June 5, 1934. G. D. BECKER 1,961,811

CRUSHER

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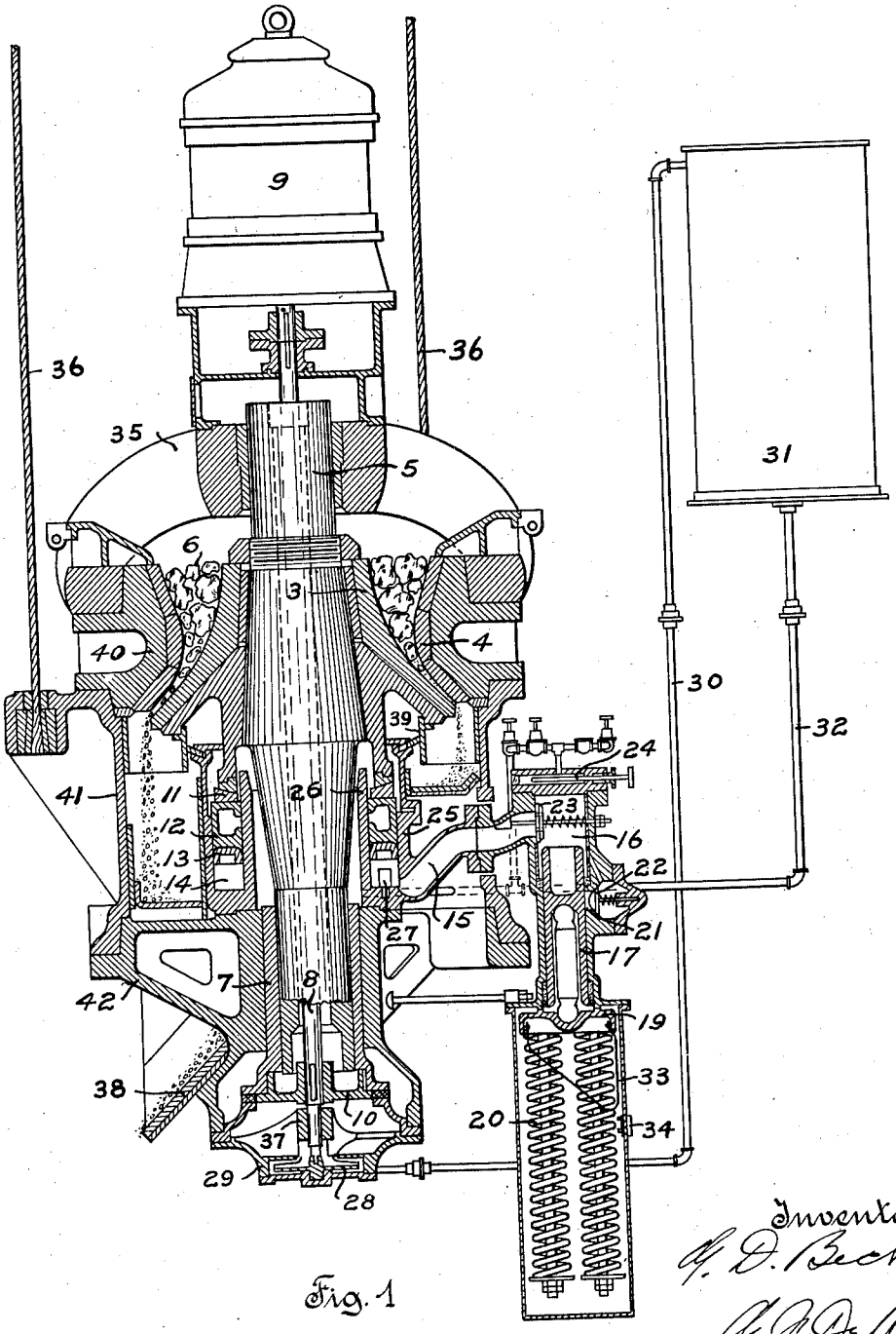


Fig. 1

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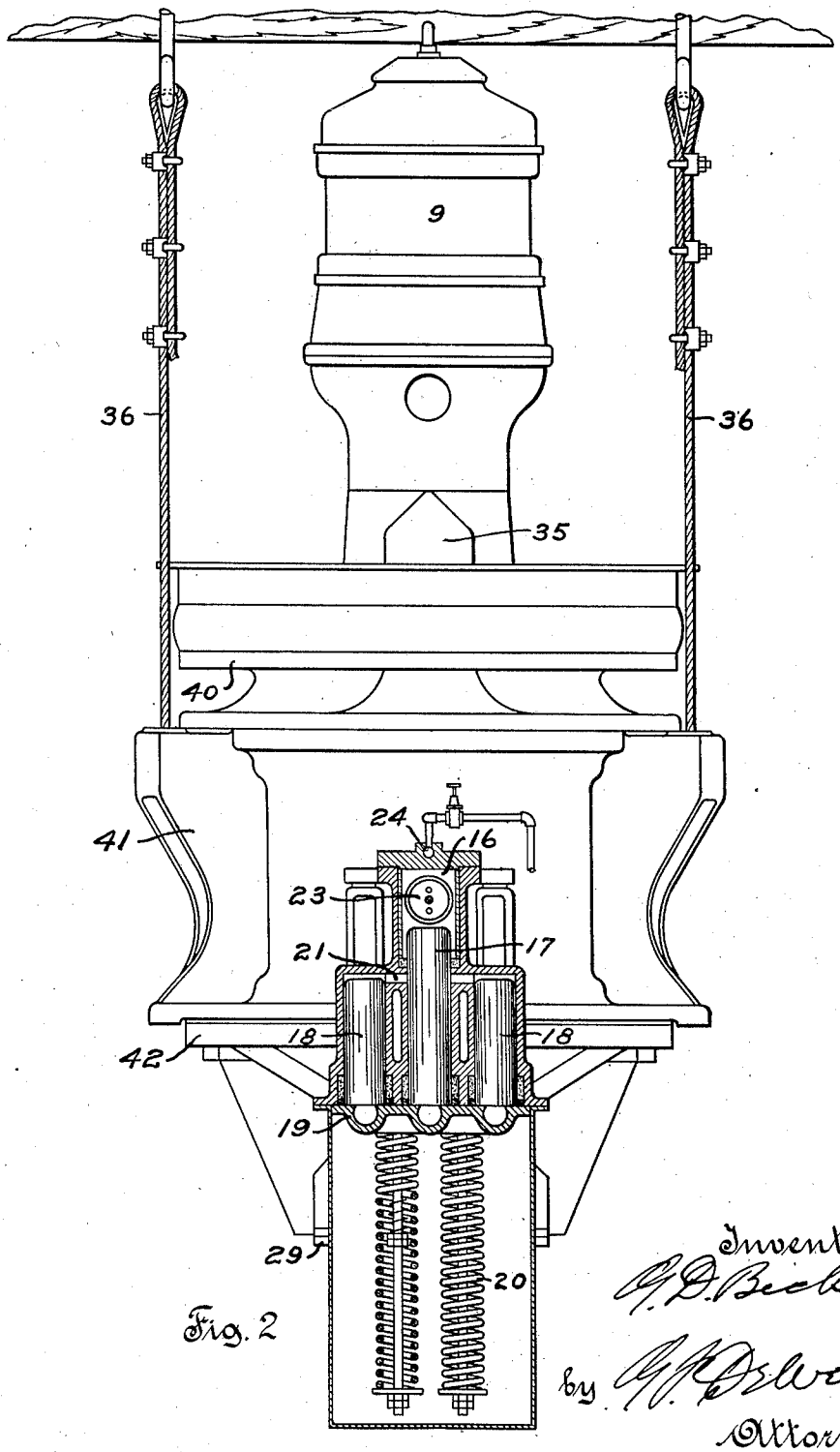


Fig. 2

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1,961,811

CRUSHER

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Application June 9, 1930, Serial No. 459,941

14 Claims. (Cl. 83—10)

The present invention relates in general to improvements in the art of supporting movable machine elements, and relates more specifically to improvements in the construction of fluid supports or pressure resisting devices especially adapted for use in connection with crushing members or the like.

An object of the invention is to provide improved means for resisting variable pressures existing between the working parts of certain types of machines such as stone crushers, whereby such machines are effectively protected against damage due to abnormal conditions of operation. Another object of the invention is to provide improved automatically functioning mechanism for releasing excessive pressures in a fluid reaction device for machine elements. A further object of the invention is to provide improvements in thrust bearing structures for crushers or the like. These and other objects and advantages will appear from the following description.

Some of the novel features of crusher construction, disclosed but not specifically claimed herein, form the subject of copending applications now Patent No. 1,799,476, April 7, 1931, and Patent No. 1,799,477, April 7, 1931.

No claim is made herein broadly to the means for gyrating one member within another member to crush material and a fluid pressure support for maintaining said members separated a predetermined amount herein disclosed for this constitutes the subject matter of a copending application Ser. No. 452,864, filed May 16, 1930, by R. C. Newhouse.

Also no claim is herein made to the novel lubricating system herein disclosed for this constitutes the subject matter of a copending application Ser. No. 453,446, filed May 19, 1930, by R. C. Newhouse and G. D. Becker.

A clear conception of an embodiment of the invention and of the mode of constructing and of operating mechanisms built in accordance therewith, may be had by referring to the drawings accompanying and forming part of this specification in which like reference characters designate the same or similar parts in the several views.

Fig. 1 is a central vertical section through a gyratory crusher of the high speed type, having an improved thrust bearing structure associated therewith.

Fig. 2 is a part sectional side elevation of the improved gyratory crusher shown in Fig. 1, a portion of the fluid support being shown in section.

The gyratory crusher specifically shown in the drawings by way of illustration, comprises in general an inner conical gyratory crushing member 3; an outer crushing member 4 surrounding the inner member 3 and cooperating therewith to form an annular crushing chamber 6; a relatively massive main shaft 5 rigidly attached to the inner member 3; a rotary eccentric 7 cooperating with the lower extremity of the shaft 5 and rotatable at high speed so as to impart rapid gyratory motion to the member 3; an electric motor 9 located above the crusher for rotating the eccentric 7 at high speed; a driving shaft 8 direct connecting the motor 9 with the eccentric 7; and suitable frame structure for supporting the various crushing and driving elements.

The outer member 4 is supported directly within an annular upper frame 40 which carries a spider 35 within which the upper extremity of the hollow main shaft 5 is journaled. The eccentric 7 gyrates the main shaft 5 about a fulcrum point located adjacent to the spider 35, and is rotatably supported in a central guide bearing formed in the lower frame 42, this lower frame being rigidly interconnected with the upper frame 40 by means of an intermediate frame 41. The entire crusher is suspended from cables 36 secured to the intermediate frame 41, for the purpose of permitting free vibration of the structure without transmitting such vibration to the building within which the crusher is ordinarily housed. The intermediate and lower frames 41, 42 may also be provided with a discharge chute 38 communicating with the discharge opening of the crushing chamber 6.

The inner crushing member 3 rests directly upon a thrust bearing comprising a floating ring-element 11, having a spherical upper surface coacting with a wearing ring fastened to the lower extremity of the member 3, and also having a plane lower surface cooperable with and slidable upon an adjacent upper plane surface of an annular plunger 12. The plunger 12 is vertically movable to vary the crusher discharge opening, between inner and outer annular walls 26, 25, respectively, which cooperate to form an annular recess within which the plunger 12 is disposed. The lower extremity of the plunger 12 is provided with a packing 13 coacting directly with a confined body of fluid such as oil under pressure which fills the annular space 14, the displacement chamber 16 and the connecting passage 15. A check valve 23 having one or more relatively small fluid return openings therethrough, is interposed between the passage 15 and the chamber 16, this check valve being normally held to its seat by means of a spring as shown.

The fluid comprising the confined body, is normally confined against displacement by means of a piston 17 which is held in its uppermost position by a plurality of coil springs 20 the tension of which may be readily varied to suit conditions. So long as the fluid in the confined body remains undisturbed, the pressure within the confined body of oil may vary between that sufficient to merely support the crushing member 3, the shaft 5 and the connecting parts, and a predetermined pressure established by the springs 20 sufficient to crush material being acted upon during normal operating conditions. It will thus be noted that the fluid confined within the chamber 16, passage 15 and space 14 provides a fluid support for the floating thrust ring element 11. The thrust element 11 is preferably located closely adjacent to the member 3 and above the eccentric 7. A suitable stop 27 may be provided for limiting the downward movement of the plunger 12 when the fluid pressure in the confined body is released, and the outer confining wall 25 of the thrust bearing may be provided at its upper end with a dust seal ring cooperating with an apron 39 to prevent ingress of dust to the bearing structure.

Located on each side of and laterally adjacent to the main or primary piston 17, is a secondary piston 18, all of these pistons 17, 18 being formed to react against a common supporting block 19 which carries a movable contact member 33 cooperable with stationary contacts 34. When the contact member 33 has been moved downwardly by the block 19 sufficiently to connect the stationary contacts 34, an alarm such as a bell may be automatically sounded, or the operation of the crusher may be stopped. The springs 20 constantly urge the block 19 in an upward direction, and upon compression of these springs a predetermined amount due to excessive pressure created in the confined oil body, the piston 17 may be forced downwardly sufficiently to permit fluid from the chamber 16 to enter a passage 21 and to thus exert the full pressure of the oil body upon the ends of all of the pistons 17, 18. A pump 24 may be provided for varying the quantity of fluid confined within the chamber 16, passage 15 and space 14, in order to alter the size of the crusher discharge opening, and a by-pass valve 22 serves to effect return of fluid from the passage 21 to the chamber 16 when the central piston 17 has re-entered the chamber 16 and before the pistons 18 have been returned to normal uppermost position.

The driving motor 9 which is supported directly upon the spider 35, is direct connected to the upper extremity of the drive shaft 8, and the lower extremity of this shaft is direct connected to the eccentric 7 by means of a driving plate 10. The lower portion of the shaft 8 is journaled in a guide bearing 37 formed in the lower cap 29. A centrifugal pump rotor 28 housed within the cap 29, is drivingly connected to the lowermost extremity of the shaft 8, and this rotor is adapted to deliver lubricating oil which drains into the cap 29, through a discharge pipe 30 to a purifier 31. From the purifier 31, the oil is delivered through a return pipe 32 to the annular recess within which the thrust bearing element 11 is confined, and the overflow from this recess serves to lubricate the eccentric 7 and the bearings associated therewith.

During normal operation of the crusher, the electric motor 9 is being operated to rotate the eccentric 7, thereby causing the main shaft 5 and the inner crushing member 3 to gyrate, the main shaft 5 also being free to rotate within the eccentric 7 and the spider 35. The material to be crushed is delivered into the upper end of the crushing chamber 6 and is fed by gravity through this chamber, being crushed as it passes downwardly between the members 3, 4. The vibration of the crusher structure as a unit, permitted by the flexible suspension cables 36, enhances the feeding action of the material gravitating through the crushing zone, and the crushed material is delivered from the machine along the discharge chute 38.

In case a piece of abnormally hard material such as a piece of steel, is admitted to the crushing chamber 6, the excessive downward pressure upon the inner crushing member 3 is transmitted through the thrust ring element 11 and the plunger 12 to the oil body confined within the space 14, passage 15 and chamber 16, and if the abnormal piece is not too large, sufficient oil is displaced from the space 14 and passage 15 to the chamber 16 past the check valve 23, to permit the obstruction to pass through the crusher discharge opening. When the oil is thus displaced, the primary piston 17 is first urged downwardly against the resistance of the springs 20, and if the obstructing piece is sufficiently large, the piston 17 will eventually be forced entirely out of the chamber 16 and the fluid pressure of the oil body will be admitted to the passage 21 and exerted against the exposed ends of the secondary pistons 18. As the piston 17 is moved downwardly, it forces the head 19 away from the secondary pistons 18, leaving the latter suspended in their bores until fluid is admitted from the chamber 16. When this condition of operation is reached, the secondary pistons 18 are initially moved down into engagement with the head 19, thereby permitting escape of considerable liquid at the same pressure from within the chamber 16 to the passage 21, after which the springs are quickly compressed by the action of full pressure upon the greater pressure area of all of the pistons 17, 18. This arrangement permits the use of springs 20 having a relatively short range of action as compared to a structure in which the full pressure of the fluid acts upon the maximum piston area at all times, and also permits maximum piston displacement with minimum variation in pressure due to compression of the springs. This quick compression of the springs 20 causes the contact member 33 to bridge the contacts 34 and to thereby ring the alarm or stop the crusher. After the obstruction has been removed from within the crushing chamber, the springs 20 become effective to urge the pistons 17, 18 upwardly, and to restore normal operating conditions within the crusher. As the springs 20 move the head 19 upwardly, the primary piston 17 first closes the gap between the chamber 16 and the passage 21, after which the oil confined within the passage 21 is returned to the chamber 16 past the by-pass valve 22. The return to normal operating condition is ordinarily much slower than the displacement from normal, due to the restricted return openings in the check valve 23, these restricted openings serving to prevent quick return to normal conditions which might result in violent raising of the member 3 and shaft 5.

It will be apparent that the springs 20 may be initially compressed to any desired extent, necessary to permit normal operation of the

crusher without producing displacement of the oil body and of the pistons 17, 18. The pressure normally established within the oil body is only equal to the pressure required to resist the weight of the crushing member 3, the shaft 5 and the thrust bearing elements, and when material is being crushed, the pressure within the oil body should not exceed the resistance offered by the springs 20 through the primary piston 17. The moment that the pressure upon the confined oil body exceeds this spring resistance, however, the primary piston 17 will move downwardly and produce displacement of the oil body as previously described.

The stop 27 serves to support the thrust bearing plunger 12, the ring element 11, the crushing member 3 and the shaft 5, before fluid has been admitted to the space 14, or when the pressure upon the confined oil body has been entirely released. This stop 27 is preferably so disposed that it will permit maximum dropping of the crushing member 3 relative to the member 4, before the stop becomes effective, and the stop functions to maintain a space beneath the packing 13 so that fluid may readily be admitted to the lower face of the thrust bearing plunger.

If it becomes desirable to vary the size of the crusher discharge opening, the pump 24 or a drain valve, may be utilized to either admit more oil to the confined oil body or to withdraw some of the oil therefrom. By admitting a greater quantity of oil to the body, the crusher discharge opening is diminished, whereas withdrawal of oil from this body increases the size of the discharge opening. While it is preferable to utilize oil in the confined liquid body, it will be apparent that any other desired fluid may be utilized.

From the foregoing description it will be apparent that the fluid support functions automatically to protect the structure against damage due to abnormal conditions of operation. The primary and secondary pressure surfaces afforded by the pistons 17, 18, enable slow initial release of the pressure, and extremely rapid final release thereof. The quantity of oil within the confined body may readily be varied to vary the size of the crusher discharge opening, without affecting the pressure releasing pistons 17, 18, and the dust seal apron 39 prevents dust from entering the thrust bearing structure.

It should be understood that it is not desired to limit the invention to the exact details of construction and to the precise mode of operation herein shown and described, for various modifications within the scope of the claims may occur to persons skilled in the art.

It is claimed and desired to secure by Letters Patent:

1. In a crusher having a pair of crushing members, and having means for relatively moving said crushing members to crush material, the combination of means for normally maintaining said crushing members a predetermined distance apart and for resisting the crushing reaction between said crushing members, said last mentioned means including a fluid pressure support, an excessive pressure relieving device, having a body of fluid under pressure therein and in communication with said fluid pressure support, said excessive pressure relieving device comprising a primary displaceable surface constantly exposed to said body of fluid, and also comprising a secondary displaceable surface, and further comprising means responsive to a predetermined displacement of said primary displaceable surface upon occurrence of excessive pressure in said body of fluid for exposing said secondary displaceable surface to said body of fluid.

2. In a crusher having a pair of crushing members relatively movable to crush material, the combination of fluid pressure actuated means for resisting the crushing reaction on said crushing members, and a fluid pressure relieving device having a body of fluid therein and in communication with said resisting means, said device comprising primary and secondary displaceable surfaces the former of which is constantly exposed to the pressure of said body of fluid, said device also comprising means for exposing said secondary displaceable surface to the pressure of said body of fluid only upon attainment of abnormal pressure in said body of fluid.

3. In a crusher having a pair of crushing members relatively movable to crush material, the combination of a fluid pressure actuated thrust bearing for normally supporting one of said crushing members and for resisting the crushing reaction thereon, means for relieving abnormal crushing reaction on said one of said crushing members, a body of fluid in communication with said thrust bearing and with said relieving means, said relieving means comprising a primary displaceable member movable upon occurrence of excessive pressure in said body of fluid, a secondary displaceable member normally unexposed to the pressure of said body of fluid and further comprising means for exposing said secondary displaceable member to the pressure of said body upon predetermined movement of said primary displaceable member.

4. In a crusher having crushing members relatively movable to crush material, the combination of a fluid thrust bearing for sustaining the crushing reaction on one of said members, fluid pressure actuated means for reducing the excessive crushing reaction on said one of said crushing members occasioned by the entrance of hard material into said crusher, and a body of fluid under pressure communicating with the fluid in said thrust bearing and with the fluid in said fluid pressure relieving means, said fluid pressure relieving means comprising primary and secondary displaceable members, and also comprising means for interconnecting said displaceable members with each other and with said body of fluid so that said primary member will move to relieve pressure upon occurrence of excessive pressure in said body of fluid and thereby expose said secondary member to said body of fluid.

5. In combination, a pair of crushing members, means for relatively moving said crushing members to crush material, means for resisting the crushing reaction on said crushing members including a body of fluid under pressure, and means for limiting the maximum resisting action of said resisting means, said limiting means comprising a primary displaceable member constantly exposed to the pressure of said body of fluid, a secondary displaceable member, and also comprising means for exposing said secondary displaceable member to the pressure of said body of fluid only upon attainment of abnormal pressure in said body of fluid, said limiting means further comprising resilient means for constantly urging said primary and secondary displaceable members toward said body of fluid.

6. In combination, a pair of crushing members, means for relatively moving said crushing members to crush material, means for resisting

the crushing reaction on said crushing members including a body of liquid under pressure, and means for causing an excessive crushing reaction to separate said crushing members, said separating means comprising interconnected primary and secondary displaceable members the former of which is constantly exposed to the pressure of said body of liquid and resilient means for constantly urging said primary and secondary members toward said body of liquid, and further comprising means for exposing said secondary displaceable member to the pressure of said body of liquid upon attainment of a predetermined displacement of said primary displaceable member.

7. In a crusher having a pair of crushing members and having means for moving one of said members relative to the other to crush material, the combination of, a thrust bearing device normally supporting said movable crushing member a predetermined distance from the other of said crushing members, a confined body of liquid under pressure within said thrust bearing device, a primary piston having a surface constantly in contact with the pressure of said body of liquid, a secondary piston having a surface normally non-exposed to said body of liquid, resilient means for constantly urging said primary piston into contact with said body of liquid, and means responsive to an abnormal crushing reaction on said thrust bearing device for causing said body of liquid to displace said primary piston and to subsequently expose said secondary piston to said body of liquid.

8. In combination, a pair of crushing members, means for moving one of said crushing members relative to the other of said crushing members to crush material, a thrust bearing normally supporting said one of said crushing members, and including a body of liquid under pressure, a primary displaceable piston having a surface constantly exposed to said body of liquid, biasing means for normally opposing the force of said body of liquid on said primary piston surface and for permitting said piston to retract from the normal position thereof upon occurrence of an abnormal crushing reaction on said thrust bearing, a secondary displaceable piston having a surface, and means responsive to a predetermined retractive movement of said primary piston for establishing a path for the flow of said liquid past said piston into contact with the surface of said secondary piston, and means operable upon cessation of said abnormal crushing reaction to establish another path for the flow of said liquid from in contact with said secondary piston surface to said body of liquid independent of said first mentioned path.

9. In combination, a movable member subject to variable reaction thrusts, a reaction support normally sustaining said member comprising a chamber containing a body of liquid under pressure, a displaceable piston having a surface constantly exposed to said body of liquid, resilient means for urging said piston to a definite limiting position against the pressure of said body of liquid, an auxiliary chamber normally independent of said body of liquid, means for unrestrictedly conducting a portion of said body of liquid from said first mentioned chamber into said auxiliary chamber only after a predetermined displacement of said piston from said normal position due to an excessive reaction thrust upon said movable member, and means operable only after the flow of a predetermined quantity of liquid into said auxiliary chamber for resiliently opposing the flow of liquid into said auxiliary chamber.

10. In combination, a movable member, a reaction support for said member comprising a confined body of liquid, a piston having a surface constantly exposed to said body, resilient means for urging said surface against said body, a chamber, means for establishing a path for the flow of a portion of said body of liquid to said chamber upon predetermined displacement of said piston and without changing the pressure on said resilient means, a check valve in said path for isolating said chamber from said body of liquid after a predetermined quantity of said liquid has flowed into said chamber, and means for returning said liquid from said chamber to said body after said check valve has isolated said chamber from said body.

11. In combination, a movable member, a thrust bearing having an annular plunger and a chamber filled with fluid under pressure for supporting said movable member, a main piston having one end thereof in contact with said fluid, resilient means for normally holding said piston in a predetermined position, an auxiliary piston normally not in contact with said fluid, and means responsive to excessive thrust on said bearing for displacing said main piston and for exposing said auxiliary piston to said fluid.

12. In combination, a movable member, a thrust bearing for supporting said member and having a chamber filled with fluid under pressure, a main piston having one face thereof exposed to said fluid, an auxiliary piston exposable to said fluid upon a predetermined movement of said main piston, and means responsive to a thrust on said bearing in excess of a predetermined amount for causing said main piston to move and slowly release the pressure in said fluid and for causing said auxiliary piston to subsequently move and quickly release the pressure in said fluid.

13. In combination, a pair of members cooperating to form a crusher chamber, means for relatively moving said members to crush material, fluid pressure means for maintaining one of said members a predetermined distance from said other member, main and auxiliary spring biased piston members associated with said fluid pressure means, and means responsive to a fluid pressure in excess of a predetermined amount for rendering said piston members successively effective to relieve said excess pressure.

14. In combination, a pair of relatively movable members, a reaction support aranged to support one of said members and having a main chamber normally containing a constant quantity of fluid subject to variable pressures caused by variable forces on said reaction support, a piston having a surface in contact with said fluid, resilient means arranged to bias said piston in a direction opposing the force of said fluid on said piston, means arranged to limit the movement of said piston caused by said resilient means, said resilient means being so proportioned as to normally exert a force on said piston greater than the force of said fluid on said piston, whereby said piston is displaced in opposition to said resilient means only when the pressure of said fluid exceeds a predetermined value, auxiliary pressure relieving means comprising a discharge chamber, and valve means operable by a predetermined displacement of said piston upon occurrence of excessive pressure in said main chamber to connect said discharge chamber with said main chamber.

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