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FEED AND OPERATION OF CRUSHING APPARATUS

2,456,074

Filed May 29, 1944

2 Sheets-Sheet 1

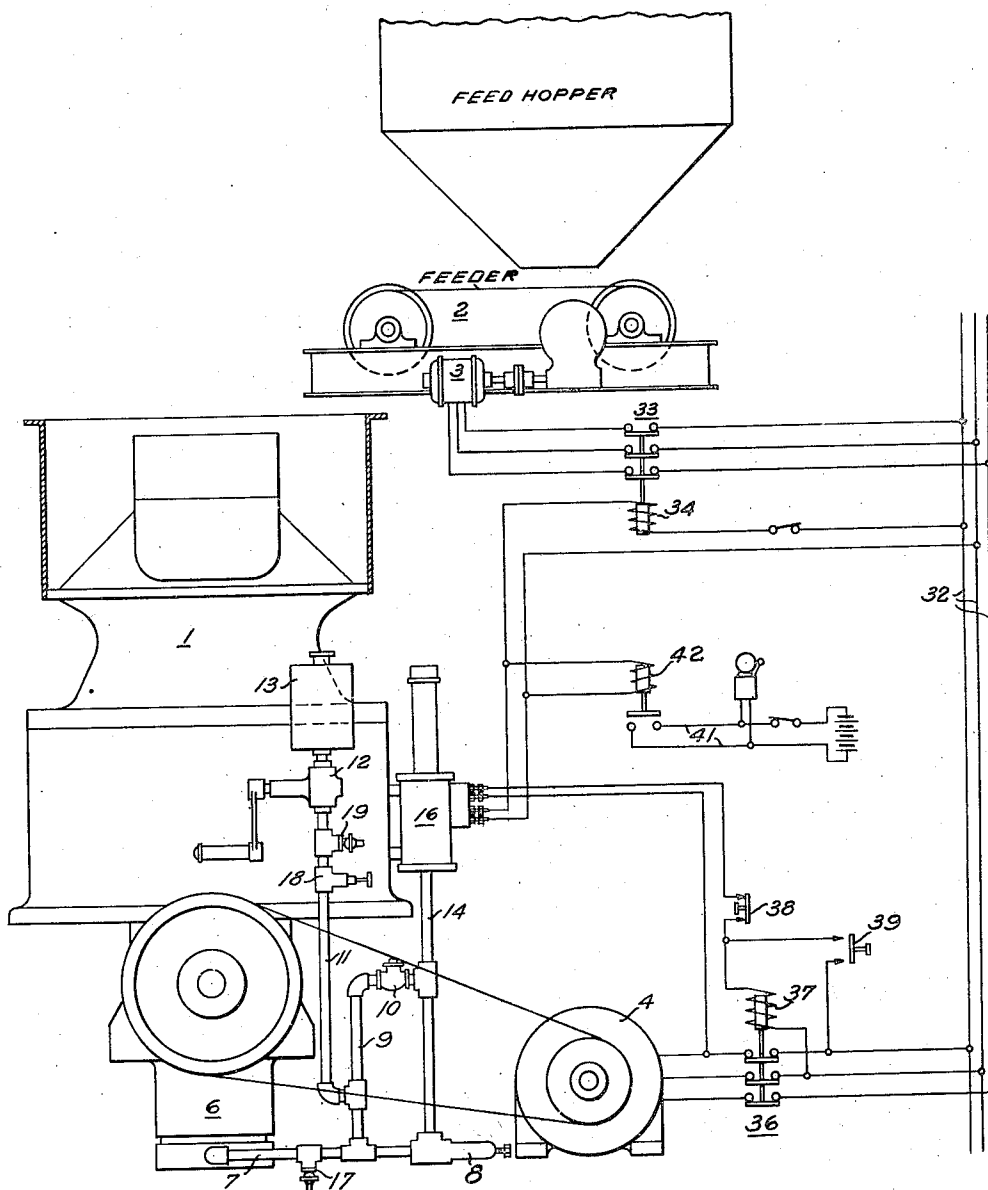


Fig. 1

Inventor
R. C. Newhouse

by William S. Galt
Attorney

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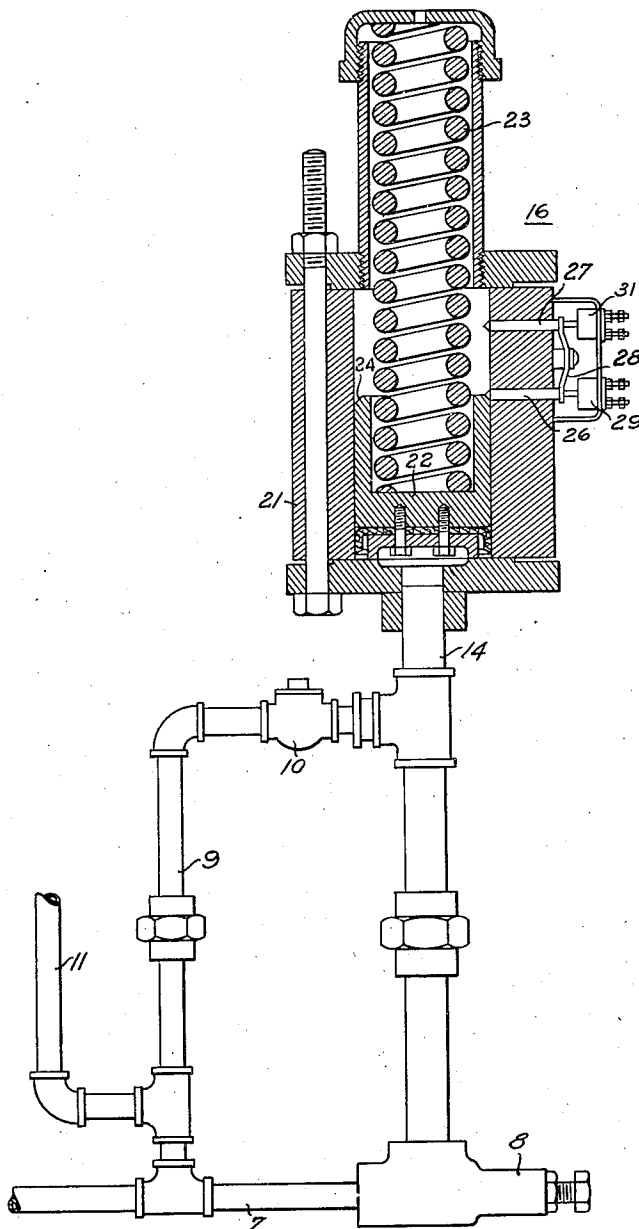


Fig. 2

Inventor
R. C. Newhouse

by William S. Galt
Attorney

UNITED STATES PATENT OFFICE

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OVERLOAD RESPONSIVE SYSTEM FOR CONTROLLING FEED AND OPERATION OF CRUSHING APPARATUS

Ray C. Newhouse, Wauwatosa, Wis., assignor to Allis-Chalmers Manufacturing Company, Milwaukee, Wis., a corporation of Delaware.

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7 Claims. (Cl. 241-34).

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This invention relates to apparatus for crushing material such as stones, ores, etc. between relatively moving crushing members, in which it is desirable to provide for automatic safety control to prevent damage to the crusher as a result of excessive crushing pressure, due to uncrushable material, packing conditions, or any other abnormal condition.

An object of the invention is to provide for automatic cutting off of feed to the crusher in case of minor abnormal conditions so that the crusher may clear itself and return to its proper setting.

Another object is to provide for automatic stopping of the crusher operation upon occurrence of serious abnormal conditions.

Still another object of the present invention concerns provision in a crusher of safety control means permitting yielding of a crushing member under only excessive crushing pressures and automatically returning the crushing member to normal crushing position only after substantially complete clearance of the crushing chamber.

The invention having the above and other objects which may appear herein may be carried into effect as fully described hereinbelow in connection with the accompanying drawings, in which:

Fig. 1 is a partly schematic view showing a crusher equipped according to the invention; and

Fig. 2 is an enlarged view of a portion of the apparatus shown in Fig. 1 including the accumulator and control switch actuating means, shown in vertical cross section.

In the embodiment of the invention shown in the drawing, the crusher 1 may be a gyratory crusher of a type well known in the art, having a gyratory head supported by a hydraulic jack. It will be unnecessary to describe in detail the internal structure and workings of such a crusher since suitable crusher structure has been fully described and illustrated in U. S. Patents Nos. 2,021,895 issued to R. C. Newhouse et al., and 2,022,135 issued to R. C. Newhouse, and in the copending application Serial No. 530,924, filed April 13, 1944, by Alexander J. Roubal. It will be understood that the hydraulic system external to the thrust bearing supporting cylinder and piston shown in the above mentioned patents and application is modified according to the present invention as fully described and illustrated herein.

According to the present invention, the gyratory crusher 1 is equipped with a feed controlling mechanism or feeder 2 driven by feeder motor

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3. The feeder 2 may feed rock, or other material to be crushed, into the crusher 1 where it passes between relatively movable crushing members actuated by suitable crusher member actuating means as shown in the above mentioned prior patents and copending application. The crusher 1 is driven by a crusher motor 4 shown in Fig. 1.

Crusher 1 is equipped with a hydraulic head support jack 6 to which fluid may be supplied and from which fluid may be withdrawn through hydraulic fluid conduit 7 connected to the high pressure side of a pressure relief valve 8 of suitable structure well known in the art. The relief valve 8 is arranged to prevent the passage of fluid from jack 6 except when the pressure exceeds a predetermined value for which the relief valve is set. Since the fluid pressure in the jack 6 and conduit 7 during crusher operation will be proportional to the crushing pressure, the relief valve 8 will be set to open when the fluid pressure exceeds that which would support the maximum safe crushing pressure. Between jack 6 and relief valve 8, a conduit 9 leads to the discharge side of a check valve 10 arranged to prevent the escape of fluid from jack 6 through conduit 9. From some point in the hydraulic system between the jack 6 and the relief and check valves 8 and 10, respectively, a conduit 11 may be connected to a hand pump 12, which may be arranged to supply fluid to the jack 6 from the reservoir 13. Hand pump 12 is used to force fluid under pressure into the system to raise the crusher member or head to its proper setting for reasons to be described hereinafter.

From the discharge or low pressure side of the relief valve 8 and the supply or inlet connection of the check valve 10, a common conduit 14 is connected to the fluid pressure space of an accumulator 16 which is arranged to receive fluid from the conduit 14 at a minimum pressure sufficient to support the crushing members of the crusher 1 in their normal crushing position under no load conditions, that is when the crusher is running without any material between the crushing members. Preferably the pressure for which the accumulator will be set will be slightly higher than the minimum.

A bleeding cock 17 may be provided in fluid pressure conduit 7 for bleeding fluid from the hydraulic jack 6 when it is desired for any reason to open the crushing members. A stop valve 18 may be placed in the conduit 11 between the hand pump 12 and the cylinder 6 to isolate the hand pump during normal operation of the crusher. A bleeding cock 19 may be provided between

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the stop valve and the hand pump 12 to relieve pressure between the stop valve 18 and the pump.

When it is desired to lower the head for any reason, it may, in preference to bleeding by cock 17, be done by opening stop valve 18 and turning hand pump 12 in a direction to take fluid from conduit 7 and jack 6 and pump it to reservoir 13.

The accumulator 16 shown in Fig. 2 consists of an accumulator cylinder 21 having a piston or plunger 22 normally biased downwardly against the end of the cylinder 21 by an accumulator spring 23. The plunger or piston 22 is slidable upwardly in the cylinder 21 by the pressure of fluid admitted through conduit 14. Spring 23 is precompressed to a degree somewhat greater than that which would be just sufficient to prevent displacement of the piston 22, by hydraulic pressure less than that sufficient to support the crusher head under no load conditions.

The upper end of the piston 22 is beveled to provide a cam surface 24. In the cylinder wall of the accumulator cylinder 21 are a pair of switch actuating plungers 26 and 27 having conical ends projecting into the path of the cam surface 24 at axially spaced points. The plungers 26 and 27 are biased inwardly by springs 28. A normally closed feed control switch 29 is mounted on the accumulator cylinder 21 in such a position that it will be actuated to a circuit opening position by the switch actuating plunger 26 when the accumulator piston 22 is displaced by a predetermined amount from its normal position as shown in Fig. 2. A second normally closed switch for crusher control is mounted on the accumulator cylinder 21 in such a position as to be actuated to a circuit opening position by the switch actuating plunger 27 when the accumulator piston 22 has been displaced by some predetermined amount larger than the amount necessary to actuate plunger 26.

The crusher driving motor 4 is energized from a power line shown at 32 which also supplies power to operate the feeder motor 3. The feeder motor 3 may be started and stopped by a contactor 33 which may be closed and held in closed position by a holding coil 34 energized through switch 29. The crusher motor 4 may be started and stopped by a contactor 36 which is actuated to closed position and held closed by holding coil 37 energized through switch 31 and normally closed stop switch 38. A starting switch 39 may be provided to actuate the contactor 36 if desirable when crusher control switch 31 is opened.

An alarm circuit 41 may be arranged to give an alarm when the speed control switch 29 is opened. The alarm circuit 41 is normally open during crusher operation, being held open by holding coil 42 in a manner well known in the art. The alarm will sound when the feeder motor and coil 42 are deenergized by the opening of control switch 29. A similar alarm circuit may be provided in an obvious manner to sound a different alarm device, such as a horn, upon deenergization of the crusher motor by opening of control switch 31. A showing of such an alarm circuit has been omitted in order to avoid unnecessary complication of the drawing.

In operation, the crusher members are first set to their proper normal crushing positions by opening stop valve 18 and pumping hydraulic fluid into the jack 6 until the proper crushing setting has been reached. When the crusher is properly set, the stop valve 18 may be closed. Conduit 14 and the space below piston 22 in the

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accumulator cylinder 21 are filled with hydraulic fluid before the crusher is placed in operation.

With the accumulator piston 22 resting against the bottom of the accumulator cylinder 21, the crusher and feeder switches 29 and 31 will be closed and energization of the power line 32 will cause the crusher motor 4 and feeder motor 3 to operate, giving a normal crushing motion to the crushing members of crusher 1 and feeding material into the crusher feed opening. So long as the crusher 1 is operating normally, the fluid pressure in jack 6, being proportional to the crushing pressure between the crushing members of crusher 1, will be insufficient to open the relief valve 8. Crusher 1 will continue to normally crush material until an excessive crushing pressure, such as might be caused by a piece of uncrushable material between the crushing members, or by packing of fine material between the crushing members, causes the hydraulic fluid pressure in jack 6 to exceed the setting of relief valve 8.

When relief valve 8 is opened by excessive fluid pressure in the conduit 7 and jack 6, fluid will escape from jack 6 through conduits 7 and 14 into accumulator 16, raising the piston 22 against the pressure of spring 23. Raising of piston 22 will cause the cam surface 24 to actuate the feeder control switch 29 to open position, whereupon the contactor 33 will fall open, and the feeder motor 3 will stop, cutting off feed of material to the crusher 1. If the uncrushable substance in the crushed, or the packing condition, or other cause of excessive pressure is of a minor nature, the crusher will clear itself of the abnormal conditions by operating without feed of material.

As soon as the crusher has been cleared of the substance causing excessive pressure, the crushing pressure will fall to zero, and the hydraulic fluid pressure in the jack 6 will fall to its no load magnitude. The minimum pressure in accumulator 16 being at least great enough to return the crushing members to their normal crushing position under no load conditions, as soon as the pressure in cylinder 6 has fallen to no load magnitude the piston 22 will force fluid through the check valve 19 and conduit 7 into jack 6, returning the crushing members of the crusher 1 to their normal operative position. The accumulator piston 22 will fall to the bottom of the cylinder 21 allowing switch actuating plunger 26 to be forced inwardly by spring 28 and allowing the speed control switch 29 to close, energizing holding coil 34 which will close the contactor and start the feeder motor 3. The crusher will now resume normal crushing operation.

In case a very large piece of uncrushable material gets between the crushing members of crusher 1, or a packed condition occurs that will not be cleared even by substantially the maximum possible opening of crusher members for which the crusher structure provides, the crushing pressure will continue to be excessive and to force the crushing members in open direction forcing fluid through conduit 7 and 14 and raising accumulator piston 22 until the cam surface 24 pushes out the switch actuating plunger 27, opening the pressure control switch 31, deenergizing voltage coil 37 and opening contactor 36, thus deenergizing the crusher drive motor 4 and stopping the crusher. This arrangement will stop the crusher before the crushing members have been forced to their maximum structurally possible opening. This will prevent the

occurrence of a jam in the crusher which could be cleared only by burning out or shoveling out the offending substance. Since the crusher members are stopped at some point short of their maximum open position, the operator can open the bleeding cock 17, or operate pump 12, to withdraw fluid from jack 6 and permit the crushing members to open, thus loosening the offensive material in the crusher and allowing it to fall through or be dislodged without difficulty:

When the abnormal condition has been cleared, and there is no material between the crushing members, the fluid pressure in jack 6 will fall to its no load value or below and the accumulator piston 22 will force the fluid from the accumulator into the cylinder 6 until the crushing members have been raised toward their normal position. If fluid has been withdrawn through the bleeding cock 17, or through pump 12, the crushing members will not return to their proper crushing position. The operator will then open the stop valve 18 and operate the hand pump 12 until sufficient fluid has been pumped into the jack 6 to raise the crushing members to their normal crushing position. The crusher is then in condition to be restarted and operated normally.

If during normal operation the feeder 2 stops frequently, or the alarm 41 informs the operator that the feeder is frequently stopping, it is probable that too much material is being fed to the crusher, resulting in repeated occurrence of excessive crushing pressure sufficient to open the crushing members slightly. When this condition occurs, the operator can slow down the feeder motor 3 or otherwise reduce the rate of feed to the crusher.

It will be understood that the specific structure shown in the drawing is illustrative only and that the invention can be applied to crushers of any type in which the crushing members are replaceable from their normal operating positions by an excessive crushing pressure, by the use of mechanical expedients which will be apparent to persons skilled in the art. The invention is, accordingly, not intended to be limited to the structure specifically shown in the drawing and particularly described herein, but is intended to include such modifications and equivalents as may readily occur to persons skilled in the art within the scope of the appended claims.

It is claimed and desired to secure by Letters Patent:

1. Material crushing apparatus comprising relatively movable crushing members, actuating means to relatively move said crushing members to crush material therebetween, support means for said members, comprising a hydraulic jack in which a trapped body of hydraulic fluid resists relative displacement of said members in an opening direction by normal crushing pressures, a fluid pressure relief valve connected with said jack and adapted to release fluid from said trapped body under a predetermined excessive pressure, said support means yielding solely through escape of fluid from said trapped body through said relief valve, hydraulic fluid pressure accumulator means adapted to receive all fluid discharged from said relief valve under excessive fluid pressure and to maintain thereon a minimum fluid pressure sufficient to actuate said jack to return said crushing members to normal operative positions only under substantially no load conditions, a fluid conduit connecting said accumulator to said jack, and means in said con-

duit to prevent flow through said conduit from said jack under normal operating conditions.

2. Material crushing apparatus comprising relatively movable crushing members, actuating means to relatively move said crushing members to crush material therebetween, support means for said members, comprising a hydraulic jack in which a trapped body of hydraulic fluid resists relative displacement of said members in an opening direction by normal crushing pressures, a fluid pressure relief valve connected with said jack and adapted to release fluid from said trapped body under a predetermined excessive pressure, said support means yielding solely through escape of fluid from said trapped body through said relief valve, hydraulic fluid pressure accumulator means adapted to receive all fluid discharged from said relief valve under excessive fluid pressure and to maintain thereon a minimum fluid pressure sufficient to actuate said jack to return said crushing members to normal operative positions only under substantially no load conditions, a fluid conduit connecting said accumulator to said jack, and means in said conduit to prevent flow through said conduit from said jack under normal operating conditions, means controlling the feeding of material to said crushing members, and means responsive to a predetermined yielding movement of said members in opening direction and operatively connected to said feed controlling means to cut off the feeding of material upon occurrence of such yielding movement.

3. Material crushing apparatus comprising relatively movable crushing members, actuating means to relatively move said crushing members to crush material therebetween, support means for said members, comprising a hydraulic jack in which a trapped body of hydraulic fluid resists relative displacement of said members in an opening direction by normal crushing pressures, a fluid pressure relief valve connected with said jack and adapted to release fluid from said trapped body under a predetermined excessive pressure, said support means yielding solely through escape of fluid from said trapped body through said relief valve, hydraulic fluid pressure accumulator means adapted to receive all fluid discharged from said relief valve under excessive fluid pressure and to maintain thereon a minimum fluid pressure sufficient to actuate said jack to return said crushing members to normal operative positions only under substantially no load conditions, a fluid conduit connecting said accumulator to said jack and means in said conduit to prevent flow through said conduit from said jack under normal operating conditions, means controlling the feeding of material to said crushing members, and means responsive to a predetermined yielding movement of said members in opening direction and operatively connected to said feed controlling means to cut off the feeding of material upon occurrence of such yielding movement, and second means responsive to a predetermined yielding movement of said members in an opening direction and operatively connected to said crusher actuating means to stop crushing action of said crushing members upon the occurrence of such yielding movement, said first and second movement responsive means being so correlated that a substantially greater relative opening movement of said members is required to stop said crushing action than to cut off said feed, said greater movement being substantially less than the maximum possible open-

ing movement as determined by the structure of the apparatus.

4. The combination of a crusher having a power driven feeder, relatively movable crushing members, means to actuate said crushing members, hydraulic jack means normally resisting displacement of said crushing members in relation to each other, a check valve normally closing said jack to escape of fluid therefrom and permitting fluid to be forced into said jack, a fluid pressure relief valve normally closing said jack against escape of fluid therefrom and permitting fluid to escape therefrom under abnormal pressure caused by excessive crushing pressure between said members, said jack means being adapted to allow said crushing members to yield in opening relation to relieve said excessive crushing pressure solely through escape of fluid through said pressure relief valve, a fluid pressure accumulator connected in closed relation with the discharge of said fluid pressure relief valve and the inlet of said check valve, and adapted to receive fluid discharged from said relief valve and return said fluid through said check valve under a predetermined pressure sufficiently great to support said crushing members only under substantially no load conditions, and means responsive to the action of said accumulator in receiving fluid and operative to stop said feeder, and to restart said feeder upon return of said accumulator to its normal condition.

5. A crusher system comprising a continuously acting power driven crusher having relatively moving crushing members, a feed control means to supply material to be crushed to said crushing members, yieldable means normally supporting said crushing members in predetermined operative relation and responsive to a predetermined excessive crushing pressure between said members to permit said members to yield relatively in opening direction, resilient energy accumulator means connected with said supporting means in a manner to accumulate energy as a result of yielding movement of said crushing members in amount sufficient to return said crushing members to normal operative relation from relatively displaced positions under no load conditions, said resilient energy accumulator means being constructed and arranged to accumulate such energy at an energy level only just high enough to return said members under substantially no load conditions, energy transfer check means connecting said supporting means and said accumulator means and constructed and arranged to normally prevent the transfer of energy from said supporting means to said accumulator means and to permit a flow of energy in the reverse direction under no load conditions, and means responsive to relative displacement of said members from their normal operative relation and operatively connected to said feed control means to cut off supply of material to said crushing members during such displacement.

6. A crusher system comprising a continuously acting power driven crusher having relatively moving crushing members, a feed control means to supply material to be crushed to said crushing members, yieldable means normally supporting said crushing members in predetermined operative relation and responsive to a predetermined excessive crushing pressure between said members to permit said members to yield relatively in opening direction, resilient energy accumulator

means connected with said supporting means in a manner to accumulate energy as a result of yielding movement of said crushing members in amount sufficient to return said crushing members to normal operative relation from relatively displaced positions under no load conditions, said resilient energy accumulator means being constructed and arranged to accumulate such energy at an energy level only just high enough to return said members under substantially no load conditions, energy transfer check means connecting said supporting means and said accumulator means and constructed and arranged to normally prevent the transfer of energy from said supporting means to said accumulator means and to permit a flow of energy in the reverse direction under no load conditions, means responsive to relative displacement of said members from their normal operative relation and operatively connected to said feed control means to cut off supply of material to said crushing members during such displacement, and a second means responsive to relative displacement of said members from their normal operative relation and operatively connected to the crusher drive to stop crushing action of said members, said first and second displacement responsive means being so correlated that a substantially greater predetermined displacement will be required to stop said crushing action than to cut off said supply of material, said predetermined greater displacement being less than the maximum possible displacement determined by the structure of said supporting means.

7. A crusher system comprising a continuously acting power driven crusher having relatively moving crushing members, means to supply material to said crusher to be crushed between said members, yieldable means normally supporting said crushing members in predetermined operative relation and responsive to a predetermined excessive crushing pressure between said members to permit said members to yield relatively in opening direction, and resilient energy accumulator means connected with said supporting means in a manner to accumulate energy as a result of yielding movement of said crushing members in amount sufficient to return said crushing members to normal operative relation from relatively displaced positions under no load conditions, said resilient energy accumulator means being constructed and arranged to accumulate such energy at an energy level only just high enough to return said members under substantially no load conditions, and energy transfer check means connecting said supporting means and said accumulator means and constructed and arranged to normally prevent the transfer of energy from said supporting means to said accumulator means and to permit a flow of energy in the reverse direction under no load conditions.

RAY C. NEWHOUSE.

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