gyratory crushers which employ such threaded adjustment ring on the frame and a cooperating threaded flange or the like on the bowl, it is necessary to provide means for rotating the heavy bowl to effect the desired adjustments. Such adjusting mechanism must be capable of rotating the heavy and ruggedly constructed crusher bowl along with its attendant apparatus over the resistance of considerable friction and binding between the relatively movable elements. Furthermore, rapid and positive operation is desirable so as to eliminate costly and time-consuming delays and non-productive shutdown time. In addition, the adjustment device must provide for effective rotation of the crushing bowl in both directions in order that the size of crushing gap may either be increased or decreased as required. Moreover, the adjustment mechanism must be safe in operation and rugged and durable in construction with a minimum of mechanical parts.

Summary of the invention

It is therefore a primary object of this invention to provide an improved automatically operable mechanism for rotating the bowl of a gyratory crusher to adjustably position the bowl on the crusher frame in a most efficient manner.

Another important object of the invention is to provide an extremely simple, compact and durable bowl adjusting device readily operable by relatively unskilled personnel to rapidly and effectively rotate the bowl in either a clockwise or a counterclockwise direction to accurately position the same on the crusher frame.

Still another object of the invention is to provide an improved adjusting mechanism for rotating a crusher bowl to adjustably position the same on the crusher frame which is highly flexible in its adaptations and readily applicable either to existing installations or to new machines, and which is furthermore substantially trouble-free with a minimum of mechanical parts subject to fatigue and resultant failure.

A further object of the present invention is to provide an improved adjusting mechanism for gyratory crusher bowls which includes a hydraulically operated pawl automatically actuated at the will of an operator, to rotate an adjusting nut carried by the bowl, the pawl being pivotally or swingably supported in a unique manner whereby the need for springs or other mechanical means for returning the same to or from a given position is entirely obviated.

These and other specific objects and advantages of the invention will become apparent from the following detailed description.

The drawings

A clear conception of the construction and operation of the bowl adjustment device embodying the invention and showing the same applied to and used in conjunction with a typical gyratory crushing machine may be had by referring to the drawings accompanying and forming a part of this specification, wherein like reference characters designate the same or similar parts in the several views.

FIG. 1 is a part-sectional side elevational view of a typical gyratory crusher embodying a bowl adjusting device of the present invention;

FIG. 2 is a somewhat enlarged fragmentary top view of the adjusting mechanism and the attendant portion of the bowl adjustment nut and showing the actuating pawl in one of its positions wherein it is approaching the end of its stroke just prior to reversal of the ram;

FIG. 3 is a similar fragmentary top view showing the pawl in another of its effective working positions near the commencement of its strokes;

FIG. 4 is an enlarged side view of the pawl and pawl guide with an electric switch operating device mounted thereon, a part of the pawl guide being broken away to also show the use of an adjustable friction drag for the pawl;

FIG. 5 is another fragmentary top view showing a similar actuating pawl but with the pawl guide modified to include a nut engaging locking portion and with the pawl friction drag in a somewhat different location;

FIG. 6 is another enlarged fragmentary top view of a somewhat modified actuating pawl which may be used in the improved bowl adjusting device; and

FIG. 7 is still another fragmentary top view showing a further modified actuating pawl capable of being interchanged with the pawls shown in the preferred arrangement.

Detailed description

While the present invention has been shown and described herein as being especially adapted for use with a gyratory crusher having a particular structural arrangement for the crusher frame, adjustment ring, concave bowl and adjustment nut therefor, it should be understood that the improved bowl adjustment mechanism may be advantageously applied to and utilized with different types of gyratory crushers, either with or without modifications, without departing from the spirit of the invention. It is also intended that the broadest possible interpretation shall be given to the descriptive terminology used herein, and it should furthermore be understood that it is entirely possible to utilize only a single pawl actuator rather than a pair of such actuators as shown and described herein.

Referring patricularly to FIG. 1 of the drawings, the gyratory crusher shown therein generally illustrates the type of crushing machine with which the present adjusting mechanism may be utilized to advantage. In this machine, the numeral **10** indicates the annular main frame or base of the crusher which terminates at its upper edge in outwardly projecting flange **11**. In turn, a concave supporting and adjustment ring **12** is seated on the frame flange **11**, and this ring **12** is formed with internal screw threads **13**. Adjustably supported on the main frame of the crusher is an annular crusher bowl or concave **15** having a radiating flange **16** formed with external screw threads **17** coacting with the threads **13** of the ring **12**, the bowl **15** also being provided with a generally frustoconical inner liner **18** suitably secured thereto. Mounted eccentrically at the upper end of a vertical rotatable shaft **20** extending centrally within the frame **10** is a gyratory crushing head **21**, and the shaft **20** and head **21** carried thereby are driven in a known manner by a suitable motor and belt drive (not shown) connected to a grooved pulley or sheave **22** which is, in turn, drivingly coupled with the lower end of the shaft **20**. Thus, the eccentrically mounted gyrating head **21** cooperates with the frustoconical liner **18** of the bowl or concave **15** to provide a downwardly and outwardly flaring annular crushing chamber or gap **23**.

In this type of gyratory crusher, the bowl supporting ring **12** is normally urged downwardly to seated condition against the stationary main frame flange **11** by an annular series of stud bolts **25** or the like having their upper ends seated against radiating portions **26** of the ring **12** and their lower ends carrying an annular reaction ring **27**. Compressed between the flange **11** of the frame **10** and the reaction ring **27** carried by the studs **25** is an annular series of coil springs **28** which are retained under compression by the studs **25**. Thus, whenever an uncrushable article such as a piece of metal or extremely hard rock or the like is deposited within the crushing chamber **23** during operation of the crusher, the springs **28** will become further compressed sufficiently to allow the concave or bowl **15** along with the ring **12** to move away from the fixed frame **10** and the crushing head **21** a distance sufficient to permit the foreign object to escape without damaging crusher parts.

As heretofore indicated, the particle size of the crushed material produced by the crusher is determined by the size of the crushing gap **23** between the bowl or concave liner **18** and the crushing head **21**. Accordingly, if it is desired to change particle size, it is necessary to change the dimensions of the crushing gap **23**. This is done by raising or lowering the crushing bowl **15** on the crusher frame **10** relative to the crushing head **21**. In the crusher illustrated, the raising or lowering of the bowl or concave **15** is accomplished by means of the coaction between the screw threads **13** of the bowl supporting ring **12** and the mating threads **17** of the bowl flange **16**, the desired adjustments being effected by rotating the bowl **15**. To facilitate rotation of the bowl **15** exteriorly of the crusher, an annular cap **30** is secured as by welding and/or bolts (not shown) to the upper annulus of the bowl **15**. This

cap **30** not only serves as a shield to protect the screw threads **13**, **17**, but it is also provided with an annular series of radiating ribs or lugs **31** which enables the cap **30** to also act as an adjustment nut for the bowl **15** as will hereinafter more fully appear. Thus, rotation of the cap **30** also rotates the bowl **15** which will accordingly be raised or lowered on the frame **10** by the coaction of the threads **13**, **17**.

In accordance with the present invention, rotation of the cap **30** and bowl **15** is accomplished either by one or by a pair of oppositely directed pawl assemblies **35**, **36** or the like, each pawl having its respective shaft or body portion **37**, **38** slidably received in a slide guide or cage **39**, **40** or the like. The pawl guides **39**, **40**, are, in turn, each pivotally mounted as at **42**, **43** respectively on a mounting plate **44** or the like, and this plate **44** is secured to the crusher laterally adjacent to the adjusting nut or cap **30** as by means of upper extensions on selected ones of the stud bolts **25**. Thus, with the pawl slide guides **39**, **40** swingable about their respective pivots **42**, **43**, reciprocating movement of the respective pawls by means of actuating forces directed against the heads **46**, **47** thereof at an angle to the longitudinal axis of their respective shafts **37**, **38** will cause the pawls **35**, **36** to swing so that the respective pawl heads **46**, **47** selectively engage the lugs or ribs **31** of the cap **30** to thereby rotate the cap **30** and bowl **15** in an obvious manner, either clockwise or counterclockwise dependent upon which of the pawls is being actuated.

In the present instance, fluid pressure is used to actuate the pawls **35**, **36**. As shown, a pair of double-acting hydraulic ram units **50**, **51** may be conveniently mounted on the plate **44** as by means of an upstanding angle iron bracket **52** or the like which is located radially outwardly of and between the pawl assemblies. With the cylinder end **53**, **54** of each of the respective ram units pivotally secured as at **55**, **56** to the upright post or bracket **52** and with the extensible piston or plunger **57**, **58** of each unit pivotally connected as at **60**, **61** to the heads **46**, **47** of the respective pawls **35**, **36**, the pawls may be selectively power actuated in an obvious manner by fluid pressure supplied alternately either to the ports **62**, **63** on opposite sides of the piston in cylinder **53** or to the ports **64**, **65** on opposite sides of the piston in cylinder **54**.

To supply pressurized fluid selectively to the cylinders **53**, **54**, a suitable hydraulic circuit may be employed. As shown in the present instance, hydraulic fluid from a supply reservoir **70** is pumped by a suitable hydraulic pump **71** either to the cylinder **53** via conduits **72**, **73** or to the cylinder **54** via conduits **74**, **75** as selected by an operator. Automatic reciprocation of the cylinders that operate the pawl may, of course, be achieved in various ways, but as shown, a pair of electrically operated solenoid valves **76**, **77** may conveniently be utilized for directing fluid flow respectively to the cylinders **53**, **54**.

The solenoid valves **76**, **77** may be actuated by means of an electrical circuit which includes a selector switch **80** interposed between the supply line **81** and lines **82**, **83** connected respectively to the solenoids **84**, **85** of the valve units **76**, **77**. Also included in the electrical circuit are a pair of limit switches **86**, **87** operated respectively by the extension and retraction of the pistons **57**, **58** of the hydraulic ram units to open and close the lines **82**, **83** respectively. The solenoid valves **76**, **77** are so designed that when the selector switch is moved to the "off" position, or when the electric current is interrupted, the flow of hydraulic fluid is automatically directed by the valves to position the hydraulic rams **50**, **51** in their retracted positions in which the pawls **35**, **36** are moved entirely away from the adjusting nut or cap **30**. Thus possible damage to the adjusting mechanism is eliminated in the event the crusher bowl **15** and the adjustment nut **30** should tend to rotate while the crusher is in operation.

To operate the adjusting mechanism shown and described herein, the hydraulic pump **71** is first energized

to supply power for the cylinder ram units **50, 51**. The desired rotation of the crusher adjusting nut **30** and the bowl **15** is then selected by means of the selector switch **80**. If the pawl limit switch contacts are closed, current then flows to the solenoid **84, 85** which shifts to the position directing flow through valve **76, 77** to port **62, 64** of the selected cylinder **53, 54** thereby extending the piston and rod **57, 58** connected to the respective pawls **35, 36**. When the hydraulic ram is extended to its predetermined distance, the contacts open in the limit switch **86, 87**, thus breaking the current to the solenoid **84, 85** which then shifts to the position directing hydraulic fluid to the port **63, 65** of the selected cylinder **53, 54** retracting the piston rod **57, 58**. At the end of the predetermined retracting stroke of the cylinder, the contacts in the limit switch again close causing the cycle to reoccur.

The recycling and resultant reciprocation of the piston rods **57** or **58** as selected by the operator in the manner thus described causes the selected pawl **35, 36** to reciprocate and simultaneously rock about its respective pivot **42, 43** and into and out of contact with the nut **30** and lugs **31** to thus rotate the nut and the bowl **15** attached thereto. This recycling action continues automatically as long as the power is on with the system energized as described, and to assure sufficient residual hydraulic power to retract the rams **50, 51** and thus withdraw the respective pawls **35, 36** entirely away from the nut **30** in case of electrical power failure, and accumulator **105** may be provided in the main hydraulic feed line **90**. Thus, if the electric power is interrupted with either of the pawl actuating pistons in its power stroke, the solenoid valve will be returned to its normal ram retract position (valve **77** of FIG. 2) by the action of its respective return spring **106, 107** since the fluid in line **73, 75** is pressurized by the accumulator **105**.

In accordance with customary practice, check valves **108, 109** are incorporated in the hydraulic feed lines from the pump to each cylinder in order to prevent feedback between cylinders. Also, other means to cause reciprocation of the pistons in the cylinders may be employed instead of the limit switches shown and described herein. Such means may comprise pressure operated valves or mechanically operated valves driven directly from the cylinder to achieve the same result. As shown, it is of course additionally desirable to incorporate an adjustable relief valve **110** in the hydraulic circuit in order to govern the hydraulic forces exerted and thereby prevent possible damage due to excessive forces.

In any event, the inventive concept involves the provision of one or more actuators suitably mounted for sliding and pivotal movement along with means of one kind or another operable on the actuator to simultaneously reciprocate and rock the same and thereby transmit radial and rotative forces to the crusher bowl. To cut down on cost, it is of course entirely possible and practical to use only a single actuating unit which may be interchangeably positionable selectively on either one of two pivot points so as to rotate the concave or bowl in the desired direction depending upon the mounting of the actuator. Furthermore, automatic operation may be dispensed with if desired, and the automatic devices such as the limit switches, selector switch and solenoid valves may be replaced by manually operated valves and a hand operated pump to thereby additionally lower the cost of the device.

As shown in FIG. 4, the limit switch **86** (or **87**) may be conveniently mounted as on a pedestal **112** or the like adjacent to the pawl assembly. In turn, the shaft of the pawl **37** (or **38**) may be provided with a trip pin carrying bar **113** secured to the pawl **37** at its extending end as by a screw or bolt **114** and spacer **115** so that the bar **113** spans the pawl guide cage **39**. The bar **113** therefore reciprocates with the pawl **37** and is guided between suitable bar guides **116** on the guide cage **39**, the bar also being provided with a pair of spaced upstanding limit switch trip pins **117, 118** for actuating the switch **86** as the pawl reciprocates.

In this same view, a friction drag device for the pawl **37** is shown in detail. This friction drag may consist merely of a small compression spring **120** or the like held captive between an adjustable set screw **121** and a disk **122** formed of bronze or other non-corrosive and wear resistent material and bearing against a side of the pawl shaft. The spring **120**, set screw **121** and disk **122** are all confined within a threaded hole **123** in the guide cage **39**, and more-or-less frictional resistance to reciprocable movement can be imposed on the pawl **37** by adjusting the set screw **121**. This frictional resistance or drag results in more positive movement of the pawl device as actuated by its hydraulic ram and the pawl is caused to swing outwardly about its pivot and away from the bowl adjustment nut immediately upon completion of each stroke.

As illustrated in FIG. 5, the pawl assemblies **35, 36** may also be provided with a locking device if desired. In this case, an extension **92** is added to the end of one or both of the slide guides **39, 40** the extension **92** being so positioned as to contact the ribs **31** on the crusher bowl adjusting nut **30** and thereby prevent rotation of the crusher adjusting nut **30** during operation of the crusher while also positively limiting rotation of the adjustment cap or nut **30** while the pawl is on its return stroke.

It should furthermore be understood that the pawl assemblies may be modified as shown, for example, in FIGS. 6 and 7. In FIG. 6, the slide guide **94** is provided with a pair of spaced pins **95, 96** or the like and the shaft or leg of the pawl **97** is formed with an elongated slot or groove **98** slidably received by the pins **95, 96**. Thus, the pins **95, 96** and the slot or groove **98** permit the same action as the pawls **35, 36** as described in detail. In FIG. 7, the swivelling slide guide **39, 40** or **94** is eliminated entirely and is replaced by a pair of guide pins **100, 101** which may be fixedly mounted on the plate **44**. In this arrangement, the pawl shaft **102** is also provided with a slot **103** which is slidably received on the pin **100**, and the pin **101** cooperates with the edge of the pawl shaft to prevent displacement and/or overtravel.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention:

I claim:

1. In a crusher having a frame, a crushing head mounted in said frame, and a crushing bowl mounted on the frame and adjustable by rotation to form an adjustable crushing gap with the crushing head; means to rotate the crushing bowl to effect adjustments comprising,

an annular member rotatable with the crushing bowl and provided with an annular series of radiating projections;

an actuator slidably and pivotally mounted on the frame and engageable with said projections; and

means operably connected to said actuator for reciprocating the same and for simultaneously swinging said actuator toward and away from said annular member and into and out of contact with the projections thereon to rotate the bowl.

2. Means to rotate the crushing bowl according to claim **1**, wherein the annular member rotatable with the crushing bowl is a cap secured to the bowl and extending upwardly therefrom.

3. Means to rotate the crushing bowl according to claim **1**, wherein a pair of actuators are provided, said actuators being swingable in opposite directions to selectively rotate the bowl either clockwise or counterclockwise.

4. Means to rotate the crushing bowl according to claim **1**, wherein the actuator is in the nature of a pawl having an elongated shaft slidably received in a pivotally mounted guide member.

5. Means to rotate the crushing bowl according to claim

4, wherein the guide member is mounted for swinging movement about a pivot axis located laterally of the pawl shaft and the plane of reciprocable movement thereof.

6. Means to rotate the crushing bowl according to claim 1, wherein the means for simultaneously reciprocating and swinging the actuator is a hydraulic power unit pivotally mounted independently of said actuator.

7. Means to rotate the crushing bowl according to claim 6, wherein the actuator and the hydraulic ram operably connected thereto are mounted as a unit on a plate secured to the crusher frame laterally of the bowl.

8. Means to rotate the crushing bowl according to claim 1, wherein the means for simultaneously reciprocating and swinging the actuator is a power device controlled electrically in response to the movement of said actuator.

9. Means to rotate the crushing bowl according to claim 3, wherein the means for selectively reciprocating and swinging the actuators includes a pair of hydraulic power units and electric control means therefor responsive to movement of the respective activators..

10. Means to rotate the crushing bowl according to claim 1, wherein means is provided for creating a frictional drag on the actuator to resist sliding movement thereof.

11. Means to rotate the crushing bowl according to claim 10, wherein means is provided for adjusting the frictional drag on the actuator to vary the resistance thereof to sliding movement.

12. A bowl adjustment mechanism for a crusher having a main frame, a crushing head mounted for movement in said frame, and a crushing bowl mounted on the frame for rotary adjustment relative thereto, said adjustment mechanism comprising,

means providing an annular series of radiating lugs for the bowl;

an actuator mounted on the frame for sliding and pivotal movement; and

means independently mounted for swinging movement and pivotally connected said actuator for simultaneously reciprocating and swinging the same into and out of contact with said lugs to thereby transmit

radial and rotative forces to the bowl through said lugs.

13. A bowl adjustment mechanism for a crusher according to claim 12, wherein the actuator is a pawl having a head engageable with the lugs and a shaft slidably contained in a pivotally mounted guide member.

14. A bowl adjustment mechanism for a crusher according to claim 13, wherein the means for reciprocating and swinging the actuator is a hydraulic ram mounted at one end laterally of the actuator and pivotally secured at its other end to the head end of the pawl.

15. A bowl adjustment mechanism for a crusher according to claim 13, wherein the guide member is provided with frictional drag means coacting with longitudinal edge of the pawl shaft to resist sliding movement thereof.

16. A bowl adjustment mechanism for a crusher according to claim 14, wherein the hydraulic ram is double-acting and is connected to a pressurized supply source past an electrically operable control valve.

17. A bowl adjustment mechanism for a crusher according to claim 16, wherein the electrical system for the control valve includes a limit switch and means carried by the actuator for tripping said switch responsve to movement of the pawl.

18. A bowl adjustment mechanism for a crusher according to claim 13, wherein the guide member is formed with an integral projection swingable with said member to a position between adjacent lugs whenever the pawl is withdrawn.

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