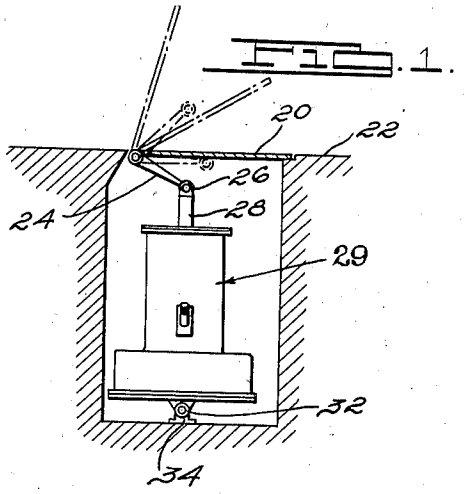
March 12, 1940. J. M. EVANS ET AL 2,193,125

HYDRAULIC OPERATING DEVICE

Filed Aug. 2, 1935 4 Sheets-Sheet 1

Fig. 1.



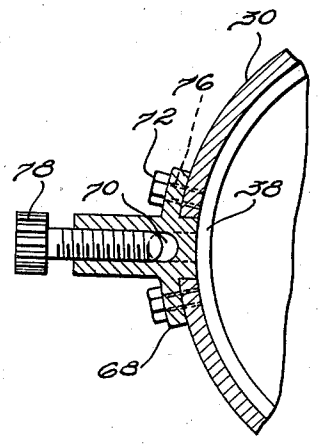
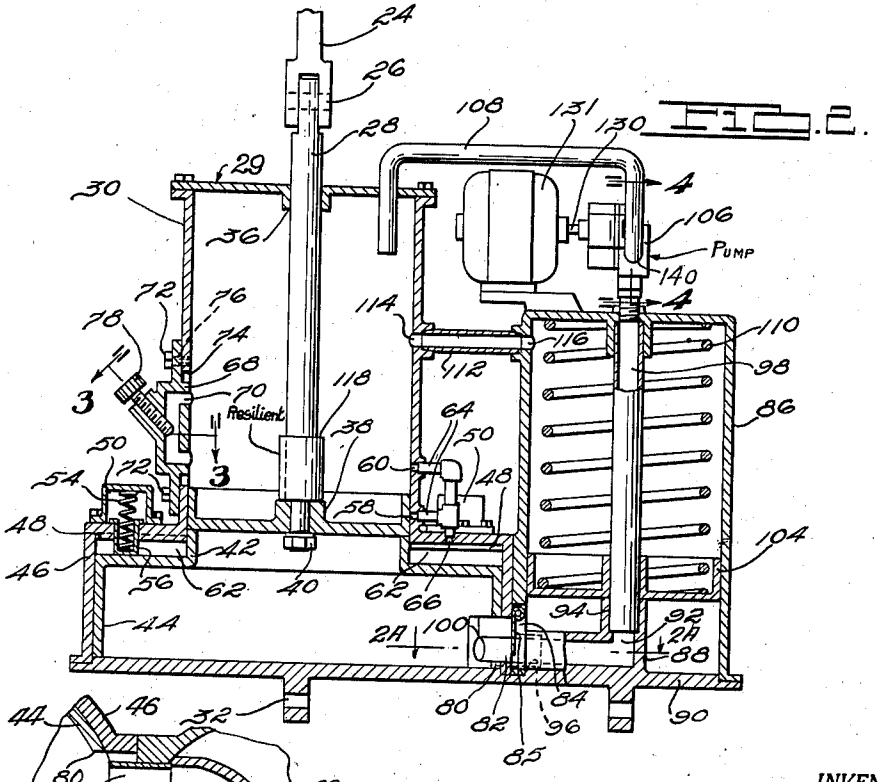


Fig. 3.

Fig. 2.



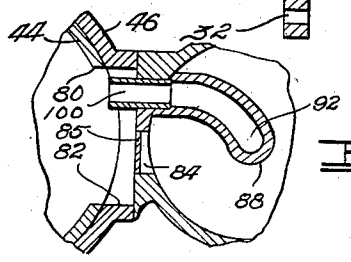


Fig. 2A

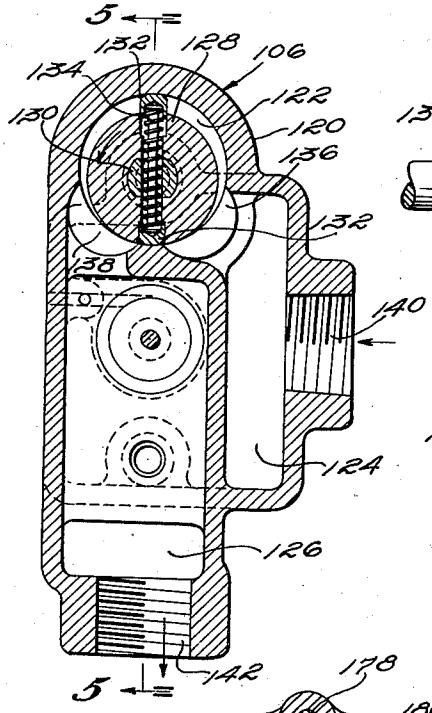
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HYDRAULIC OPERATING DEVICE

Filed Aug. 2, 1935 4 Sheets-Sheet 2

Fig. 4.



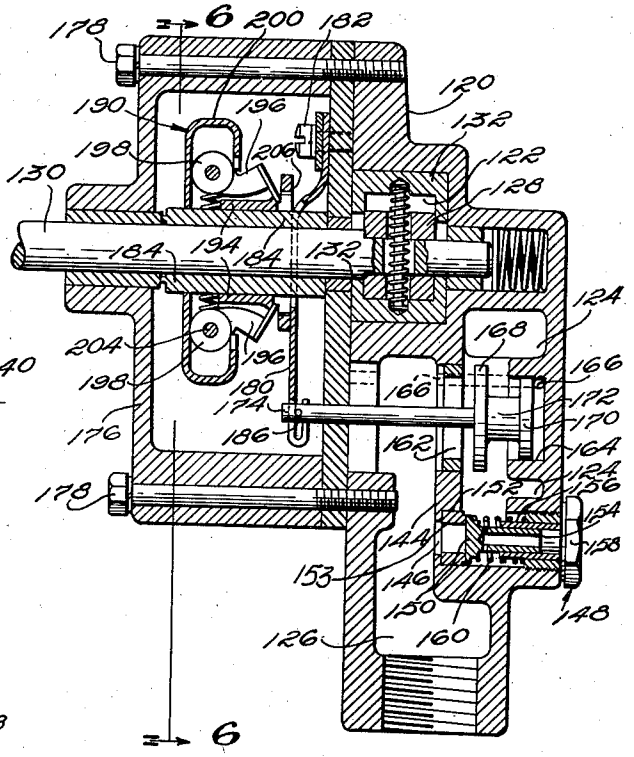


Fig. 5.

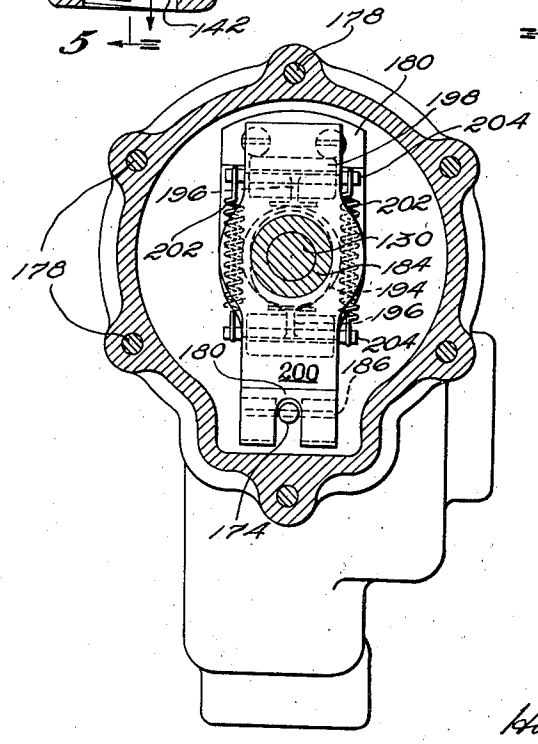


Fig. 6.

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HYDRAULIC OPERATING DEVICE

Filed Aug. 2, 1935 4 Sheets-Sheet 3

FIG. 7.

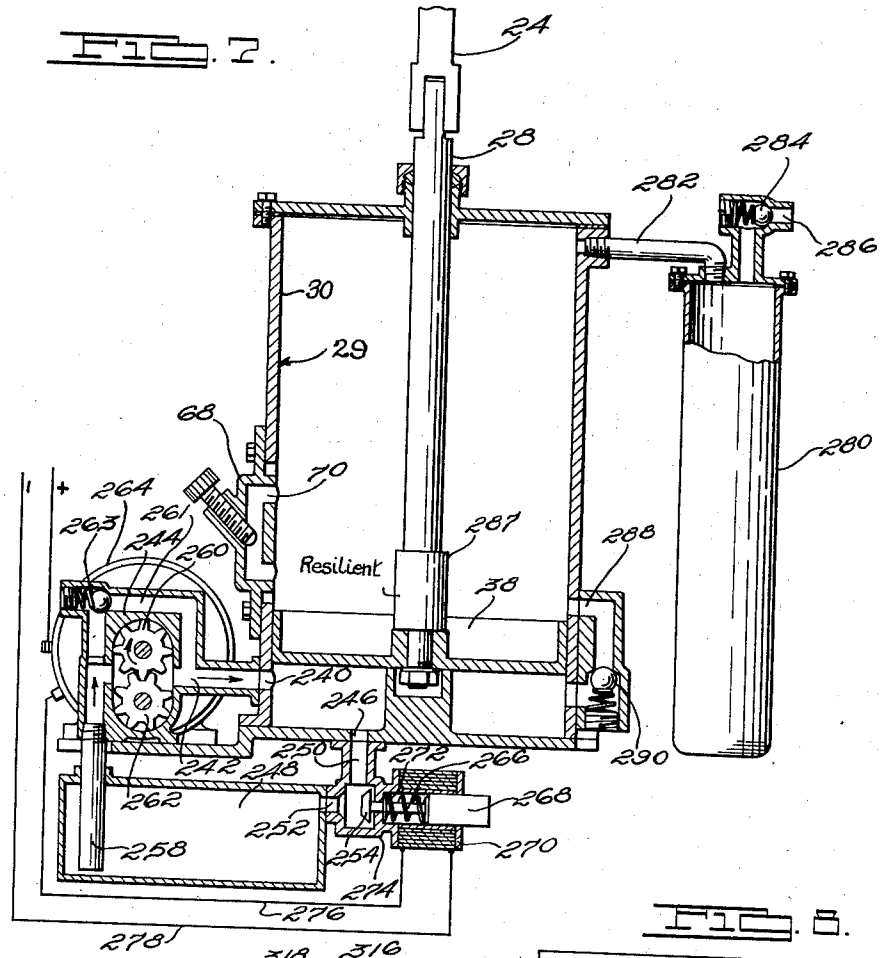
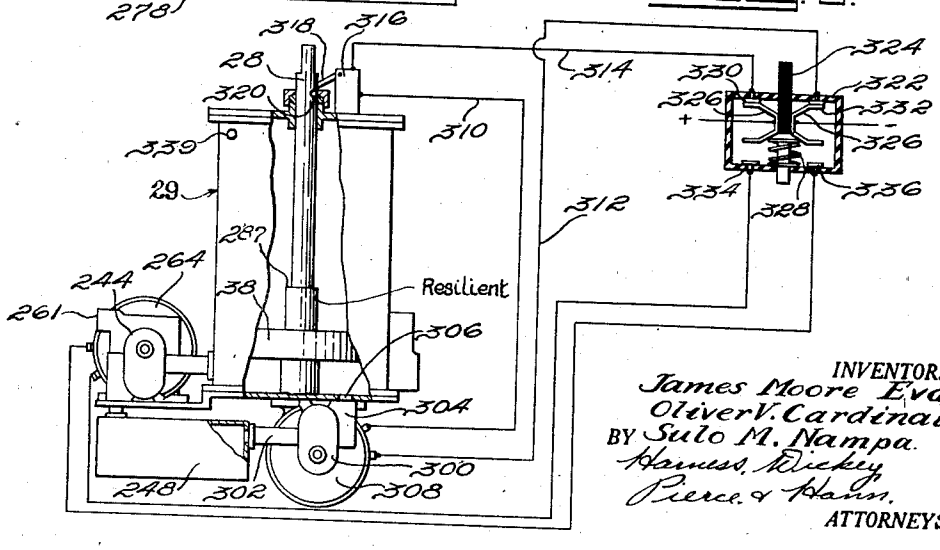


FIG. 8.



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HYDRAULIC OPERATING DEVICE

Filed Aug. 2, 1935 4 Sheets-Sheet 4

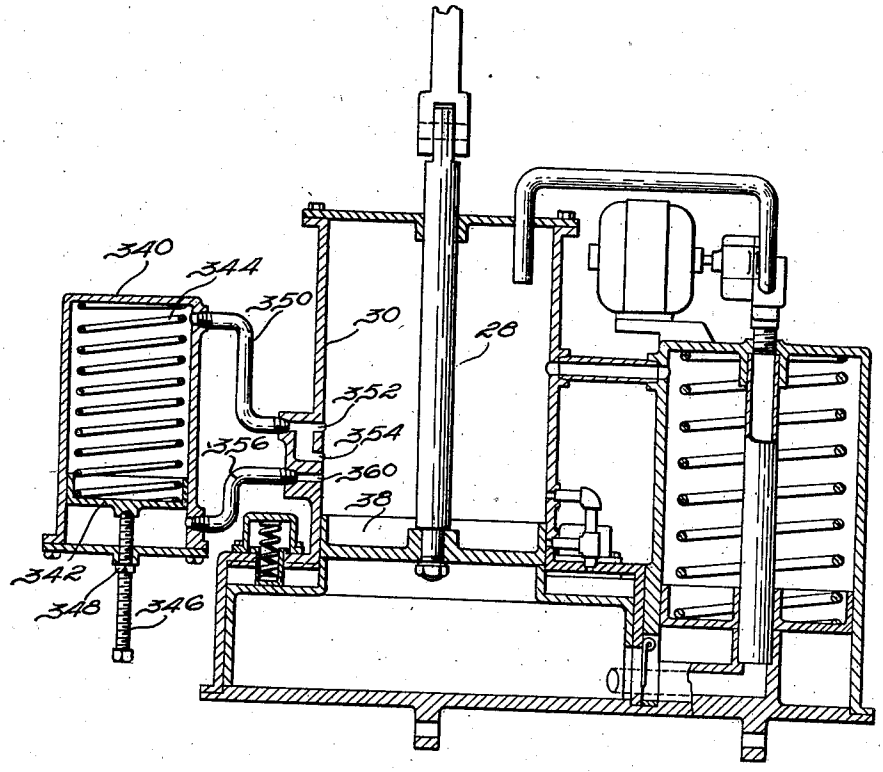


FIG. 9.

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Patented Mar. 12, 1940 2,193,125

UNITED STATES PATENT OFFICE

2,193,125

HYDRAULIC OPERATING DEVICE

James Moore Evans, Oliver V. Cardinal, and Sulo M. Nampa, Detroit, Mich., assignors, by mesne assignments, to Grade Crossing Guard Corporation, Memphis, Tenn., a corporation of Tennessee

Application August 2, 1935, Serial No. 34,322

11 Claims. (Cl. 121—44)

The present invention relates to protective devices for use at road crossings, and more particularly to hydraulic mechanism for operating such devices, as well as other devices.

It is an object of the present invention to provide a hydraulic ram embodying means to subject the ram piston to an abnormal actuating force to overcome the initial static friction of the actuated mechanism.

It is also an object of the present invention to provide a hydraulic ram of the last mentioned character embodying an auxiliary piston of enlarged surface area, which is capable of a limited movement to assist in overcoming the initial resistance of the actuated mechanism.

It is also an object of the present invention to provide a hydraulic ram of the above character embodying positive means to return the auxiliary piston to normal position.

It is also an object of the present invention to provide a hydraulic ram embodying means to permit an interruption or reversal of the ram movement in response to an overload.

It is also an object of the present invention to provide a hydraulic ram of the last mentioned character embodying an auxiliary chamber constructed to absorb the overload.

It is also an object of the present invention to provide a hydraulic ram in which the normal rate of movement is resumed upon removal of the overload, but in which a too rapid resumption of some of such normal rate is avoided.

It is also an object of the present invention to provide a hydraulic ram in which the mechanism for absorbing overloads is effective throughout only a portion of the ram movement.

It is also an object of the present invention to provide a hydraulic ram in which the mechanism for absorbing overloads is rendered ineffective as the ram approaches the limit of its travel.

It is also an object of the present invention to provide a hydraulic ram constructed to introduce a hesitation in the ram movement, and in which the mechanism for accomplishing this embodies a by-pass connection around the ram piston.

It is also an object of the present invention to provide a hydraulic ram embodying mechanism to temporarily interrupt the ram movement at an intermediate point, and constructed to effect a rapid resetting of the interrupting mechanism upon the resumption of the ram movement.

Other objects and advantages of the present invention appear in the following description and in the appended claims.

In the drawings:

Figure 1 is a schematic diagram illustrating an embodiment of the present invention;

Fig. 2 is a view in vertical section of the hydraulic ram illustrated in Fig. 1;

Fig. 2A is a fragmentary detailed view taken along the line 2A—2A of Fig. 2;

Fig. 3 is a fragmentary view in section, taken on the line 3—3 of Fig. 2;

Fig. 4 is a view in vertical section, taken on the line 4—4 of Fig. 2, of a pump which may be used in the practice of the present invention;

Fig. 5 is a view in vertical section, taken along the line 5—5 of Fig. 4;

Fig. 6 is a view in vertical section, taken along the line 6—6 of Fig. 5;

Fig. 7 is a view in vertical section of a hydraulic ram embodying the present invention in modified form;

Fig. 8 is a view in side elevation with certain of the parts broken away of a second modification of the present invention; and

Fig. 9 is a view in vertical section of a third modification of the present invention.

As described in more detail hereinafter, an illustrative embodiment of the present invention comprises generally a normally retracted guard, suitably positioned in the area to be protected; and a hydraulic ram operatively connected to the barrier and actuable to raise the guard from the retracted position to an extended position in which the latter is effective to positively prevent passage through the protected area, and to also lower the guard to the retracted position.

The hydraulic ram, which is regarded as the subject of invention independently of its association with the crossing guard, is preferably automatically responsive to the approach of a train or other vehicle. Upon being actuated, the ram preferably moves the guard through an initial or warning movement; thereafter causes the guard to move at a reduced rate for an interval, or to stop for an interval; and finally moves the guard to a final extended position. The ram is preferably arranged to rapidly and positively return the guard from the extended to the retracted position. The return movement may be either regular or modulated, as in the case of the extending movement. Preferably, also, the ram embodies mechanism to permit the movement to be interrupted or temporarily reversed in response to an excessive overload, such as the passage of a vehicle over the guard, after which the regular movement thereof is resumed. As illustrated, the arrangement is such that a too

rapid resumption of the original movement is prevented. The latter provision is desirable in connection with the use of the present invention in connection with crossing guards, in preventing the ram from forcibly striking the underparts of vehicles after having been forcibly retracted by the passage thereover of the front wheels of the vehicles.

In accordance with one illustrated construction, the mechanism for introducing a hesitation in the movement of the ram piston comprises a passage which communicates with the interior of the ram cylinder at two spaced points, and forms a by-pass around the ram piston when the latter occupies a position between such points. As illustrated, the vertical positioning of the by-pass is conveniently adjustable to determine the position in the ram movement at which the hesitation occurs. The effective area of the by-pass is also conveniently adjustable by a suitable valve to control the degree of retardation in the ram movement. In accordance with another illustrated construction, an auxiliary piston chamber is provided to effect either a retardation or interruption in the ram movement. This auxiliary piston corresponds in general to a corresponding structure disclosed in the co-pending application of Evans and Nampa, Serial No. 34,321, filed August 2, 1935, now Patent No. 2,187,513, and assigned to the same assignee as the present application. The present construction, however, represents an improvement, in that mechanism is provided to promptly unload the auxiliary chamber upon the resumption of the ram movement.

As illustrated, the mechanism for absorbing overloads, and for permitting an interruption or reversal of the ram movement in response thereto, comprises an auxiliary chamber including a spring biased piston. The force of the biasing spring exceeds the normal load on the ram piston, but in response to an overload, a portion of the actuating fluid is diverted into the auxiliary chamber, forcing the associated piston upwardly, and permitting either a retardation, interruption or reversal of the ram movement. Upon removal of the overload, the auxiliary piston resumes its normal position under the influence of its biasing spring, and the ram piston resumes its original rate of movement. Preferably, and as illustrated, the return of the auxiliary piston to normal position is delayed by check valve mechanism, preventing a too rapid return of the ram piston to the position occupied at the time the overload was imposed.

When the guard reaches the fully extended position, however, it is desirable that positive means be employed to prevent moving the barrier from such extended position. Accordingly, as illustrated, the mechanism for absorbing overloads functions only during a part of the ram movement. When the ram reaches the extended position, a by-pass port is opened, rendering the auxiliary mechanism ineffective. As illustrated, means are also provided to relieve the actuating pressure on the ram piston.

A crossing guard embodying the present invention may be used in relatively exposed areas and may be subjected to weather and other conditions which make it difficult to maintain the guard in a freely movable position. For example, during winter months snow and ice may enter the exposed parts of the system and obstruct the initial movements thereof. To meet conditions of this character, the mechanism may be arranged to provide an abnormal actuating force throughout the initial barrier movement, thereby positively overcoming any abnormal static friction in the device. As illustrated, this is accomplished by providing the hydraulic ram with an auxiliary piston of large surface area in actuating relation to the main ram piston. Means are preferably provided to prevent more than a limited amount of movement of this auxiliary piston, and to positively return it to normal position after such limited movement. In initiating the ram movement, however, the actuating fluid bears against the combined surface areas of the main and auxiliary pistons, the area of the auxiliary piston being sufficient to supplement the force of the main piston and forcibly overcome any initial static friction in the piston. As described in more detail hereinafter, the return of the auxiliary piston to normal position may be accomplished by spring mechanism in conjunction with means to apply a differential pressure to the auxiliary piston.

Referring to Figs. 1, 2 and 3, an illustrative embodiment of the present invention comprises a guard **20** which normally occupies a horizontal position substantially flush with the surface of an associated roadway **22**, and is pivotally connected by a crank **24** and pin **26** to the upper end of the push rod **28** of a hydraulic ram **29**. Ram **29** is pivotally connected by clevis **32** to a support **34**, suitably embedded in roadway **22**.

Upon actuation of ram **29** as hereinafter described, push rod **28** forces guard **20** from the illustrated full line position to the extreme dotted line position, the barrier movement being either retarded or interrupted at a suitable intermediate dotted line position.

Referring particularly to Figs. 2 and 3, push rod **28** passes through an opening **36** in the upper surface of the cylinder **30** and is secured to a piston **38** by a stud **40**. Piston **38** is slidably fitted within cylinder **30** and is normally supported in the illustrated position on the rim **42** formed at the top of an auxiliary piston **44**. Piston **44**, which acts as hereinafter described, to apply an abnormal force to push rod **28** during the initial movements of the latter, is slidably supported for limited movement within an enlarged lower portion **46** of cylinder **30**.

The underside of the shoulder portion **46** includes a plurality of radially disposed ribs **48** which limit the upward movement of piston **44** and prevent the development of a suction seal between members **44** and **46**.

Piston **44** is normally biased to the illustrated lowermost position by a plurality of springs supported around the horizontal surface portion **46**, within housings **50**. Each spring assembly comprises a spring **54**, the upper end of which bears against the housing **50** and the lower end of which is received within a sleeve **56**, slidably fitted in an aperture formed in portion **46**.

In order to enable the springs **54** to return piston **44** to the lower position after the initiation of the regular ram movement, a plurality of ports, such as **58** are cut into the side wall of cylinder **30**. Each of such ports communicates with the chamber portion **62** through nipples such as **64** and ports such as **66**. Ports **58** are closed off by piston **38** when the latter occupies the normal illustrated position, but are opened thereby in the course of the initial movement thereof. A plurality of ports such as **60**, normally exposed, provide an escape for the fluid which normally occupies the chamber portion **62**.

In accordance with the embodiment illustrated

in Figs. 2 and 3, the hesitation in the ram movement is provided by a by-pass line disposed to permit the passage of fluid around the piston 38 at an appropriate stage in the movement thereof, thereby retarding the operating rate. As shown, a plate 68, cored out to provide a passage 70, is secured to cylinder 30 by bolts 72 in position to close an opening 74 formed in the cylinder wall. Bolts 72 pass through vertical slots 76 formed in plate 68 and opening 74 is somewhat larger than the cooperating portion of plate 68. The position of plate 68 with respect to cylinder 30 is therefore adjustable, allowing a corresponding adjustment in the vertical position at which the hesitation in the ram movement is effected. The degree of hesitation in the ram movement is also conveniently adjustable by a screw valve 78 which may be turned inwardly or outwardly in plate 68 to restrict or enlarge the effective cross-sectional area of passage 70.

Openings 80 and 82 formed in the side walls of piston 44 and portion 46 of cylinder 30, respectively, register with an opening 84 formed in the lower portion of the side wall of an overload cylinder or chamber 86, and provide communication between the underside of piston 38 and the lower portion of cylinder 86. Opening 84 may be restricted by a pivoted flapper type check valve 85, for a purpose mentioned later. A collar 88 formed on the base 90, which serves as a common support and enclosure for cylinders 30 and 86, is cored out at 92 and is provided with annular recesses 94 and 96, respectively, into which pipes 98 and 100 are tightly fitted. Pipe 100 extends through openings 80 and 82 into the interior of cylinder 30, in laterally displaced relation to valve 85. Pipe 98 extends through an opening in piston 104 and through an opening formed in the upper surface of chamber 86 and terminates in a threaded connection with the outlet side of a pump 106. The intake side of pump 106 is suitably connected by pipe 108 with the interior of cylinder 30. As will be understood, pipe 108 extends somewhat below the normal fluid level in cylinder 30.

Piston 104, which is slidably fitted in chamber 86 and is normally supported therein on the upper portion of collar 88, is biased to such position by a spring 110. The strength of spring 110 is preferably in excess of the normal load imposed on push rod 28. In the event of an overload on push rod 28, however, piston 104 may be forced upwardly in chamber 86 against the force of spring 110, the actuating fluid in such case passing from the lower chamber portion of cylinder 30 through openings 80, 82 and 84 to the underside of piston 104.

Nipple 112 connects ports 114 and 116, formed in the side walls of cylinder 30 and chamber 86, respectively. Port 114 is positioned slightly below the level at which the underside of piston 38 stands when the latter is in the extreme upper position. Port 116 is preferably positioned near the top of chamber 86. While piston 38 is below port 114, nipple 112 provides an escape for the fluid which normally fills the space above piston 104. When, however, piston 38 passes beyond port 114, both the upper and lower portions of chamber 86 are in communication with the portion of cylinder 30 then below piston 38. Under these conditions, accordingly, chamber 86 and the associated parts are ineffective to permit an interruption or reversal of the movement of piston 38 in response to overload conditions.

Pump 106 may be of any suitable reversible flow type, but is preferably of the type disclosed and claimed in the co-pending Evans Patent No. 2,105,999, granted January 18, 1938, assigned to the same assignee as the present application. This preferred form is also illustrated in detail in Figs. 4 through 6 of the present drawings.

In general, and referring to Figs. 4, 5 and 6, the pump casing is formed to provide an inlet chamber, a pump chamber and an outlet chamber. Suitable ports are provided to connect the pump chamber to the inlet and outlet chambers. A by-pass connection around the pump chamber interconnects the intake and outlet chambers when the pump is operating below a predetermined rate. This by-pass serves to permit a reversal of flow through the pump, without requiring that such reverse flow pass through the pump chamber. A valve for controlling the by-pass is controlled in accordance with the rate of operation of the pump, and at a predetermined rate, closes the by-pass connection. An overload valve is also provided to by-pass the pump chamber.

Considering the above elements in more detail, casing 120 is formed to provide a pump chamber 122, an inlet chamber 124, and an outlet chamber 126. A pump rotor 128, eccentrically mounted in chamber 122 on a drive shaft 130 (associated with motor 131, Fig. 2), and having a plurality of pumping blades 132 pressed outwardly by a spring 134, draws fluid from inlet chamber 124 through port 136, and forces it into outlet chamber 126 by way of port 138. Chamber 124 communicates with a suitable source of fluid supply through opening 140, and pipe 108 (Fig. 2) and chamber 126 is provided with a suitable outlet passage 142, connecting with pipe 98.

The common wall 144 which separates chambers 124 and 126 is provided with an opening 146, which is normally closed by a spring pressed release valve designated generally at 148. Valve 148 comprises a head 150, which abuts a seat 153 slidably fitted in a recess 152 formed in wall 144; a shank 154 slidably fitted in a sleeve 156 which is threaded into casing 120 and terminates in an external head 158; and a biasing spring 160 which surrounds shank 154 and bears against a shoulder formed thereon and a similar shoulder formed on sleeve 156. Rotation of head 158 in one direction or the other causes sleeve 156 to move inwardly or outwardly with respect to casing 120, elongating or compressing spring 160 and correspondingly varying the contact pressure of valve head 150. As will be understood, if the pressure in chamber 126 exceeds the force exerted by spring 160, valve 148 is forced open, permitting the fluid to pass freely between chambers 124 and 126, through opening 146.

Wall 144 is also provided with a second opening 162, which affords communication between chambers 124 and 126 of casing 120. A valve 168, disposed to engage the margins of opening 162 to close the latter, is connected to a piston 170 by a central post 172. Piston 170 is slidably fitted in a cylinder 164 formed on the interior of casing 120, axially concentric with opening 162. A passage 166 connects chamber 126 and cylinder 164. The diameters of piston 170, cylinder 164 and opening 162 are the same so that in any position both sides of valves 168 are subjected to equal and opposite fluid pressures, and is un-

affected by the pressures within chambers 124 and 126.

The shank 174 of valve 168 extends through the casing 120 and into the interior of a governor housing 176, which is suitably secured to casing 120 by studs 178. A spring 180, suitably secured to the interior of housing 176 by studs 182, surrounds a governor sleeve 184 which is tightly fitted on shaft 130, and is connected at its lower end to shank 174 by a pin 186. Spring 180 is disposed to bias valve 168 to the left, to close opening 162. As long, however, as the speed of shaft 130, and hence of the pump, is below a certain value, the centrifugal governor mechanism designated generally 190, forces spring 180 to the right as viewed in Fig. 5, in which position it actuates valve 168 to the open position. When the pump speed exceeds the predetermined value, however, governor mechanism 190 is retired, and spring 180 is rendered effective to close valve 168.

Although governor mechanism 190 may be of any conventional type arranged to function as above described, it preferably comprises the sleeve 184, tightly fitted on shaft 130; an auxiliary sleeve 194 slidably fitted on sleeve 184 and having projecting shoulders disposed to engage the end sections of two governor arms 196; a pair of weights 198 connected to arms 196 and slidably positioned within a frame 200 which serves to guide the movements thereof and is tightly fitted on sleeve 184; and a pair of biasing springs 202, disposed to engage pins 204 which pass through weights 198, and serve to bias the latter inwardly. As will be understood, upon rotation of shaft 130, governor 190 rotates correspondingly, and weights 198 are centrifugally pushed outwardly within frame 200. This motion of weights 198 causes arms 196 to move sleeve 194 to the left as viewed in Fig. 5. In response to this motion, collar 206 which is secured on sleeve 194 and provides a bearing surface for spring 180, also moves to the left as viewed in Fig. 5, under the influence of spring 180. This motion of spring 180 also closes valve 168. If the speed of shaft 130 falls below a predetermined value, springs 202 force weights 198 inwardly, causing collar 206 to move to the right as viewed in Fig. 5. This action forces spring 180 to the right, re-opening valve 168.

With reference to the operation of the system as a whole, motor 131 may be started in any suitable manner. In accordance with the illustrated use of the hydraulic ram of the present invention in connection with crossing guard, motor 131 may preferably be started in response to the approach of a vehicle to the crossing to be protected. Mechanism for accomplishing this forms no part of the present invention and has not been illustrated. As described in the Goodman Reissue Patent No. 20,157, granted November 3, 1936, however, it may be accomplished by positioning suitable switching mechanism along the roadway to be protected, for actuation by approaching vehicles when within a predetermined distance of the crossing.

Upon being started, motor 131 operates pump 106 in the manner above described. At the beginning of this operation, valve 168 of pump 106 occupies the open position, permitting a free passage of fluid between the inlet and outlet chambers thereof, and subjecting the hydraulic ram piston to no upward force. As the speed of pump 106 increases, however, governor mechanism 190 permits valve 168 to be closed under the influence of spring 180. Thereafter, the pressure developed within pump 106 is transmitted to the underside of pistons 38 and 44 by way of pipes 98 and 100.

This pressure is distributed over the relatively large area of both pistons 38 and 44, both of which start upwardly, carrying push rod 28 along with them. As previously mentioned, the abnormal initial force on push rod 28, provided by auxiliary piston 44, is desirable to positively insure a prompt initial movement of push rod 28.

As will be understood, as piston 38 moves upwardly, the actuating fluid above it is transferred through pipe 108 to pump 106. Similarly, the fluid in the chamber portion 62 between piston 44 and portion 46 of cylinder 30, is transferred to the region above piston 38 by way of the exhaust ports 60.

When piston 38 passes above and exposes port 58, a differential pressuure is imposed on the upper surface of piston 44. As will be understood, the pressure through ports 58 may either partially or entirely balance the upward pressure on piston 44, depending upon the size of the ports. The pressures are preferably substantially balanced, so that piston 44 starts downwardly under the influence of gravity, supplemented by the downward biasing force of springs 54.

Depending upon the initial load imposed on push rod 28, and also depending upon the size of the exhaust ports 60, the initial rate movement of piston 38 may exceed the initial rate of movement of piston 44. Under these conditions, piston 38 may expose ports 58, and initiate the return movement of piston 44 before the latter reaches the upper limit of its stroke. In any event, however, the upward movement of piston 44 is interrupted when the upper surface thereof engages the ribs 48 formed on the underside of portion 46.

At a point in the upward movement of piston 38, determined by the location of plate 68, piston 38 passes above and exposes the lower end of passage 70, and a portion of the actuating fluid is diverted through the latter, reducing the pressure exerted on piston 38 and reducing the speed thereof. As will be understood, the degree of reduction in speed of piston 38 depends upon the relation of the area passage 70 to the area of piston 38.

When piston 38 traveling at the reduced rate, passes above the upper opening of passage 70, the previously mentioned by-pass is interrupted and the original rate of movement of piston 38 is resumed. It will be understood that the distance travelled by the piston 38 at the reduced rate depends upon the spacing between the upper and lower openings of passage 70.

The upward movement of piston 38 and push rod 28 may be limited by the character of the mechanism actuated thereby. Preferably, however, the hydraulic ram embodies mechanism to cushion the final movements of push rod 28 and stop it as it approaches its limit of travel. As illustrated, bumper 118 which surrounds push rod 28 engages the upper surface of cylinder 30 when piston 38 is somewhat below the end of pipe 108. Upon being stopped by bumper 118, piston 38 remains in the upper position as long as motor 131 is maintained in operation. Preferably, relief check valve 148 associated with pump 106 is adjusted to open in response to the pressure developed in pump 106 under these conditions, thereby relieving the actuating pressure on piston 38. Alternative arrangements to relieve the

pressure on the piston at the top of the stroke and to provide an adjustably predetermined limit to the piston travel are disclosed and claimed in the above identified co-pending application Serial No. 34,321.

The stopping of motor 131 may be effected in any suitable manner, depending upon the use to which the hydraulic ram of the invention is put. When used in connection with crossing guards, however, the stopping is preferably accomplished automatically in response to the passage of a vehicle past the protected crossings, in the manner disclosed in the above identified Goodman Reissue Patent 20,157.

Upon the stopping of motor 131, the pressure developed by pump 106 falls to zero. Also, valve 168, associated with pump 106, is actuated to the open position by governor 190 in the previously described manner. This latter action permits the fluid to return freely through the pump.

In the embodiment illustrated in Fig. 2, this latter action permits piston 38 to start downwardly under the influence of gravity, the fluid beneath piston 38 being forced upwardly through pipe 98, through pump 106 and pipe 108 into the upper portion of cylinder 30.

As previously mentioned, in the use of the hydraulic ram of the present invention in connection with crossing guards, it may frequently happen that a vehicle will strike the barrier. In accordance with the illustrated embodiment of the present invention, it is considered preferable that an occurrence of this kind, if occurring during the initial movement of the barrier, be effective to force the barrier downwardly, permitting the vehicle to pass over it. If, however, this occurs after the barrier has reached its extended position or substantially so, it is preferable that the barrier be positively extended and prevented from being retracted.

Spring 110 which biases the auxiliary piston 104 to the lower illustrated position, is preferably of sufficient strength to maintain the latter in the illustrated position as long as the load on push rod 28 falls within a predetermined range of values. If, however, push rod 28 is subjected to an excessive load while piston 38 is below relief port 114, the actuating fluid is diverted through openings 80 and 82 and valve 85 into the region beneath piston 104 and forces the latter upwardly, against the force of spring 110. If the excessive load on push rod 28 is sufficient to cause it to move downwardly, a correspondingly increased upward movement of piston 104 results.

Upon removal of the overload, rod 28 starts upwardly again under the combined influence of the pressure developed by pump 106 and of the energy stored in spring 110. In order to prevent the latter force from causing an abrupt and sudden start of push rod 28, the return movement of piston 104 is preferably delayed. As illustrated, this may be accomplished by flapper valve 85, which swings back to permit a relatively free passage of fluid into the chamber beneath piston 104, but partly closes off openings 80 and 82, preventing a too rapid return of the fluid.

The advantages of this latter feature will be apparent. For example, in connection with the use of the hydraulic ram of the present invention to control crossing guards, the delayed return of the auxiliary piston prevents injury to the underparts of vehicles, which might otherwise occur if the barrier were permitted to rapidly fly upward after having been forced downwardly by the front wheels of the vehicle.

When piston 38 passes above and exposes relief port 114, the fluid pressure in cylinder 86 is balanced on opposite sides of piston 104. Accordingly, any overloads encountered while piston 38 occupies a position above port 114 are not absorbed by piston 104, and, as long as such overloads do not exceed the value required to actuate check valve 148 associated with pump 106, the motion or position of piston 38 is not affected by them. As will be understood, the pressure required to actuate release valve 148 of pump 106 falls between the actuating pressure developed in pump 106, and the over-load value to which the piston 104 is designed to respond. With this arrangement, check valve 148 remains closed under over-load conditions which are absorbed by piston 104, and is opened only when piston 38 reaches the upper limit of its travel, at which time it functions as previously described to relieve the actuating pressure on piston 38.

In accordance with the embodiment illustrated in Fig. 7, a positive return of the piston is provided. As illustrated, a compressible fluid pressure is employed, which becomes effective upon interruption of the main actuating pressure, to force the piston to the normal position. The fluid is compressed during the work stroke of the ram piston.

Referring to Fig. 7, in which corresponding parts are given the same reference characters as in the earlier described figures, push rod 28 is connected to member 24 and to piston 38 in previously described manner. As also described, piston 38 reciprocates in cylinder 30, the upward movement thereof being provided with a hesitation period by the assembly designated generally at 68.

An inlet passage 240 formed in the side wall of cylinder 30 communicates with the outlet passage 242 of a conventional gear pump 244. An outlet passage 246 formed in the base of cylinder 30 communicates with a supply chamber 248 by way of nipples 250 and 252 and a normally open electro-magnetically controlled valve 254. Chamber 248 communicates with the inlet side of pump 244 by way of pipe 258.

As will be understood, the pump chamber of pump 244 includes two gears 260 and 262 pivotally supported in meshed relation and arranged to be driven by a suitable motor 264. Gears 260 and 262 are closely fitted within the interior of pump 244 so that rotation of these gears forces liquid through the pump. A passage 261 connecting opposite sides of the pump chamber is normally closed by a spring pressed check valve 263, which is adapted to open in response to the pressure imposed thereon when piston 38 reaches the upper limit of its stroke, to relieve the actuating pressure on piston 38.

The stem 266 of valve 254 is connected to the armature 268, associated with solenoid 270.

A spring 272, seated between the end of armature 268 and a shoulder 274, biases valve 254 to the open position. The circuit for solenoid 270 is preferably completed as long as motor 264 is in operation, and is interrupted when the latter circuit is interrupted. With this arrangement, valve 254 remains closed except while motor 264 is at rest. As illustrated, the motor and solenoid circuits are connected in series, including conductors 276 and 278, and may be connected to a suitable external source of power in any desired manner.

An auxiliary cylinder or chamber 280 communicates with the upper portion of cylinder 30 through pipe 282. A suitable spring pressed check valve 284 connects the interior of chamber 280 to the atmosphere through passage 286, in the event the pressure in chamber 280 falls below atmospheric pressure.

Except as hereinafter described, the portion of cylinder 30 above piston 38 normally includes only enough of the fluid actuated by pump 244 to close off the opening 288. The remainder of cylinder 30 and cylinder 280 may be filled with any compressible fluid, such as air. Pipe 282 enters cylinder 30 at a point above the level reached by any fluid in cylinder 30 when piston 38 reaches the limit of its stroke, so that none of such fluid passes into cylinder 280.

In operation, the starting of pump 244 occurs simultaneously with the closing of valve 254, as above mentioned. The latter action closes exhaust passage 246, so that the pressure developed by pump 244 forces piston 38 upwardly in cylinder 30. In the course of the upward movement, the assembly designated generally 68 introduces a hesitation in the movement of piston 38 in the previously described manner. During this hesitation, a portion of the actuating fluid passes into the region above piston 38. Such fluid is later discharged as described below.

During the upward movement of said piston, 38, the fluid above piston 38 and in cylinder 280 is compressed. Cylinder 280 is preferably of rather limited diameter relative to cylinder 30 so that when piston 38 reaches the upper limit of its stroke, a relatively high fluid pressure is developed in cylinder 280.

The pressure developed within cylinder 280 cushions final upward movement of piston 38, and may, if desired, be relied upon to bring piston 28 to rest at the upper limit of its stroke. Preferably, however, a resilient sleeve, such as 287, is positioned around push rod 28 to engage the underside of the top of cylinder 30 and interrupt the final movement of piston 38. As will be understood, the interruption in the movement of piston 38 occurs before the liquid thereabove reaches the level of the opening into pipe 282. With the arrangement illustrated, pump 244 may be maintained in operation after piston 38 reaches the limit of its stroke, at which time check valve 263 opens, preventing the actuating pressure on piston 38 from exceeding a predetermined maximum.

To effect the return of piston 38 to the illustrated position, valve 254 may be opened by deenergizing solenoid 270, and motor 264 may be stopped, if this has not already been accomplished in the manner above mentioned. Upon the opening of valve 254, the pressure within cylinder 280 forces piston 38 downwardly to the illustrated position, the rate of downward movement being determined in accordance with the volumes of cylinders 30 and 280 and the amount of compressed fluid, as will be understood.

During the period, in the downward movement, that piston 38 occupies the space between the upper and lower openings of passage 70, a limited amount of the fluid beneath piston 38 may pass through opening 70 into the region above piston 38. Depending upon the characteristics of cylinder 30 and exhaust passage 250, it has been found in practice that this period is relatively short and that no appreciable modification in the speed of piston 38 results therefrom.

When piston 38 reaches the lower end of its stroke, it exposes an exhaust passage 288, which communicates with the portion of cylinder 30 beneath piston 38 but is normally closed off by a spring pressed check valve 290.

At this time, the oil above piston 38 is at a level somewhat above the previously described normal oil level, because of the oil which entered the space above piston 38 during the time, in the upward movement of the latter, that passage 70 connected the upper and lower portions of cylinder 30. This additional oil above piston 38 raises the fluid pressure within cylinder 30 to a value sufficiently high to open check valve 290, releasing such additional oil. Check valve 290 is adapted to reclose when the oil reaches substantially the normal level in cylinder 30.

In accordance with the modification illustrated in Fig. 8, a positive return of the piston is provided by a pumping system which reverses the pumping action utilized to effect the work movement of the piston. As illustrated, this is accomplished by using one pump to provide the work movement of the pistons, and an auxiliary pump used to effect the return movement of the piston. When the piston reaches the upper limit of its stroke, the work pump may be stopped, or the effect thereof may be by-passed as described in connection with Fig. 7 of this application. When the return movement is to be effected, the return pump is automatically started. At the termination of the return movement, the return pump is automatically stopped.

With the exception of the above mentioned auxiliary motor and pump, and the selectively operated switching mechanism, the structure disclosed in Fig. 8 may be as described in connection with Fig. 7, and accordingly, corresponding reference characters are used where appropriate.

Referring to Fig. 8, push rod 28, piston 38, cylinder 30, work pump 244, motor 264, supply tank 248 are constructed and arranged as described in connection with Fig. 7.

The outlet passage 302 of return pump 300 is connected to supply source 248 and the inlet passage of pump 300 is connected through openings 306 to the portion of cylinder 30 beneath piston 38. Pump 300 is preferably a duplicate of pump 244, except that the by-pass structure 261 is not required in pump 300.

The circuit for motor 308, which is suitably connected to drive pump 300, includes conductors 310 and 312 and 314. Conductors 310 and 314 may be connected through the contacts (not shown) of a cam operated switch 316 suitably positioned on the top of cylinder 30, and having an actuating arm 318. Arm 318 is positioned for engagement and rotation by a cam 320 formed at the upper end of rod 28 when piston 38 reaches the lower limit of its stroke. The contact structure within switch 316 may be arranged in any suitable well known manner so that the circuit through switch 316 is complete except when cam 320 has engaged arm 318 and moved it downwardly.

As illustrated, the operation of pump motors 264 and 308 is controlled by a master switch 322, having an actuating stem 324 formed of insulating material and which carries suitable contact structure 326. Spring 328 biases the contact structure 326 to the normal illustrated position in which contacts 330 and 332 are closed. Movement of stem 324, however, to the lower position, opens contacts 330 and 332 and closes contacts 334 and 336. The actuation of stem 324 may

be accomplished in any suitable manner, depending upon the use to which the hydraulic ram is to be put. In connection with the control of crossing guards, for example, the approach of a vehicle to a crossing may be caused to move stem 324 to the lower position and the passage beyond the crossing of the vehicle may be caused to allow stem 324 to resume the illustrated position. A suitable arrangement for accomplishing this is disclosed in the above identified Goodman Reissue Patent 20,157.

In operation, movement of stem 324 to the lower position opens contacts 330 and 332 and closes contacts 334 and 336. With piston 38 in the illustrated position, the former action is of no effect, since the circuit for motor 308 is interrupted at the now open contacts of switch 316. The latter action completes the circuit for work motor 264, which, accordingly, drives pump 244 and forces piston 38 upwardly as previously described. With the illustrated arrangement, and as described in connection with Fig. 7, the final movement of piston 38 may be cushioned by a bumper 287. Pump 244 may be allowed to remain in operation continuously while piston 38 occupies the extreme upper position, the output thereof circulating through passage 261. Although no mechanism for effecting a hesitation in the movement of piston 38 or for absorbing overloads encountered during the intermediate portion of the travel of piston 38, has been illustrated, it will be understood that the arrangements described in connection with Figs. 7 and 2 are applicable.

During the first part of the movement of piston 38, cam 320 passes beyond and releases arm 318, allowing closure of the contacts of switch 316. This action is of no effect, however, since master switch 322 is now in the opposite position.

Upon release of the actuating arm 324 of switch 322, contacts 334 and 336 thereof are opened and contacts 330 and 332 are closed. The former action interrupts the circuit for, and stops, work motor 264. The latter action completes the circuit for return motor 308, which includes conductor 310, contacts of switch 316, conductor 314 and conductor 312. In response to completion of this circuit, return motor 308 drives pump 300, drawing the fluid beneath piston 38 into reservoir 248. The space above piston 38 is preferably vented, as at 339, and, the space below piston 38 being a closed system under control of pump 300, piston 38 is caused to closely follow the fall of the fluid in cylinder 30. In this connection it is noted also that the rate of the return movement is determined by the rate of operation of motor 308, and may be caused to bear any desired relation to the rate of the work movement.

The embodiment of the present invention disclosed in Fig. 9 of the drawings, is identical in construction with the modification illustrated in Fig. 2, and has the same operating characteristics, with the exception that the plate 68 and related parts, of Fig. 2, is replaced by an auxiliary chamber 340 and certain related parts, in order to provide an interruption in the upward motion of piston 38, instead of the hesitation described in connection with Fig. 2.

The co-pending application of Evans, Serial No. 34,321 filed August 2, 1935, and assigned to the same assignee as the present application, discloses a hydraulic ram system embodying an auxiliary chamber similar in many respects to chamber 340 of Fig. 9 of the present application, for the purpose of providing either a retardation or an interruption in the upward movement of the associated ram piston. The arrangement shown in Fig. 9 is an improvement over the above mentioned arrangement in that mechanism is provided to promptly unload the auxiliary chamber as soon as the upward motion of the ram piston is resumed. This latter arrangement is desirable to prevent this auxiliary chamber from absorbing a part of the effects of overloads which are intended to be absorbed by the overload mechanism described in detail in connection with Fig. 2. As illustrated, this is accomplished by providing an auxiliary relief port for the fluid which normally occupies the upper portion of the auxiliary chamber, and arranging this port to be exposed just after the ram piston resumes its movement.

Referring to Fig. 9, in which parts which correspond to parts described in connection with Fig. 2 are correspondingly designated, the piston 342, slidably fitted within chamber 340, is biased to an illustrated normal position by a spring 344. The normal position of piston 342 is determined by a screw 346 which is threaded through the lower surface of chamber 340 and bears against piston 342. A lock nut 348 is provided to lock adjusting screw 346 in any desired position. The upper part of chamber 340 communicates with the interior of chamber 30 by a passage 350 and two somewhat spaced openings 352 and 354. The lower part of chamber 340 communicates with the interior of cylinder 30 through a passage 356 which enters cylinder 30 at a position just below the position of inlet port 354. As described in the above mentioned co-pending application Serial No. 34,321, filed August 2, 1935, the spacing between opening 352 and 360 is preferably somewhat in excess of the length of piston 38. As also described in the just mentioned application, the resisting force of spring 344 is preferably somewhat less than the normal load imposed on push rod 28.

Accordingly, when in the upward movement of piston 38, opening 360 is exposed, the actuating fluid is diverted through passage 356 into chamber 340 and forces piston 342 to the top thereof. Depending upon the characteristics of spring 344 and the size of passage 350 and opening 352, this action may either be caused to interrupt or merely retard the motion of push rod 28.

During the course of this upward movement of piston 342, the fluid which normally occupies the region above piston 342 passes through passage 350 and opening 352 into cylinder 30.

When piston 342 reaches the upper limit of its travel, the original rate of movement of push rod 28 and piston 38 is resumed. In response to this continued movement, piston 38 passes above and exposes opening 354. As mentioned, openings 354 and 360 are positioned in closely spaced relation so that this action occurs promptly after the resumption of movement of piston 38. The relative positioning of openings 352 and 354 is preferably such that at the time opening 354 is exposed, opening 352 is closed off by piston 38.

With both openings 354 and 360 exposed, the pressures exerted on the upper and lower sides of piston 342 by the fluid within cylinder 30 are balanced, and piston 342 promptly resumes the illustrated position under the differential pressure exerted by spring 344.

As the movement of piston 38 continues, opening 352 is exposed. This action has no effect, however, since, at this time, openings 354 and 360 are also exposed.

In the course of the downward movement of piston **38**, opening **352** is again closed off, without effect. In response to continued movement of piston **38**, opening **354** is also closed off, without effect. Similarly, the closing off and opening of port **360** by the continued movement of piston **38** is without effect. It is seen, therefore, that chamber **340** and the related elements have no effect on the movement of piston **38** in the downward direction.

Although specific embodiments of the present invention have been illustrated and described, it will be evident that various modifications may be made in the form, number and arrangement of parts without departing from the spirit and scope thereof. The described embodiments, accordingly, are to be considered in an illustrative, and not in a limiting, sense.

What is claimed is:

1. In a fluid pressure operated ram, a cylinder, a piston supported within said cylinder, means for subjecting said piston to fluid pressure to cause movement thereof in said cylinder, and means for controlling the rate of movement of said piston comprising a member embodying a by-pass passage, and means for adjustably securing said member to said cylinder so that the ends of said passage communicate with the interior of said cylinder.

2. In a fluid pressure operated ram, a cylinder, a piston supported within said cylinder, means for subjecting said piston to fluid pressure to cause movement thereof in said cylinder, and means for controlling the rate of movement of said piston comprising a member having a by-pass passage formed therein, a valve for controlling the effective area of said passage, and means for adjustably securing said member to said cylinder with the ends of said passage in communication with the interior of said cylinder.

3. In a fluid pressure operated ram, a cylinder, a piston supported within said cylinder, means for subjecting said piston to fluid pressure to cause movement thereof within said cylinder, auxiliary means associated with said ram for absorbing overloads encountered during the movement of said piston, and means for limiting the range in said movement throughout which said overload mechanism is effective.

4. In a fluid pressure operated ram, a cylinder, a piston supported within said cylinder, means for subjecting said piston to fluid pressure to cause movement thereof within said cylinder, means for absorbing overloads encountered during the movement of said piston, and means for rendering said overload mechanism ineffective when said piston approaches a limit of the movement thereof.

5. In a fluid pressure operated ram, a cylinder, a piston supported within said cylinder, means for subjecting said piston to fluid pressure to cause movement thereof within said cylinder, means for absorbing overloads encountered during the movement of said piston, and means rendered effective by movement of said piston for rendering said overload mechanism ineffective when said piston approaches a limit of the travel thereof.

6. In a fluid pressure operated ram, a cylinder; a piston supported within said cylinder; means for subjecting said piston to fluid pressure to cause movement thereof within said cylinder; and overload mechanism for absorbing overloads encountered during the movement of said piston comprising an auxiliary chamber, a piston supported within said auxiliary chamber, a connection between said fluid pressure means and the portion of said auxiliary chamber at one side of said auxiliary piston, means for applying a predetermined loading on said auxiliary piston in opposition to the force applied to it through said connection, a secondary connection between said fluid pressure means and the portion of said auxiliary chamber at the other side of said auxiliary piston, and means to open and close said secondary connection whereby to render said overload mechanism ineffective and effective respectively.

7. In a fluid pressure operated ram, a cylinder; a piston supported within said cylinder; means for subjecting said piston to fluid pressure to cause movement thereof within said cylinder; means for absorbing overloads encountered during the movement of said piston comprising an auxiliary chamber, a piston movably supported within said auxiliary chamber, means for connecting the portion of said auxiliary chamber at one side of said auxiliary piston to said fluid pressure means, means for applying a predetermined loading on said auxiliary piston in opposition to the force applied to it through said connection, and means for limiting the range of movement of said first mentioned piston throughout which said overload mechanism is effective comprising a secondary connection between the portion of said auxiliary chamber at the other side of said auxiliary piston and said fluid pressure means rendered effective by movement of said first mentioned piston.

8. In a fluid pressure actuated ram, a movable member, a piston operatively connected to said member, means for actuating said piston to move said member, said actuating means comprising a source of fluid pressure and an auxiliary piston disposed to engage said first mentioned piston, means for limiting the movement of said auxiliary piston, and means including a fluid circuit completed by movement of one of said pistons for effecting a return movement of said auxiliary piston.

9. In a fluid pressure actuated ram, a movable member, a piston operatively connected to said member, an auxiliary piston arranged to cooperate with said piston to effect an initial movement of said member, means for applying fluid pressure directly to each of said pistons during said initial movement, means for stopping said auxiliary piston at the conclusion of said initial movement, and means including a fluid circuit completed by travel of one of said pistons for effecting a return movement of the auxiliary piston.

10. In a fluid pressure actuated ram, a movable member, a piston operatively connected to said member, an auxiliary piston arranged to cooperate with said piston to effect an initial movement of said member, means for applying fluid pressure directly to each of said pistons during said initial movement, means for stopping said auxiliary piston at the conclusion of said initial movement, a fluid circuit completed by travel of one of said pistons for counterbalancing the fluid pressure acting on the auxiliary piston when it is at said stopped position, and additional means rendered effective by said counterbalancing for effecting a return movement of the auxiliary piston.

11. In a fluid pressure operated ram, the combination of a cylinder, a piston movably supported within said cylinder; means including a pump for applying fluid pressure to the piston to cause movement thereof within the cylinder,

and means for retarding the speed of movement of the piston for a predetermined interval when the piston reaches an intermediate point in its travel, comprising an auxiliary chamber, an auxiliary piston in said auxiliary chamber and having means associated therewith for urging it in one direction therein, a fluid connection rendered effective by movement of the piston for diverting fluid from said cylinder to said auxiliary chamber so as to urge said auxiliary piston in the opposite direction whereby the actuating force on said piston is reduced and said auxiliary chamber is filled, and an additional fluid connection rendered effective by a further movement of said piston for applying fluid pressure to said auxiliary piston in a direction to urge it in said one direction whereby said urging means is effective to restore said auxiliary piston to its original position.

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