June 12, 1962 G. D. BECKER 3,038,670

HYDRAULIC RELEASE FOR GYRATORY CRUSHERS AND THE LIKE

Filed March 24, 1958 2 Sheets-Sheet 1

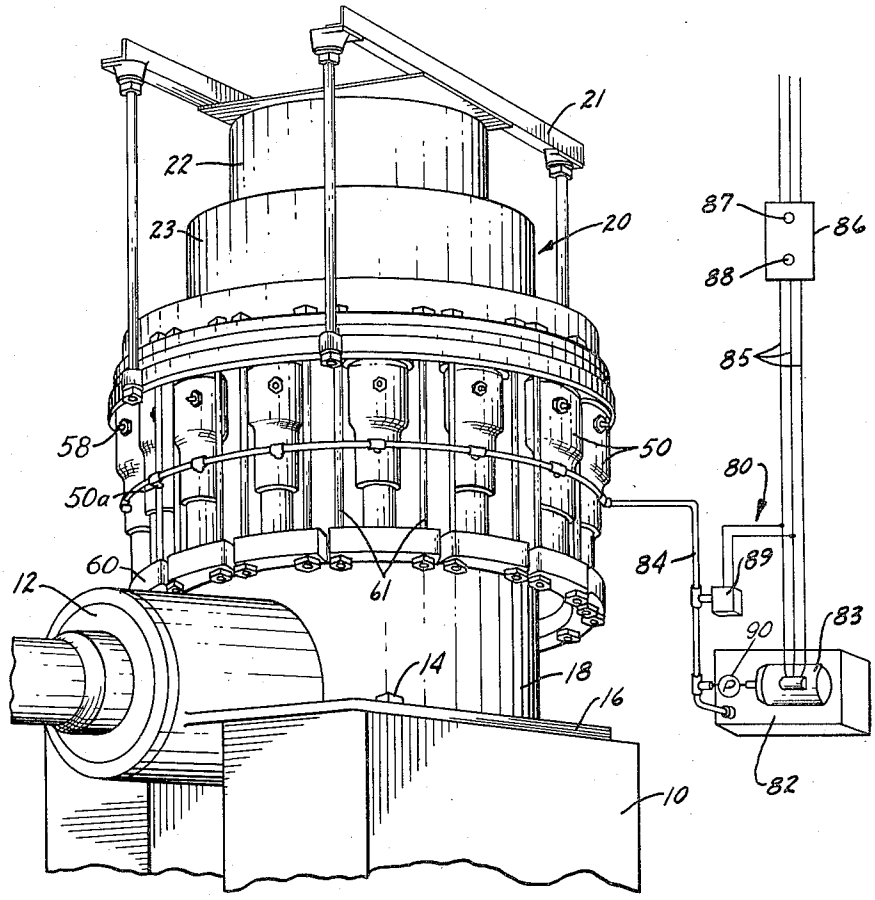



Fig. 1.

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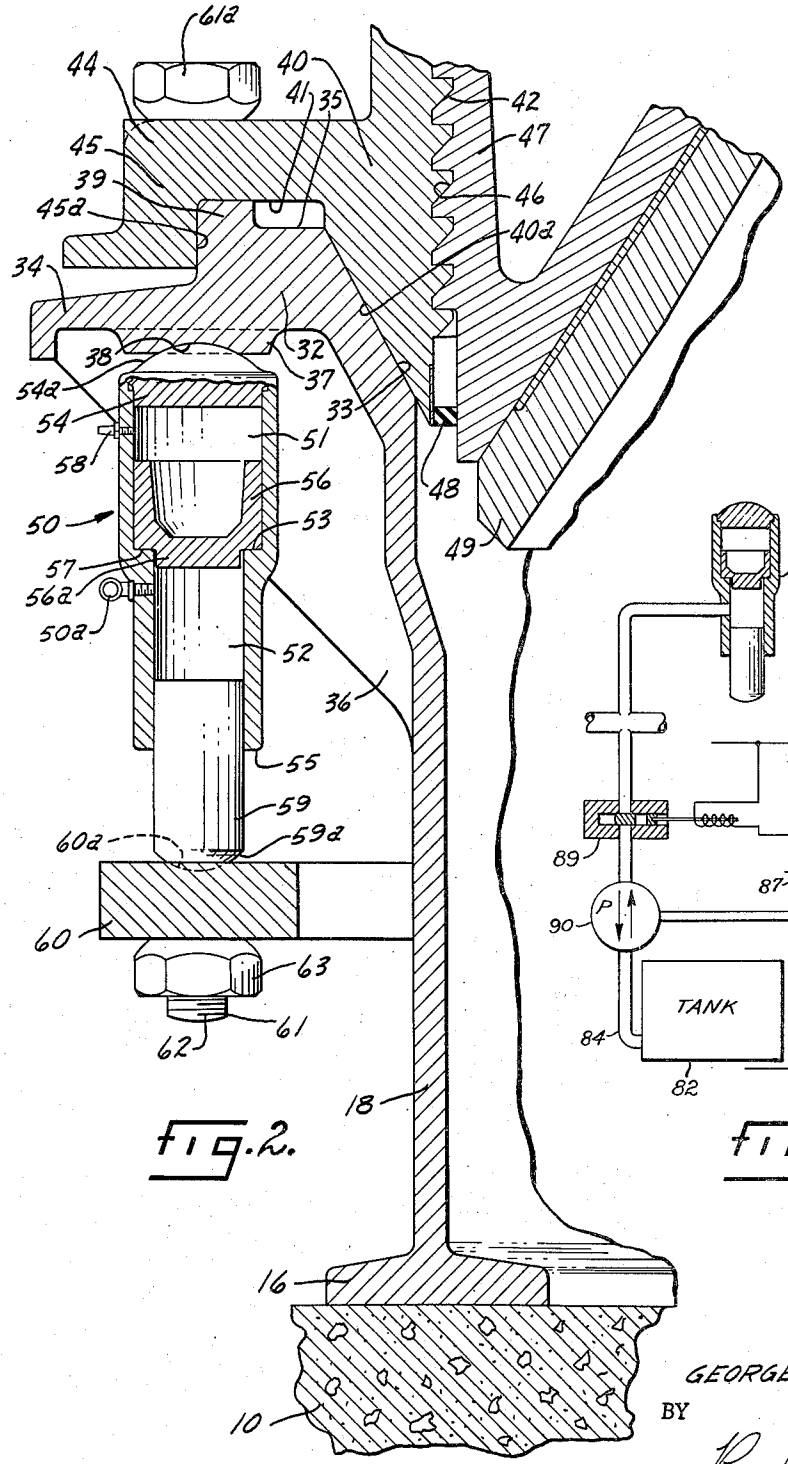



fig. 2.




fig. 3.

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# 3,038,670
# HYDRAULIC RELEASE FOR GYRATORY CRUSHERS AND THE LIKE

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The present application relates to an improvement in cone crushers of the type in which a cone shaped head rotates eccentrically within a bowl. It has for one purpose to provide improved releasing means for moving the bowl of the crusher when uncrushable materials become wedged between the bowl and the head.

Another purpose is to provide a hydro-pneumatic system for alternately releasing and securing the bowl of a cone crusher to its bowl supporting structure.

Another object is to provide a bowl securing and releasing means for a gyratory crusher whereby conventional mechanical linkages for securing the bowl to its supporting structure are eliminated and replaced by fluid pressure.

Another object is to provide a hydraulic-pneumatic cylinder adapted for use on a gyratory cone crusher for securing and releasing the bowl to the main crusher frame and which is adapted to release the coupling pressure between the frame and the bowl by the release of the hydraulic fluid from the cylinder.

Other purposes will appear from time to time in the course of the specification and claims.

I illustrate my invention more or less diagrammatically in the accompanying drawing wherein:

FIGURE 1 is a perspective view of a typical cone crusher showing my hydro-pneumatic cylinders and their control system;

FIGURE 2 is a vertical sectional view taken through a hydro-pneumatic cylinder; and

FIGURE 3 is a schematic view of a control system for the oil pump motor.

Like parts are indicated by like reference characters throughout the specification and drawings.

Referring now to the drawings, a cone crusher is shown in FIGURE 1 as attached to a base **10** by bolts **14** that secure the base flange **16** to the base supporting structure. The crusher itself consists of a circumferential crusher frame or bottom shell **18** and a superstructure **20** which may consist of a feeding platform **21**, a hopper **22**, and a crushing chamber **23**.

Circumferentially disposed around the bottom shell are a plurality of hydro-pneumatic cylinders **50** with their associated control circuit **80**.

It will be understood that the details of the crusher are conventional and need not be further described here. Suffice it to say that in crushers of this type the material is fed through the hopper **22** into a crushing cavity formed between a relatively stationary bowl and a gyrating head. The head includes a crushing mantle and is eccentrically mounted to alternately narrow and widen the cavity between the bowl with its liner and the mantle during gyration. The mantle and head are propelled by power from the source **12**.

Turning now to FIGURE 2 my improved hydro-pneumatic cylinder is shown in section along with the main crusher frame **18** and the bowl supporting ring **40**. The base flange **16** and circumferential crusher frame **18** extend upwardly and terminate in a main crusher frame flange **32** which is shown as having an outwardly and downwardly extending apron **34** and a plurality of reinforcing ribs **36**. It will be understood that the ribs may be disposed at structurally convenient locations around the circumference of the crusher frame and they have



been omitted from FIGURE 1 for purposes of clarity. Flange **32** has an inner, upwardly conic surface **33** which terminates in an annular horizontal surface **35**. Disposed exteriorly and upwardly with respect to the horizontal surface **35** is an upstanding flange **39** which abuts against a lower surface **41** of the bowl support ring **40**. The undersurface of the flange **32** is formed with a slightly projecting portion **37** which has indentations **38** therein to receive the upper end of a hydro-pneumatic cylinder **50**.

The hydro-pneumatic cylinders **50** include an upper chamber **51** and a lower chamber **52** roughly defined by an offset portion or shoulder **53** located approximately midway between the cap **54** and the bottom **55** of the cylinder. The cap **54** is formed with a rounded top as indicated at **54***a* and is screw threaded or otherwise suitably secured to the upper end of cylinder **50** to form a gas tight seal. Disposed in the upper chamber **51** is a gas holding piston **56** having a bottom projection **56***a* adapted to be loosely received within the lower chamber **52**. Piston **56** has an annular surface **57** which seats upon the shoulder **53**. The gas holding piston **56** is reciprocable within the chamber **51** and is precisely machined in order to provide a gas tight fit under comparatively high gas pressures. A filler valve **58** which may be a conventional automatic valve similar to the filler valve found on bicycle and automobile tires is located near the top of chamber **51**.

The bottom of the cylinder is closed by a hydraulic piston **59** having a rounded bottom **59***a* which is reciprocable in the chamber **52**. A suitable hydraulic valve **50***a* is positioned in the lower portion of the cylinder near the shoulder or middle offset.

The hydro-pneumatic cylinder is held in place by a lower movable abutment **60** which is not connected to the crusher frame and may be continuous or discontinuous. In FIGURE 1, I have shown it as discontinuous. The abutment is formed with an indentation **60***a* to receive the rounded end **59***a* of the hydraulic piston **59**. A pair of bolts **61** straddles each hydro-pneumatic cylinder and extends through the lower abutment **60** upwardly through the main crusher frame flange **32** and the support ring flange **44**. The bolts are headed as at **61***a* to seat in the support ring flange and are screw threaded as at **62** to receive an adjusting nut **63**.

The bowl support ring is indicated at **40** and has an internally screw threaded portion **42**. The ring is formed with an outwardly projecting flange **44** with an outwardly and downwardly extending apron **45** which forms an internal annular cavity **45***a* having a lower surface **41**. An outwardly and upwardly inclined conic surface **40***a* seats on surface **33**. The internal screw threaded portion **42** is in engagement with a similarly threaded portion **46** of the bowl **47**. The screw threaded portion does not extend to the lower extremities of the bowl and to provide a bar to the entry of dust and abrasive material, a renewable dust seal indicated at **48** is interposed between the bowl supporting ring and the bowl itself. A suitable bowl liner **49** is securely fastened to the bowl **47** by any well known means.

Referring to FIGURE 1, the hydraulic control system is illustrated diagrammatically as consisting of an oil reservoir **82**, a suitable oil pump **90** and an oil pump motor **83**. A pipe line **84** extends between the oil reservoir and the hydro-pneumatic cylinders and is connected to each through the hydraulic connections **50***a*. Power is supplied to the motor **83** through suitable leads **85** connected to a starter **86** having control buttons **87** and **88**. Disposed in the pipeline **84** between the reservoir and the cylinders is a solenoid operated valve **89** which is connected across two of the leads to the oil pump motor between the motor and the starter. The solenoid valve

is live no matter which direction the motor is operated so that the valve will always be open whether the motor is run to pump in or to pump out.

It will be realized that whereas I have described and shown a practical and operative device, nevertheless, many changes may be made in the size, shape, number and disposition of parts without departing from the spirit of my invention. I therefore wish may description and drawings to be taken in a broad sense illustrative or diagrammatic rather than as limiting me to my specific disclosure. It will be understood for example that whereas I have illustrated a single hydro-pneumatic cylinder disposed between a pair of bolts **61**, it would be entirely feasible to place a pair of cylinders between each pair of bolts in order to provide a more positive and uniform extension and retraction movement. Similarly I have shown my hydro-pneumatic cylinders placed below the level of the flanges **32** and **44** but it would be entirely possible to dispose the cylinders above the flanges. In addition, the lower movable abutment **60** may be continuous as shown in FIG. 2 or discontinuous as in FIG. 1.

The use and operation of my new and improved hydro-pneumatic release system is as follows.

Steel springs are the means presently employed on a great many gyratory crushers for holding the bowl in place on the main crusher frame. During normal operation these springs are under compression so that the bowl, acting through the bowl support ring **40**, is securely held with respect to the crusher frame. The springs are yieldable enough so that when uncrushable material enters the crushing cavity, the bowl liner and main crusher frame will separate slightly if necessary to pass the material through. As soon as the material has been passed, the springs acting under compression will pull the bowl support ring back into contact with the main crusher frame. It often happens however that large uncrushable materials such as tramp iron or dipper teeth find their way into the crushing cavity and when these materials are too large to be passed through, the crusher will eventually stall. The crusher will stall in a position such that the bowl supporting ring **40** will have been lifted from the main crusher frame **18** and the surfaces **33** and **40***a* will be separated. The full force of the springs will then be exerted on the uncrushable material. Removing the uncrushable material is a dangerous and difficult task and frequently requires considerable time. The hydro-pneumatic cylinder provides a yielding medium interposed between the main crusher frame and the bowl which allows the amount of give or play necessary to the normal operation of the crusher but at the same time securely hold the two parts together. If uncrushable material enters the cavity and stalls the crusher the combination of compressed air and hydraulic liquid may be so operated that the pressure on the uncrushable material will be rapidly released, the uncrushable material quickly removed, and operation resumed.

During normal operation of my system the upper chamber **51** of the hydro-pneumatic cylinder may be filled with a compressed gas at around 2500 lbs. per square inch. Nitrogen may advantageously be employed. The gas seats the piston **56** in place on the shoulder or middle offset **53**. The lower chamber **52** is filled with a substantially incompressible hydraulic liquid such as oil, and as a consequence the upper cap **54** of the cylinder is pushed against the projection **37** on the lower side of the flange **32**, and the lower piston **59** pushes against the movable abutment. Displacement of piston **59** is prevented by the bolts **61** which pass through the abutment and the two flanges. The net effect is that the bowl supporting ring **40** is held down against the main crusher frame **18** and the crushing bowl is thus firmly positioned. The two flanges **44** and **32** are held tightly together and the pressure of the gas is exerted against the small lower



piston **59** only to the extent that the gas holding piston **56** is raised from the middle offset.

Now, in the event of the entrance of uncrushable materials into the crushing chamber great pressure will be exerted against the crushing bowl. The pressure will be transmitted through the bolts **61** to the lower movable abutment **60** and will tend to raise it adjacent that portion of the cavity in which the uncrushable material is located. As the abutment **60** moves upwardly it will force the lower hydraulic piston **59** upwardly into chamber **52** pushing the oil ahead of it against the gas holding piston **56**. As the gas holding piston moves upwardly into the upper chamber the nitrogen will be compressed even further. When the driving motor stalls the crushing action is stopped on the hardest material in the crushing chamber and the full pressure of all of the cylinders adjacent this portion of the crushing cavity comes to bear on the noncrushable piece.

Heretofore, it has been common practice when the machine has stalled to dig out the crushing chamber by hand. This is an onerous and time consuming task. When the non-crushable material, usually tramp steel is bared it is a very difficult and dangerous process to remove it. Common practice is to burn it out, but the last piece must be burned out before the crusher will be relaxed so that it can again be started. When the last piece is burned out, the crusher usually returns to a normal, unstressed condition with considerable commotion and at great danger to the workman holding the acetylene lance used for burning.

When a crusher equipped with my hydro-pneumatic cylinder stalls, the cylinder will yield and the gas will be further compressed in a manner analogous to the compression of springs as indicated above. In a similar manner, great pressure will be brought to bear on the tramp steel and the crusher will stall.

To remove the uncrushable material, the drain button **87** is depressed to energize an electric circuit which runs the oil pump motor **83** in a direction suitable for removing the hydraulic fluid from the lower chamber of the piston. It will be understood that valve **89** is closed during normal operation so that the hydraulic fluid, which may be oil, for example, is trapped in lower chamber **52**. As the oil is drained from the pistons the nitrogen expands until the gas holding piston **56** reaches the shoulder **53**. At the same time the piston **59** travels upwardly into the chamber **52** as far as necessary or until it touches the nitrogen piston. With proper design this relaxing motion should be sufficient to relieve the pressure on the non-crushable material. Although the use of a pump has been described to drain the oil from the cylinders, it may be feasible under some conditions to permit the oil to flow out on its own under the pressure exerted by the compressed gas acting on piston **56**. It should also be understood that the pump unit is preferably reversible so that oil can be pumped either in or out. The wiring should be so arranged, however, that regardless of whether oil is being pumped in or out, valve **89** is open. Likewise, when the pump is not running or the oil is not draining under the influence of the gas pressure in the cylinders, valve **89** is closed.

After the noncrushable material has been removed, the fill button **88** is depressed and the pump motor run in the opposite direction to pump oil from the reservoir **82** through the pipe **84** that girdles the hydro-pneumatic pistons, through the hydraulic connections **50***a* and into the lower chambers. When sufficient oil has been pumped to seat the bowl support ring **40** on the conical surface **33**, valve **89** is closed, the motor is de-energized, and normal operation resumed.

It will be understood that the length of stroke of the hydraulic piston **59** may be suitably regulated so that the pressure on the non-crushable material will be relieved before the piston reaches the level of the hydraulic valve. In one known type of cone crusher for example having a

cone with a diameter of seven feet at the lower edge, the length of a stroke may be on the order of 4½ to 5 inches. However, I have designed pistons with a 7½ inch maximum travel and a 5½ inch stroke. In this same machine, and with a 2¾ inch stroke in the upper chamber **51**, a maximum working pressure of approximately 4400 p.s.i. adiabatic may be obtained. The hydraulic piston **59** in such an installation would exert a force on the order of 65,000 lbs.

Throughout the claims, I have used the term "double fluid pressure cylinder assembly" to denote a structure utilizing a compressible and an incompressible pressure fluid as working fluids.

I claim:

1. In combination, a gyratory cone crusher having a circumferential main frame wtih an outwardly extending flange adjacent its upper edge, a bowl support ring tiltably mounted on said flange and upwardly movable therefrom, a bowl mounted on the bowl support ring, yielding means for normally holding the bowl support ring downwardly against said flange and to thereby substantially fix the bowl in relation to the main frame while permitting overload release, the bowl support ring having a surface adapted to engage a complementary surface on the main frame of the crusher to thereby seat the bowl on the frame of the crusher and having an outwardly projecting flange overlying the main frame when the crusher is in normal operation, a movable abutment member extending exteriorly of the main frame of the crusher and disposed substantially in alignment with the flanges, the abutment member being positively limited in its path of movement in a direction away from the bowl support ring flange by rigid restraining means, but being free to move toward the bowl support ring flange on the restraining means, a hydropneumatic cylinder disposed between the abutment member and the two flanges when they are in abutting relationship, the cylinder being closed at one end, an interior piston mounted within the cylinder by means associated with the cylinder, an exterior piston disposed in the cylinder and projecting outwardly therefrom at the opposite end of the cylinder to thereby form a closed chamber encompassed by the upper and lower pistons and the lower portion of the cylinder walls, one of said chambers being adapted to contain a compressible fluid and the other of the chambers being adapted to contain a substantially non-compressible fluid, and an external circuit including pump means adapted to alternately bleed off and recharge the substantially non-compressible fluid in response to the operation of a selectively operable control circuit.

2. In a cone crusher having a main frame and a crushing bowl support structure tiltably and upwardly mounted on the main frame, restraining means for maintaining the support structure in engagement with the main frame under normal crushing stresses and for releasing pressure between the support structure and main frame under abnormal crushing stresses, said restraining means including a double pressure cylinder assembly operatively positioned between the support structure and the main frame, said double pressure cylinder assembly including a cylinder having a closed end, a first piston extending outwardly from the other end of the cylinder and into engagement with the main frame or support structure, and a second piston within the cylinder, said second piston forming two fluid pressure chambers, means for admitting a compressible fluid to one chamber and means for selectively admitting and bleeding off incompressible fluid to the other chamber, said incompressible fluid chamber being formed between the first and second pistons.

3. Means for maintaining a crushing bowl supporting member in engagement with a main frame member under normal crushing stresses and for relieving engaging pressure between the frame and bowl supporting members under abnormal crushing stresses, said crushing bowl supporting member being tiltably and upwardly mounted on the main frame member, said means including an abutment, connecting means between the abutment and one of the members, the other member being between the abutment and said one member, said connecting means limiting the travel of the abutment member to a pre-determined position in one direction, a double pressure cylinder assembly positioned between the abutment member and the other member, said double pressure cylinder assembly including a cylinder having a first outwardly extensible and retractable piston at one end and a second internal piston between the first piston and the other end, said other end being closed, said second piston dividing the cylinder into an upper and a lower chamber, means for admitting a compressible fluid to one of the chambers, and means for selectively admitting and exhausting a substantially incompressible fluid to the other chamber, said incompressible fluid chamber being formed between the two pistons.

4. The structure of claim 3 further including stop means within the cylinder to limit the travel of the second piston to thereby limit the size of the compressible fluid chamber.

5. Means for maintaining a crushing bowl support structure which is tiltably and upwardly mounted on the main frame of a crusher in engagement with the main frame under normal crushing stresses and for relieving the restraining force under abnormal crushing stresses, said means including an abutment member, connecting means between the crushing bowl support structure and the abutment member for limiting the travel of the abutment member with respect to the support structure in one direction while permitting relative movement in the other direction, a double fluid pressure cylinder between the said abutment member and the main frame, said main frame being positioned between the abutment member and the support structure, said double fluid pressure cylinder having an outwardly extensible and retractable piston at one end and a second internal piston dividing the cylinder into a pair of pressure chambers, means for admitting a compressible fluid to one of the pressure chambers, and means for selectively admitting and bleeding off a substantially incompressible fluid to the other pressure chamber, said incompressible fluid pressure chamber lying between the two pistons.

6. The structure of claim 5 further including stop means within the cylinder for limiting the travel of the internal piston towards the extensible and retractable piston.

7. In combination, a gyratory cone crusher having a circumferential main frame with an outwardly extending flange adjacent to its upper edge, a bowl support ring tiltably mounted on said flange and upwardly movable therefrom, a bowl carried by the bowl support ring, yielding means operable to hold the bowl support ring downwardly against the main frame flange under normal crushing stresses and to permit the separation of the bowl support ring and main ring flange under abnormal crushing stresses, the bowl support ring and main frame having complementary seating surfaces, the bowl support ring having an outwardly projecting flange overlying the main frame flange when the crusher is in normal operation, said yielding means including a movable abutment member positioned exteriorly of the main frame of the crusher and disposed generally in alignment with the flanges, the abutment member being positively limited in its path of movement in its direction away from the bowl support ring flange by a rigid restraining means but being free to move toward the bowl support ring flange, a hydropneumatic cylinder positioned between the abutment member and the two flanges, the cylinder being closed at one end, an interior piston mounted within the cylinder and an exterior piston exposed in the cylinder and projecting outwardly from the other end of the cylinder to thereby form, with the interior piston in the closed end of the cylinder, an upper and lower pressure chamber, one of said chambers being adapted to contain a compressible

fluid and the other of said chambers being adapted to contain a substantially non-compressible fluid, and a control circuit including pump means adapted to drain off and refill the substantially non-compressible fluid.

8. For use in a gyratory crusher having a frame and a bowl assembly tiltably mounted on said frame for movement toward and away from said assembly, yielding means for holding the bowl assembly against the frame under normal crushing stresses while enabling overload release under abnormal crushing stresses, said yielding means, including, in combination, an abutment generally vertically aligned with the frame and means for limiting movement of the abutment member away from the frame and a double fluid pressure cylinder assembly operatively disposed between the frame and abutment member, said cylinder assembly including a cylinder having compressible and substantially non-compressible expandable fluid pressure chambers within the cylinder, a reciprocal piston urged outwardly from the cylinder into engagement with the abutment member in response to the combined additive pressures in the chambers, and means for collapsing one of the expandable pressure chambers to thereby provide at least a limited travel of the abutment member toward the frame to thereby facilitate separation of the bowl assembly from the frame under abnormal crushing stresses.

9. Yielding means for holding the bowl assembly of a gyratory crusher against the crusher frame on which it is tiltably mounted under normal crushing stresses while enabling overload release under abnormal crushing stresses, said yielding means including, in combination, an abutment generally vertically aligned with the frame and means for limiting movement of the abutment away from the frame and a double fluid pressure cylinder assembly operatively disposed between the frame and abutment member, said cylinder assembly including a cylinder having compressible and substantially non-compressible expandable fluid pressure chambers within the cylinder, a reciprocal piston urged outwardly from the cylinder into engagement with the abutment member in response to the combined additive pressures in the



chambers, and means for collapsing one of the expandable pressure chambers to thereby provide at least a limited travel of the abutment member toward the frame to thereby facilitate separation of the bowl assembly from the frame under abnormal crushing stresses.

10. The yielding means of claim 9 further characterized in that the collapsing means includes a fluid line connected to the non-compressible pressure chamber and adapted for a connection to a source of substantially non-compressible fluid, valve means in the line and means for opening the valve means to thereby enable the substantially non-compressible fluid to be drained from the chamber under abnormal crushing stresses.

11. A method of releasing abnormal forces between the frame and the bowl in a cone crusher having the bowl mounted for movement toward and away from the frame,

said method including the steps of applying an initial restraining force in a direction to urge the bowl into normal crushing engagement with the frame,

said initial restraining force being composed of a yieldable force superimposed on a confined volume of a non-compressible pressure fluid,

intensifying the initial restraining force in response to abnormal movement between the bowl and the frame,

reducing the intensified restraining force by temporarily removing at least a portion of the confined volume of non-compressible pressure fluid from the system, and,

after removal of said portion of the confined volume of non-compressible pressure fluid, returning the bowl and frame to normal crushing engagement.

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