Jan. 29, 1935. H. F. VICKERS 1,989,387

HYDRAULIC HOISTING UNIT AND CONTROL SYSTEM THEREFOR

Filed Oct. 13, 1934 3 Sheets-Sheet 1

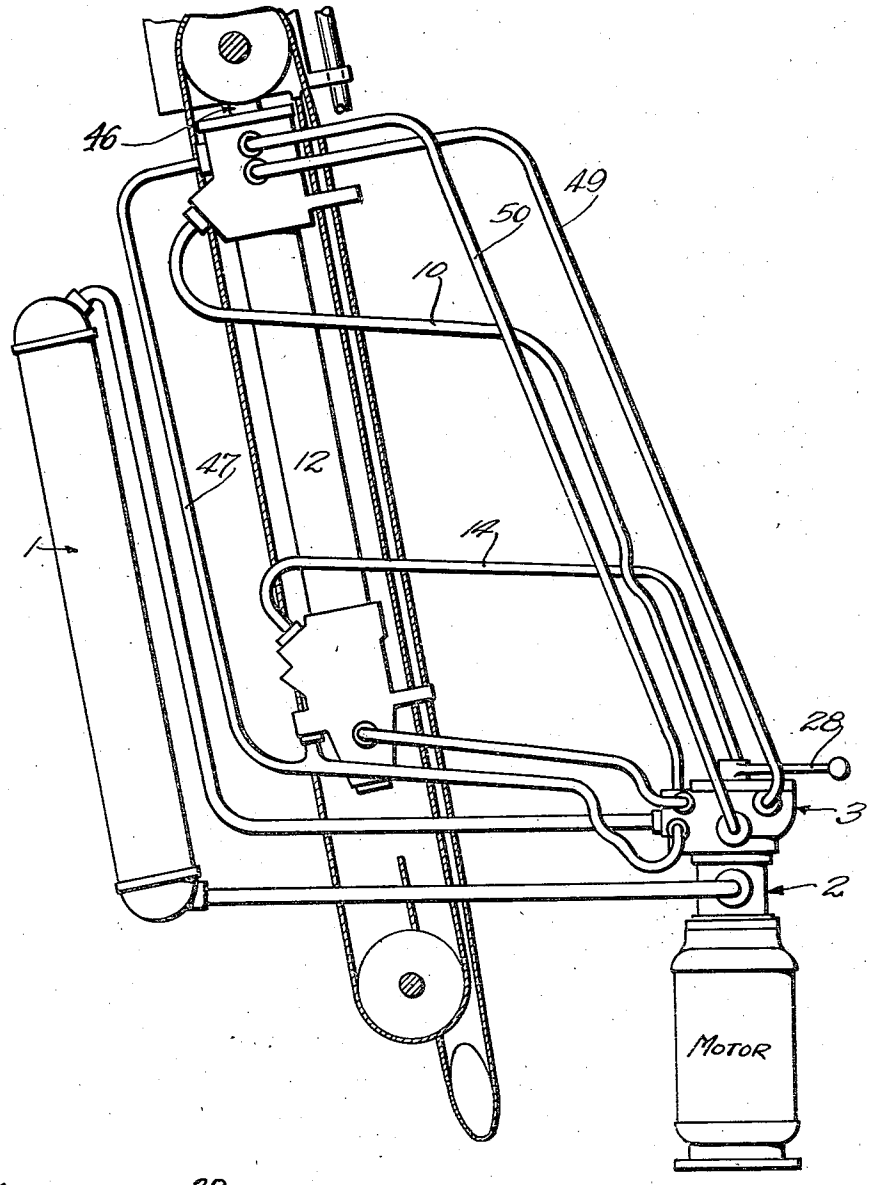


FIG 1

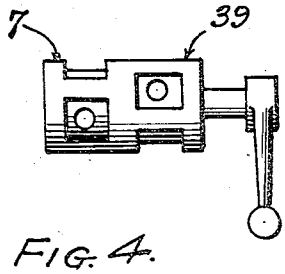


FIG. 4.

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HYDRAULIC HOISTING UNIT AND CONTROL SYSTEM THEREFOR

Filed Oct. 13, 1934 3 Sheets-Sheet 2

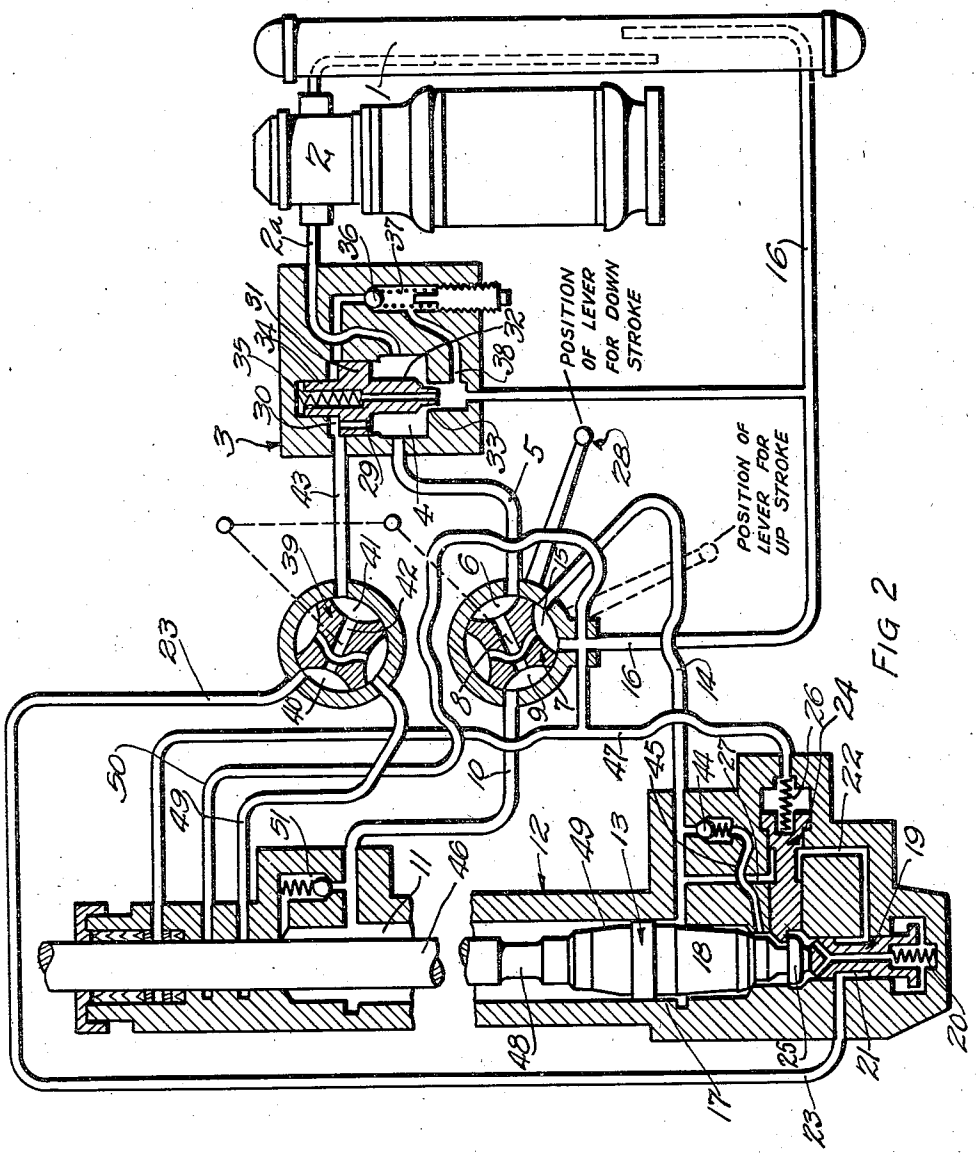


FIG 2

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HYDRAULIC HOISTING UNIT AND CONTROL SYSTEM THEREFOR

Filed Oct. 13, 1934 3 Sheets-Sheet 3

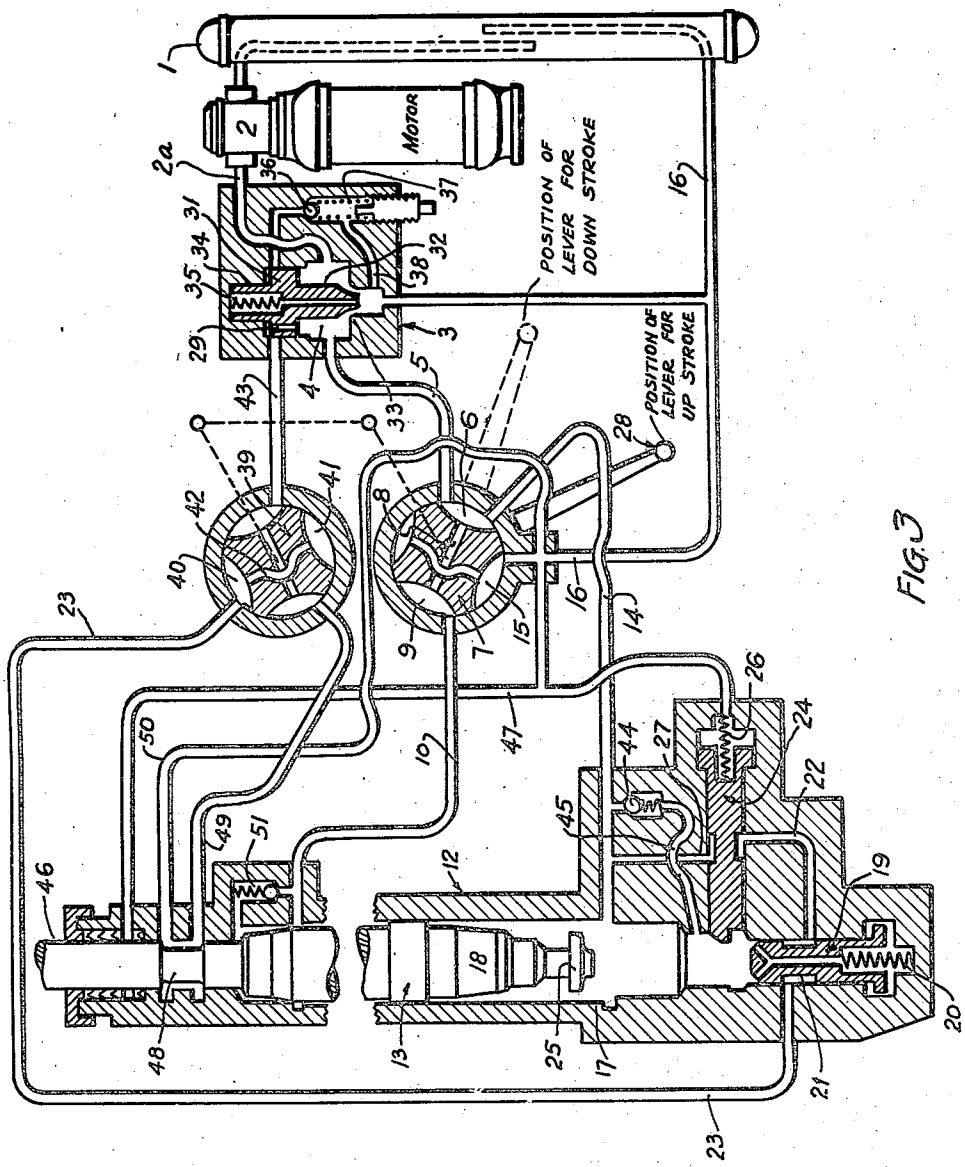


FIG. 3

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HYDRAULIC HOISTING UNIT AND CONTROL SYSTEM THEREFOR

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Application October 13, 1934, Serial No. 748,224

11 Claims. (Cl. 121—46)

This invention relates to a hydraulic hoisting unit and control system therefor, and particularly to a novel compact hoist wherein the hoisting element embodies a piston, the rectilinear movement of which is directly connected to the hoist or elevator.

Heretofore, hoists of the general type embodied in the present invention have usually been actuated by air pressure which, due to its expansibility, has made it difficult to obtain an even smooth control of the elevating mechanism.

It is an important object of the present invention to provide a self-contained hydraulic hoist unit, the moving element of which is directly and positively connected to the hoist or elevator and smooth positive control is obtained for movement of such hoist member during its complete stroke; this smooth positive control being obtained by a combination of elements and a novel circuit in combination therewith.

A further feature of the present invention has to do with novel means for positively and automatically locking the hoist piston in lowermost position when the elevator reaches the upper end of its stroke; this locking being accomplished only after the pump has been bypassed; still another and similar feature has to do with the novel bypassing of the hydraulic pump when the hoist piston reaches the upper end of its stroke.

Other features contemplate a control system peculiar to a rectilinear hoist wherein a balanced relief valve and directional control valves are placed in combination with the hoist structure and are responsive to movements of the hoist elements whereby to automatically bypass the pump pressure at certain predetermined instances in the path of movement of the hoist; other features include the mechanical latch of the hoist unit and means for interlocking this mechanical latch with the pressure relief system to insure positive mechanical latching before such pressure relief. Still further features have to do with various details of construction and combinations of elements as will be more clearly set forth in the specification and claims.

In the drawings:

Fig. 1 is an elevation of one adaptation of the present invention to the lifting of a hoist or elevator car a distance three times the stroke of the hoist plunger, the various elements of the entire unit being shown and arranged in a compact manner so as to conserve space.

Fig. 2 is a view largely diagrammatic of the complete circuit diagram of the self-contained hoist unit; all the conduits being shown in a single plane to more readily follow the various circuits and controls.

Fig. 3 is a diagrammatic view, similar to Fig. 2, but illustrating the control valves in position for the up stroke of the piston cylinder unit or the down stroke of the hoist, the piston being shown in its uppermost position.

Fig. 4 is an elevation of the control valve unit and showing the manner of forming the directional control valve and the auxiliary or pilot valve on the same stem.

Although the hoist unit itself embodies certain structural details which are believed to be novel, the accurate smooth control of the hoist is dependent upon certain features of the circuit in combination therewith and it is believed a better understanding will be had by following through this circuit as closely as possible.

Oil from the reservoir 1 is a source of supply for a suitable pump 2, preferably of the constant displacement type such as shown in my Patent No. 1,937,367, dated November 28, 1933, this pump in turn supplying oil under pressure to a main feed line 2a and pressure relief valve 3. This valve is of the balanced type as explained in detail in my application Serial No. 552,692, filed July 23, 1931. Operating features of the valve will be taken up later as the description progresses.

Oil under pressure flows through the main line 2a into a chamber 4 of the relief valve 3 and from there the oil normally flows through line 5 into entrance chamber 6 of a rotary type balanced reversing valve 7. The rotary valve 7 is provided with a diametrically extending conduit 8 through which the oil flows under pressure to a chamber 9, opposite to and equal in area to the chamber 6, and from this chamber 9 oil flows through conduit 10 into the upper end 11 of the cylinder 12. With the valve 7 in the position shown in Fig. 2, the flow of liquid under pressure to the upper end 11 of the cylinder 12 will result in driving a piston 13 downwardly. As best shown in Fig. 1, this piston is directly connected to a cable and through a series of sheaves to the hoist or elevator, so that downward motion of the piston 13 results in an upward movement of the hoist or elevator.

Generally following through the operation here, the piston will start from the position shown in Fig. 3 and continue its movement until it arrives at its lowermost position as shown in Fig. 2. During this downward stroke of the piston 13, or upward stroke of the hoist, oil is discharged through a conduit 14 which leads di-

rectly into a chamber 15 forming a part of the valve 7. The chamber 15 connects the conduit 14 with an exhaust conduit 16 for returning the liquid back to the reservoir 1. The bore at the lower end of the cylinder 12 is reduced starting at a point 17 and the lower end of the piston 13 is tapered as at 18 so that during the lowering stroke of the piston 13 the taper portion 18 entering the reduced diameter of the cylinder will restrict the exhaust of liquid to the line 14 in gradually decreasing amounts, thus smoothly and hydraulically cushioning the piston at the end of the stroke.

After the piston 13 is cushioned and gradually comes to rest, it will contact with a valve 19, moving the valve against the action of the spring 20 until a recess 21 of the valve registers with conduits 22 and 23. A somewhat similar valve 24 is positioned transversely of the cylinder housing, and this valve is in the form of a latch in that the end thereof is shaped to enter behind an enlarged head portion 25 formed at the lower end of the piston 13. The latch valve 24 is normally urged home by a spring 26, and it will be seen that when the head 25 is lowered to the position shown in Fig. 2 and the latch valve 24 moves forwardly to engage behind the head 25 the conduit 22 because of a recess in the latch valve 24 will be placed in registration with a conduit 27 which leads to the main conduit 14. When the valve 7 is in the full line position, as shown in Fig. 2, and as indicated by the handle 28, it will be seen that the conduits 27 and 14 lead to the return tank by way of the chamber 15 and conduit 16.

At this point, the importance of the relief valve 3 comes into play; the relief valve 3, being a balanced relief valve, operates in a quick acting manner and in doing so eliminates chattering. The details of this valve are more clearly set forth in the above mentioned application Serial No. 552,692 and in general may be said to comprise a main chamber 4 for receiving the liquid from the pump 2; the pressure existing in chamber 4 which, of course, depends upon the restriction set up by the hoist, is delivered through a restricted orifice 29 to a chamber 30 which is formed above a piston portion 31 of the main control valve 32. The diameter of the valve 32, seating on the valve seat 33, is equal to the diameter of the extension portion 34 which fits into an upper portion of the relief valve housing. It will therefore be seen that an equal pressure existing in the chamber 4 and in chamber 30 will not tend to move the piston 29 in either direction, with the result that the light spring 35 will maintain the position of the valve as shown.

The maximum pressure of the relief valve is determined by a ball member 36, backed by an adjustable strength spring 37 and when the pressure in chamber 4 and in the chamber 30 becomes sufficiently high to unseat the ball 36, then oil can flow past the valve 36 through a conduit 38 and hence through conduit 16 back to the tank. It will be seen that as the valve 36 is capable of by-passing a much greater amount of liquid than can be delivered through the restricted orifice it is no longer possible for the pressure in chamber 30 to increase; with the result that any further increase in pressure in chamber 4 becomes effective against the piston 31 which opens and empties the valve 32 allowing surplus oil to flow between valve 32 and its seat 33 and thus permitting full discharge of oil back to the tank. Likewise, when the pressure in chamber 4 becomes reduced to a value less than that required to unseat the valve 36, then the pressure in chamber 4 and in chamber 30 again becomes even and the valve will be returned to its seat by the small spring 35. As the spring 35 is only sufficient in strength to overcome the friction of the piston 31, the rise and fall of pressure to ultimately open or close the relief valve is very small and a very accurate adjustment of the valve can therefore be had.

It will thus be seen that any appreciable dropping of pressure in chamber 30 will immediately cause the valve 32 to open and the complete exhausting of the chamber 4 to the conduit 16 and to the tank. It will also be seen that when the piston 13 reaches the lower end of its stroke (and likewise the elevator or hoist reaches the top of its stroke) so that the valve 19 is depressed until the conduits 22 and 23 are connected, and the latch valve 24 springs in behind the head 25 to align the passageways 22 and 27, then the conduit 23 is connected to the tank, and thus to the atmosphere, through the conduits 22, 27, 14, chamber 15, and conduit 16.

The conduit 23 connects directly into a second balanced valve 39 the rotary part of which valve is adapted to be actuated simultaneously with the valve 7. In actual practice these two valves 7 and 39 are formed on a common shaft as described in my application Serial No, 704,253 of December 28, 1933, and as best shown in Fig. 4, so that the two are rotated as one unit. When the valve 39 is in the position shown in Fig. 2, the conduit 23 is in communication with chamber 40, which chamber connects to an opposite and balanced chamber 41 through a conduit 42. The valve 39 acting as a pilot valve for the relief valve 3 is connected to the chamber 30 of the relief valve by means of a conduit 43. It will thus be seen that whenever the conduits 27, 22 and 23 are in alignment, as shown in Fig. 2, due to the position of the valve 19 and the latch valve 24, that the chamber 30 will be open to atmospheric pressure with the result that the piston 31 will move upwardly to open the valve 32 so that the pump 2 will operate at substantially no pressure. However, before the pump is relieved of pressure, and by the same token, before the pressure is relieved from the piston 13, it is absolutely necessary that the latch valve 24 is mechanically secured behind the head 25. In other words, the latch valve is interlocked with the pressure relief of the pump to be sure that the latch is positioned in mechanical engagement with the piston before pressure relief takes place.

When it is desired to lower the hoist or elevator, and hence raise the piston 13, the valves 7 and 39 are rotated to the position shown in Fig. 4; in this position it will be seen that the conduit 23 is no longer connected to the conduit 43 and chamber 30 of the relief valve, and hence the chamber 30 is no longer open to atmospheric pressure. The result will be that the pressure in chamber 30 will rise to equal that in chamber 4, at which point the spring 35 will move the piston 31 downwardly, thus allowing pressure to be available up to the point controlled by the ball check valve 36. This available pressure in chamber 4 is delivered through conduit 5, chamber 6, passageway 8, chamber 9 and conduit 10 to the chamber 11 of the cylinder 12. The same pressure is also delivered from the chamber 6 through conduit 14, check valve 44 and conduit 45 to the opposite end of the piston 13. The purpose of the check valve 44 is to permit full line

pressure to be available for moving the piston, instead of going through the restricted outlet formed in the tapered portion 18 of the piston and cylinder wall. As the area of the lower end of the piston 13 exposed to pressure in the line 14 is greater by the area of the rod 46 than that exposed to pressure in the chamber 11, the piston 13 will move upwardly to return the elevator, and oil exhausting from the chamber 11, through the conduit 10 and the valve 7, will join the flow from the pump through conduit 5 and thus aid in filling a larger displacement end of the cylinder. Therefore, the thrust available and the volume required for movement of the piston upwardly are equivalent only to the dispacement of the rod 16. The supplying of operating pressure through the conduit 14, check valve 44 and conduit 45 becomes effective on the large plunger 24 causing it to move outwardly and release the enlarged portion 25 of the piston 13, so that travel of the piston 13 may occur in the direction desired.

The housing surrounding the large plunger 24 is connected to atmospheric pressure through a drain pipe 47 to permit of this outward movement of the large plunger by operating pressure from the line 14. Movement of the piston upwardly, or in the lowering direction, continues until a reset portion 48, formed in the piston rod 46, reaches the position shown in Fig. 3; when in this position it will be seen that the reset portion serves to connect a conduit 49 with a conduit 50. In the position of the pilot valve 39, as shown in Fig. 4, it will be seen that conduit 49 is in communication with the conduit 43. It will also be seen from Fig. 2 that the conduit 50 is in communication with the exhaust line 16. Thus when the piston reaches the upper end of its stroke and, of course, when the hoist or elevator reaches the bottom of the lift, the pressure in chamber 30 of the relief valve is again dropped to atmospheric pressure which again removes the load from the pump as originally described.

When approaching the end of the upward stroke, as best shown in Fig. 1, it will be noted there is provided a reduced portion 49 of the piston 13; and a certain section of this reduced portion is tapered and cooperates with a reduced portion of the cylinder to give a cushioned stop as previously described in connection with the other end of the stroke of the piston. A check valve 51 permits of full line pressure to the back of the piston 13 and starting from the uppermost position, as shown in Fig. 3.

What I claim is:—

1. A hydraulic actuating system comprising a source of pressure supply, a piston and cylinder unit, a hydraulically operated by-pass valve for by-passing the piston and cylinder unit and positioned between said source of supply and said piston and cylinder unit, valve structure including a directional control valve for reversing the movable element of the piston and cylinder unit and a pilot valve unit for controlling the actuation of said by-pass valve, and means positioned adjacent one end of said cylinder and actuated by the movable element of the piston and cylinder unit and connected hydraulically with said pilot valve unit and by-pass valve for permitting actuation of said by-pass valve when the movable element of the piston and cylinder unit reaches one end of its stroke.

2. A hydraulic actuating system comprising a source of pressure supply, a piston and cylinder unit, a hydraulically operated by-pass valve for by-passing the piston and cylinder unit and positioned between said source of supply and said piston and cylinder unit, valve structure including a directional control valve for reversing the movable element of the piston and cylinder unit and a pilot valve unit for controlling the actuation of said by-pass valve, and combined mechanical and hydraulic means positioned adjacent one end of said cylinder for mechanically locking the piston relative to the cylinder and connected hydraulically with said pilot valve unit and by-pass valve for permitting actuation of said by-pass valve when the movable element of the piston and cylinder unit reaches one end of its stroke.

3. A hydraulic actuating system comprising a source of pressure supply, a piston and cylinder unit, a hydraulically operated by-pass valve for by-passing the piston and cylinder unit and positioned between said source of supply and said piston and cylinder unit, valve structure including a directional control valve for reversing the movable element of the piston and cylinder unit and a pilot valve unit for controlling the actuation of said by-pass valve, and combined mechanical and hydraulic means positioned adjacent one end of said cylinder for first mechanically locking the piston relative to the cylinder and connected hydraulically with said pilot valve unit and by-pass valve for then permitting actuation of said by-pass valve when the movable element of the piston and cylinder unit reaches one end of its stroke.

4. A hydraulic actuating system comprising a pump, a piston and cylinder unit hydraulically connected to said pump, a hydraulically operated by-pass valve for by-passing said unit and positioned between the pump and piston and cylinder unit, valve structure including a reversing valve for the movable element of the piston and cylinder unit and a pilot valve for the by-pass valve, said reversing and pilot valve being adapted to be actuated in unison, means positioned adjacent one end of the cylinder and having a mechanical part adapted to cooperate with a portion of the piston to positively hold the piston at one end of its stroke against movement from any external source, said means including a valve part and said by-pass valve cooperating with said valve part of said means and said pilot valve to insure maintenance of pressure upon the piston until said mechanical part has been moved to positive locking position.

5. A hydraulic actuating system comprising a pump, a piston and cylinder unit hydraulically connected to said pump, a hydraulically operated by-pass valve for by-passing said unit and positioned between the pump and piston and cylinder unit, valve structure including a reversing valve for the movable element of the piston and cylinder unit and a pilot valve for the by-pass valve, said reversing and pilot valve being adapted to be actuated in unison, a latch adapted to cooperate with a portion of the piston and to normally move into a positive locking position relative to the piston when such piston reaches one end of its stroke, said latch including a valve part, and means actuated by the movement of the piston towards the end of its stroke and cooperating with the valve part of said latch, by-pass valve and pilot valve for permitting actuation of said by-pass valve.

6. A hydraulic actuating system comprising a pump, a piston and cylinder unit hydraulically connected to said pump, a hydraulically operated

by-pass valve for by-passing said unit and positioned between the pump and piston and cylinder unit, valve structure including a reversing valve for the movable element of the piston and cylinder unit and a pilot valve for the by-pass valve, said reversing and pilot valve being adapted to be actuated in unison, parts of said cylinder forming means adapted to cooperate with spaced apart portions on the piston and to be hydraulically connected to said pilot valve and by-pass valve for permitting actuation of said by-pass valve when the movable element of the piston and cylinder unit reaches either end of its stroke.

7. A hydraulic actuating system comprising a pump, a piston and cylinder unit hydraulically connected to said pump, a hydraulically operated by-pass valve for by-passing said unit and positioned between the pump and piston and cylinder unit, valve structure including a reversing valve for the movable element of the piston and cylinder unit and a pilot valve for the by-pass valve, said reversing and pilot valve being adapted to be actuated in unison, parts of said cylinder forming means adapted to cooperate with spaced apart portions on the piston and to be hydraulically connected to said pilot valve and by-pass valve for permitting actuation of said by-pass valve when the movable element of the piston and cylinder unit reaches either end of its stroke, said reversing valve and pilot valve maintaining the same position before and after actuation of said by-pass valve.

8. A hydraulic actuating system comprising a source of pressure supply, a piston and cylinder unit, a hydraulically operated by-pass valve for by-passing the piston and cylinder unit and positioned between said source of supply and said piston and cylinder unit, valve structure including a directional control valve for reversing the movable element of the piston and cylinder unit and a pilot valve unit for controlling the actuation of said by-pass valve, and combined mechanical and hydraulic means positioned adjacent one end of said cylinder for mechanically locking the piston relative to the cylinder and connected hydraulically with said pilot valve unit and by-pass valve for permitting actuation of said by-pass valve when the movable element of the piston and cylinder unit reaches one end of its stroke, said means being released from its mechanical locking position by the entrance and building up of fluid pressure in one end of the cylinder preparatory to movement of the piston from its mechanically locked position.

9. A hydraulic actuating system comprising a source of pressure supply, a piston and cylinder unit, a pressure relief unit positioned between the source of supply and said unit and including a valve member operated by a normally substantially balanced piston, said valve operating in closed position to direct the flow of fluid pressure to the piston and cylinder unit and in open position to by-pass the fluid pressure back to the tank, a pilot valve for controlling the actuation of said valve to cause by-pass of the fluid pressure, and means positioned adjacent one end of the cylinder and actuated by the movement of the piston towards the end of its stroke and hydraulically connected with said pilot valve and relief unit to permit actuation of said valve member.

10. A hydraulic actuating system comprising a source of pressure supply, a piston and cylinder unit, a pressure relief unit positioned between the source of supply and said piston and cylinder unit, a port adjacent one end of the cylinder for conducting a source of fluid pressure into said end of the cylinder for actuating said piston, a spring pressed latch one end of which is normally positioned in the path of one end of the piston, said piston having an abutment portion against which the latch is adapted to automatically contact when the piston reaches the end of its stroke, whereby to positively prevent movement of the piston by any external source, a portion of said latch having a valve part adapted to be hydraulically connected with said relief unit when the latch is in mechanical locking position relative to the piston to permit actuation of said pressure relief unit, the inner surface of said latch being exposed to fluid pressure entering one end of the cylinder through said port whereby the entrance of and building up of fluid pressure in said end of the cylinder, preparatory to moving the piston towards the other end of the cylinder, will force the latch away from its locking position to release the piston.

11. A hydraulic actuating system comprising a pump, a piston and cylinder unit hydraulically connected to said pump, a hydraulically operated by-pass valve for by-passing said unit and positioned between the pump and piston and cylinder unit, valve structure including a pilot valve for the by-pass valve, a latch adapted to cooperate with a portion of the piston and to normally move into a positive locking position relative to the piston when such piston reaches one end of its stroke, said latch including a valve part, and means actuated by the movement of the piston towards the end of its stroke and cooperating with the valve part of said latch, by-pass valve and pilot valve for permitting actuation of said by-pass valve.

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