June 30, 1953 C. A. HARSCH 2,643,515

ELECTRIC CONTROL SYSTEM FOR EXPANSIBLE MOTOR OPERATED BOOM

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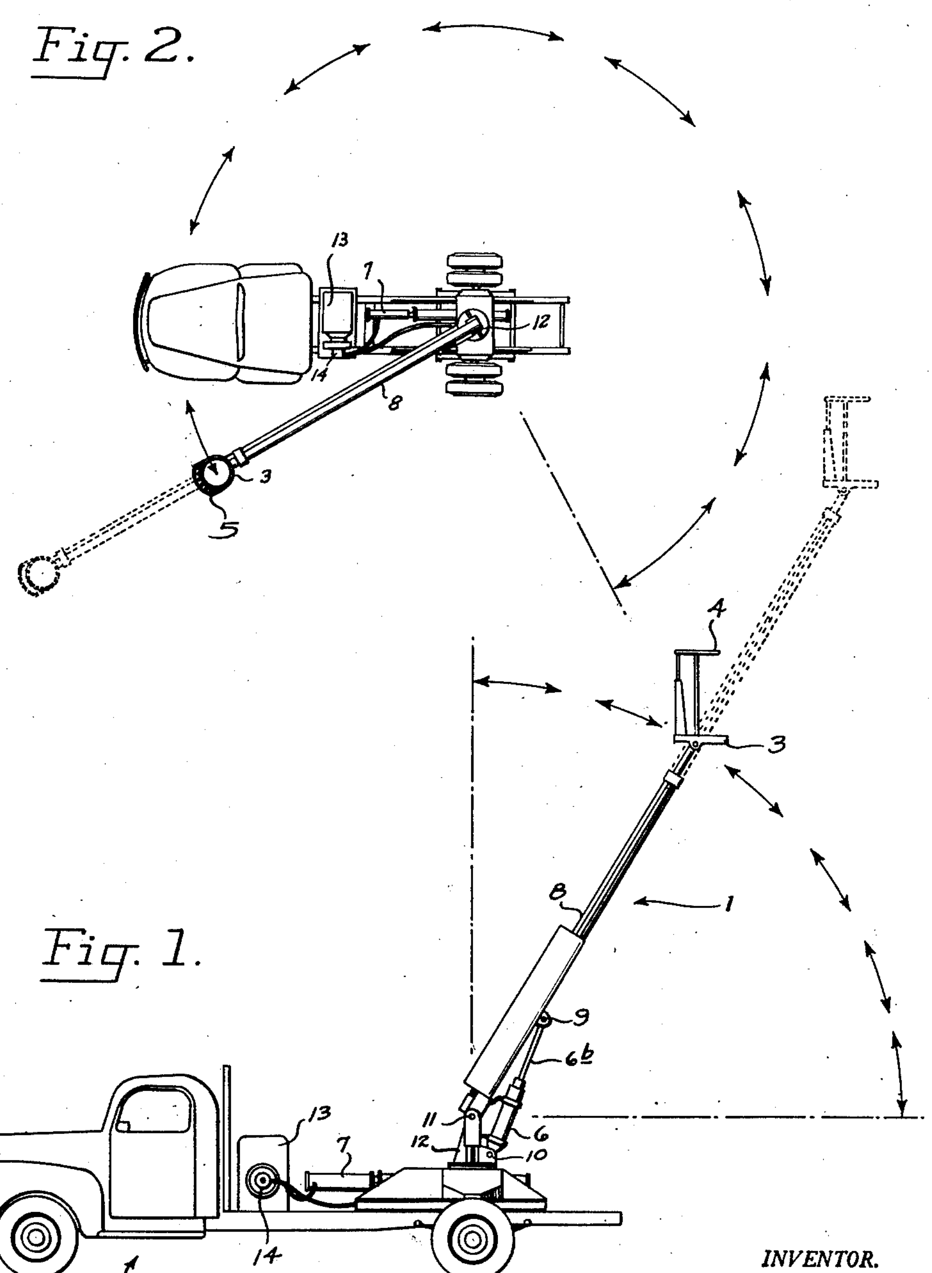
Fig. 2.

Fig. 1.



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ELECTRIC CONTROL SYSTEM FOR EXPANSIBLE MOTOR OPERATED BOOM

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Fig. 3.

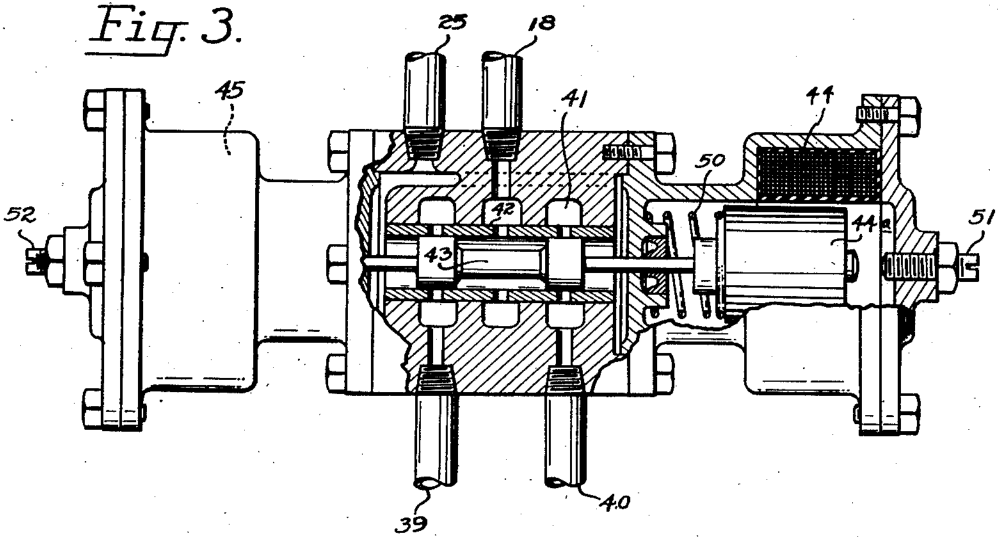


Fig. 4.

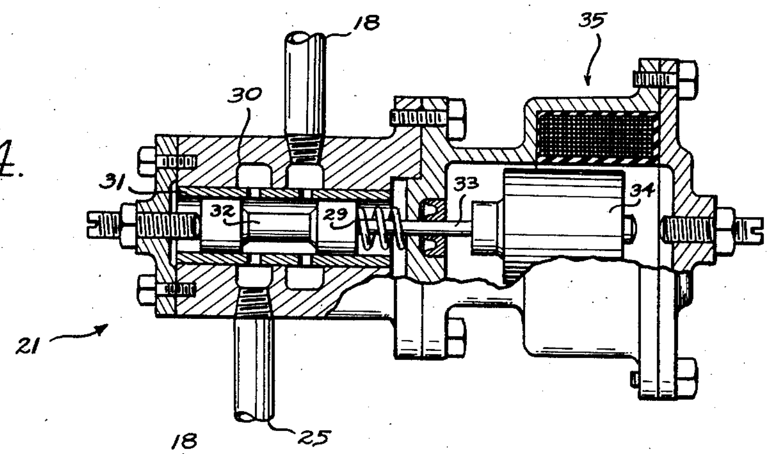
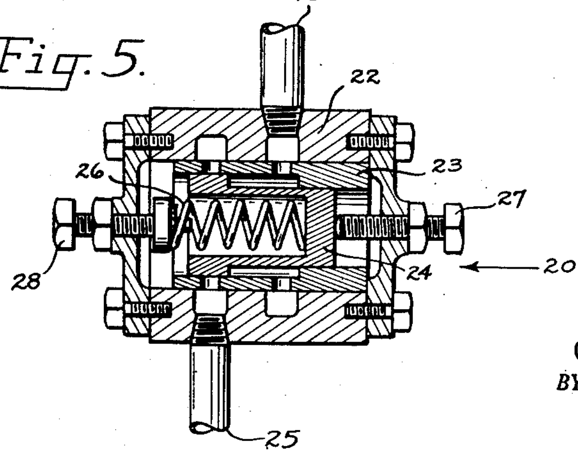


Fig. 5.



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June 30, 1953 C. A. HARSCH 2,643,515

ELECTRIC CONTROL SYSTEM FOR EXPANSIBLE MOTOR OPERATED BOOM

Filed Oct. 17, 1950 3 Sheets-Sheet 3

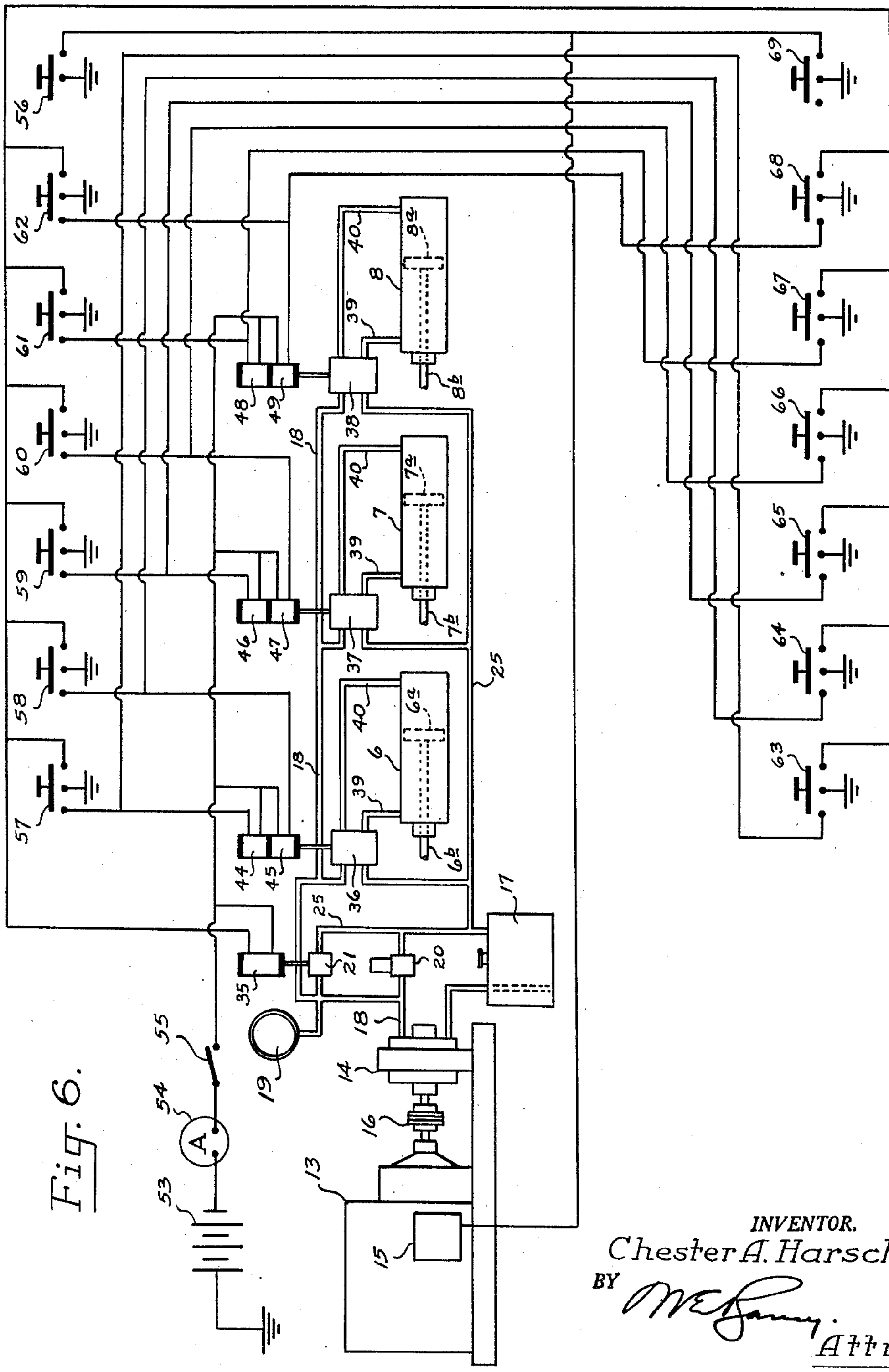

Fig. 6.

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UNITED STATES PATENT OFFICE

2,643,515

ELECTRIC CONTROL SYSTEM FOR EXPANSIBLE MOTOR OPERATED BOOM

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Application October 17, 1950, Serial No. 190,480

10 Claims. (Cl. 60—52)

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This invention relates to an extensible hydraulic boom and includes an electro-hydraulic boom operating mechanism for providing a positive, instantaneous, boom movement without unduly taxing the working parts thereof.

One object of my invention is to provide a hydraulic boom control mechanism which will have available, at all times, a constant volume of operating fluid yet which will operate under "no load" conditions except when the boom is actually moving.

The public utility companies of America have long sought a portable hydraulic boom, capable of following three independently selectable paths of movement, for use by utility maintenance crews. Such a boom should carry a self-leveling workman's cage at the terminal end and should be capable of control either from the cage itself or from the vicinity of the base of the boom. Thus, costly and laborious pole climbing could be eliminated by placing a workman, together with his tools, in the cage and by manipulating the boom until the workman is elevated to a position directly adjacent a street lamp, telephone pole cross tie, or other elevated work area. Being mindful of the attributes which such a hydraulic boom must possess, I have turned my inventive efforts toward the provision of a structure possessing such attributes and toward the provision of a mechanism for controlling the movements thereof.

The extensible hydraulic boom with which I am concerned is capable of performing many varied and hitherto costly tasks for the aforementioned public utility companies. These tasks include tree-trimming operations, mid-span line repair and reinsulation, street light moving or servicing, high-position painting, and telephone pole maintenance. It will be noted that each such task requires that the boom (1) have a high degree of mobility, (2) be capable of an exact and positive control, and (3) be capable of holding, for a considerable length of time, any position to which it is adjusted. Accordingly, I have mounted my boom upon a truck chassis and have provided three separate hydraulic motors, correlated with the three paths of movement, respectively, for moving the boom out and in, up and down, and to and fro with a rotary swinging movement. Each hydraulic motor, in turn, is controlled by a solenoid-actuated control valve which either (1) blocks all flow of hydraulic fluid in order to lock the boom in place or (2) feeds fluid to one side of a motor piston while exhausting it from the other side to move the boom accordingly. The operating structure is completed by providing a pump to supply pressure fluid to the control valves.

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While the above described boom control mechanism appears to answer the needs of the typical utility maintenance crew, it is not entirely free from inherent problems. One such problem stems from the fact that adequate pressure fluid must be available at all times to move the boom in a positive manner to the position desired. A lineman, for example, often must work in the vicinity of high-tension transmission lines. While riding in the cage at the end of my boom, he must have positive control over his movements in order to approach, ride under, or pass over such lines with precision. If the boom's hydraulic supply pump were shut down each time the boom came to rest (as is conventional with some hydraulic boom mechanisms where the pump cannot operate under a continuous load), a lag would occur, while sufficient pressure was built up, when it was again desired to effect a boom movement. This lag could be very dangerous if the motor control valves were manipulated before the required pressure became built up. For example, my experience has shown that under such conditions, some conventional hydraulic booms will drop a few feet before they begin to move up because sufficient pressure fluid is not immediately available. To obviate this difficulty, I have employed a driving motor with which I engage, directly, a positive displacement hydraulic pump. The driving motor, in turn, is governed to turn at a constant speed. Thus, both motor and pump turn at a constant speed and the pump delivers a constant volume of pressure fluid at all times. With such a mechanism, no lag or delay is encountered between the moment a control signal is effected and the moment the corresponding boom movement is initiated.

Another problem inherent in a hydraulic boom control mechanism stems from the high working stresses which are impressed upon the constant speed hydraulic pump and motor unit associated therewith. Since the hydraulic boom must be highly mobile if it is to be useful in the remote areas serviced by most utility companies, a truck or trailer mounted boom is most practical. Such a mounting, however, requires that a gasoline or diesel engine be employed to drive the constant volume hydraulic pump (either the truck motor itself or a small separate motor may be employed). As has been explained, however, such a motor must be governed to run at a constant speed during and between movements of the boom so that pressure fluid will be available instantaneously. Furthermore, since the boom is quite large (I have built hydraulic booms which are capable of a 26-foot reach), the driving motor must develop sufficient power to pump a large volume of fluid. To run a gasoline or diesel motor, hour after hour, at a high speed and under a heavy load (my boom operates under 500 to 600 pounds per square inch pressure) is damaging to the motor and highly wasteful of fuel. Accordingly, my inventive efforts have been directed toward the provision of a hydraulic boom control mechanism which will allow the pump motor to operate under a "no load" condition except when the boom is actually moving. Such a mechanism, within the scope of my invention, includes a solenoid-actuated by-pass valve which is correlated with the solenoid-actuated motor control valves controlling the boom movements. The by-pass valve is normally open to divert the constant volume of pressure fluid from the control valves as the fluid is supplied by the pump. Thus, under normal conditions, the pump need only circulate a free-flowing fluid through the by-pass valve. On the other hand, when the boom is to be moved, I provide a control mechanism which closes the by-pass valve at the same time any one of the control valves is opened. Thus, the pressure fluid is no longer diverted but is immediately and instantaneously available to feed one or more of the hydraulic motors through the corresponding control valves.

Accordingly, another object of my invention is to provide a constant volume pump which is adapted, selectively, to pressurize a hydraulic operating mechanism having a by-pass valve whereby the pump output is diverted from the mechanism and is free flowing except when the by-pass valve is closed.

A further object of my invention is to provide an operable circuit means interconnecting a series joined pump, by-pass valve, and hydraulic mechanism whereby the latter two are actuated concurrently to require the pump to supply pressure to the mechanism only when such pressure can be utilized thereby.

A further and more specific object of my invention is to provide a dual series of control switches for an electro-hydraulic boom operating circuit wherein the first series of switches is carried adjacent the terminal end of the boom and the second series of switches is carried adjacent the base of the boom to allow control of the boom movements from either location.

These and other objects and advantages of my invention will be hereinafter described with reference to the accompanying drawings, in which:

Fig. 1 is a side view of my portable boom and base showing the hydraulic boom and control mechanism therefor mounted on a truck chassis and indicating, in dashed lines, the position to which the boom may be extended;

Fig. 2 is a plan view, similar to Fig. 1, showing the boom in another position and indicating, by arrows, the rotary swinging movements of which the boom is capable;

Fig. 3 is a detail view, partially broken away better to disclose the operating parts thereof, showing one of the solenoid-actuated motor control valves utilized with my hydraulic operating mechanism;

Fig. 4 is a detail view, partially broken away, showing the solenoid-actuated by-pass valve in its normally open position so as to divert a constant volume of pressure fluid;

Fig. 5 is a detail view, in cross section, showing the pressure relief valve which I use to relieve any excess pressure which may build up within my hydraulic operating mechanism; and

Fig. 6 is a schematic working diagram showing the various elements of my hydraulic operating mechanism as symbols and indicating the relationship of these elements one to another.

I have shown a preferred embodiment of my invention in combination with a hydraulically operated boom indicated generally by the numeral **1**. Since this boom can best serve the needs of a public utility maintenance crew if it is portable, I prefer the chassis of a truck **2** as a mobile mounting base. It is to be noted, however, that a trailer, sled, or other mobile platform may be used as a mounting base since the details thereof are without the scope of my invention.

The terminal end of the boom **1** carries a self-leveling workman's cage **3** having a safety rail **4** and a foot control panel **5** thereon. As will be understood by one skilled in the art and as is shown by the arrows and dashed outlines in Figs. 1 and 2, the boom **1** is capable of three degrees of movement. To this end, I journal a rotatable base **12** on the truck chassis. This base carries a horizontal axle **11** upon which I pivot the lower section of the extensible boom **1**.

The three paths of boom movement are effected by three hydraulic motors, **6**, **7**, and **8**, having piston elements, **6**a, **7**a, and **8**a, respectively (see Figure 6). For example, if the hydraulic motor **6** is to move the boom up and down, I pivot one end of the motor on the base **12**, as at **10**, and I pivot the end of the motor piston rod **6**b to the lower section of the boom, as at **9**. As pressure fluid is supplied to one side of the piston **6**a and exhausted from the other side thereof, the boom **1** will move in the direction of the arrows of Figure 1.

In a similar manner, the hydraulic motor **7** is secured to the truck chassis so as to lie in a horizontal plane. The piston rod **7**b is joined, as by means of a rack and pinion, to the rotatable boom base **12**. Thus, as the piston **7**a moves back and forth to describe a working stroke, the base **12** and the boom **1** swing in a rotary movement as shown by the arrows in Fig. 2. The hydraulic motor **8** is disposed within the extensible boom **1** itself in order to move the cage **3** in or out as shown by the dashed line positions in Figs. 1 and 2. As for the self-leveling movements of the cage **3**, any conventional mechanical link or mercury switch mechanism may be utilized since such is without the scope of my invention.

Adjacent the cab of the truck **2**, I have shown a gasoline engine **13** carried in direct operative engagement with a constant speed gear pump **14**. It is the pump **14** which supplies a constant volume of pressure fluid to actuate the three aforementioned hydraulic motors **6**, **7**, and **8**. Accordingly, the speed of the gasoline engine **13** is governed (any conventional governing mechanism may be utilized) to cause the pump **14** to deliver a constant volume of fluid whereby an instantaneous actuation of the boom **1** may be effected.

Referring now to the schematic diagram of Fig. 6, I have therein shown the hydraulic motors **6**, **7**, and **8**, the engine **13**, and the pump **14** as symbolic representations. The engine **13** includes a magneto or coil **15** and a slip clutch **16** through which the constant speed pump **14** is driven. The pump **14**, on the other hand, derives fluid from a reservoir 17 and supplies pressure fluid to a hydraulic pressure line 18 having a gauge 19. As shown in Fig. 6, the hydraulic pressure line 18 divides to supply two branch lines each of which carries a valve. These valves, respectively, are the pressure relief valve 20 (shown in detail in Fig. 5) and the solenoid actuated by-pass valve 21 (shown in detail in Fig. 4).

The pressure relief valve 20 is joined to the hydraulic pressure line 18 to relieve excess pressure which may build up therein. To this end, a hollow core 22 carries a ported sleeve 23 together with a cylindrical valve element 24 (see Figure 5). Pressure fluid is supplied to the inlet ports of the core and sleeve through the aforementioned hydraulic pressure line 18. The outlet ports, which are normally closed by the valve element 24, lead to a hydraulic discharge line 25 joined to the aforementioned pump reservoir 17. A compression spring 26 is arranged to bias the valve element 24 to the closed position against an adjustable stop bolt 27. Similarly, an adjustment bolt 28 is provided to vary the force of the spring 26. As will be readily apparent, the compression spring 26 holds the valve element 24 in the closed position until a sufficient, predetermined, pressure is built up around the cylindrical land of the valve element to force it to the left against the spring force. Such a movement to the left joins the pressure line 18 and discharge line 25 across the valve ports. For example, my hydraulic operating mechanism can best function at a pressure in the neighborhood of 500 pounds per square inch. Under such conditions, I prefer to adjust the stop bolt 28 so the pressure relief valve 20 will open at approximately 550 pounds per square inch. This prevents damage to the hydraulic mechanism.

Unlike the pressure relief valve 20, the solenoid actuated by-pass valve 21 is biased, by means of the spring 29, to the open position. This by-pass valve includes a hollow core 30 carrying a ported sleeve 31. Within the sleeve, a spool valve element 32 is biased to a position uncovering the inlet and outlet ports which join the hydraulic pressure line 18 and the hydraulic discharge line 25. A rod 33 joins the spool valve 32 to the armature 34 of an operating solenoid 35. Thus, when the solenoid 35 is actuated, the normally open spool valve 32 is moved to the closed position (to the right in Fig. 4) by the armature 34. Thereafter, pressure fluid is no longer diverted from the hydraulic pressure line 18 to the hydraulic discharge line 25 across this valve but, rather, must flow elsewhere (as for example, to one of the control valves 36, 37, or 38 as will now be described).

Referring again to Fig. 6, it will be seen that each hydraulic motor, 6, 7, and 8 is controlled by a double solenoid control valve 36, 37, and 38, respectively. Each of these control valves is identical and the details thereof are best shown with reference to Fig. 3. Each control valve has a central supply port joined to the hydraulic pressure line 18, a double end exhaust port joined to the hydraulic discharge line 25, and two motor control ports joined to the control lines 39 and 40. Each such line leads to a valve passage within the hollow core 41. The core passages, in turn, lead to the ports formed about the periphery of the sleeve 42. Flow is controlled by means of the spool valve 43 which is joined, at both extremities, to a pair of identical armatures 44*a* and 45*a* within the solenoids 44 and 45, respectively. While, for purposes of clarity, I have

shown both of the solenoids 44 and 45 as located at one side of the valve 36 in the schematic diagram of Fig. 6, the preferred valve structure is that shown in Fig. 3 wherein one solenoid is located at each side of the spool valve 43. Furthermore, and also for purposes of clarity, I have numbered the solenoids controlling the valve 37, as numerals 46 and 47, and I have numbered the solenoids controlling the valve 38, as numerals 48 and 49.

Returning to Fig. 3, the spool valve 43 is biased to a lock or no flow position in which the ports leading to the control lines 39 and 40 are closed. This bias is supplied by means of two identical centering springs 50. Each control valve is also supplied with a means to vary the quantity of flow passing therethrough. This means takes the form of two adjustable stop bolts 51 and 52 which contact the ends of the armatures 44 and 45, respectively, when the solenoids are actuated. Thus, by adjusting the bolts 51 and 52, the flow through each control valve can be varied as desired.

The operation of each of the identical control valves 36, 37, and 38 should now be apparent. Thus, using valve 36 as an example, when neither of the solenoids 44 or 45 is actuated, the springs 50 bias the spool valve 43 to the position shown in Fig. 3 wherein flow to the two control lines 39 and 40 is blocked and the boom is locked. If the solenoid 44 is actuated, the spool valve 43 moves to the right and pressure fluid flows from the pressure line 18 through the valve to the control line 40 and supplies one side of the hydraulic motor 6. At the same time, pressure fluid is exhausted from the other side of the hydraulic motor through the control line 39, past the end of the spool valve 43, and out the exhaust port to the discharge line 25. I have termined the normal position of each control valve (as shown in Fig. 3), the "lock" position since, in such a position, no flow takes place through the control lines 39 and 40 and the corresponding one of the three boom movements is locked and is immobile.

Returning now to Fig. 6, I have therein shown an operable electric circuit means interconnecting the solenoids actuating each control valve and the solenoid 35 actuating the by-pass valve 21. This electric circuit may derive current from any convenient source as, for example, the battery 53 which may be located within the aforementioned truck 2. The lead from the negative side of the battery 53 traverses the conventional ammeter 54 and switch 55 to feed current to each of the solenoids 35, 44, 45, 46, 47, 48, and 49. The other lead from each of these solenoids is mated to one terminal of a corresponding switch 57 to 62 inclusive shown in the upper portion of Fig. 6. If desired, a second series of switches, 63 to 68 inclusive (see the lower portion of Fig. 6), may be mated to the corresponding solenoids. The first series of switches are aligned along the foot control panel 5 (see Fig. 2) in order that a workman standing in the cage 3 may actuate the switches with his feet. If the second series of switches is utilized, they may be located at the base of the boom or in the cab of the truck 2. This may be desirable where the boom is to be used as a hoist or crane and where control is desired from some point other than the cage 3.

As before mentioned, each of the switches is mated to a corresponding one of the solenoids controlling the valves 36, 37, and 38. For example, the switch 57 and the switch 63 control the solenoid 44; the switch 58 and the switch 64 control the solenoid 45; etc. On the other hand, one of the important features of my invention concerns the joinder of the solenoid 35 in common with each of the switches. Thus, each switch carries three contact points and the center contact is grounded. Of the other two contacts, one is joined to a control valve solenoid and the other is joined to the solenoid 35 controlling the by-pass valve 21. Depression of any one of the switches, therefore, will actuate one of the control valves 36, 37, and 38, and will also actuate the by-pass valve 21.

I have also included with my electro-hydraulic operating mechanism, an emergency means for stopping the constant volume gear pump 14. This means takes the form of an emergency switch 56 which is joined to the magneto or coil 15 in order to ground the same if desired. Thus, when the emergency switch 56 is depressed, the magneto or coil 15 is grounded and the gasoline engine 13 stops. This stops the gear pump 14 since the pump and the engine are in direct operative engagement. If the second series of switches 63 to 68 inclusive is utilized, a second emergency switch 69 may also be included in such a circuit.

In the operation of my invention, let it be assumed that the truck 2 has been driven to a point adjacent the base of a high tree which must be trimmed to prevent interference with high-tension transmission lines which pass thereover. During transportation, the hydraulic boom 1 is carried in a contracted and lowered position with the cage 3 riding over the cab of the truck 2. Accordingly, after the gasoline engine 13 has been started and the switch 55 has been closed, a workman mounts the boom by stepping on the hood and cab of the truck and up into the cage 3 so the safety rail 4 surrounds his waist. Once in the cage 3, the foot control panel 5 lies directly in front of and at the feet of the workman. Thus, each of the first series of switches 56 and 62 inclusive, is within easy reach of the workman's feet so that he may manipulate the boom with both hands free to work.

Before any control switch is depressed and while the boom 1 is at rest, the position of each control valve 36, 37, and 38, the solenoid actuated by-pass valve 21 and the pressure relief valve 20 is as shown in Figs. 3, 4, and 5, respectively. Thus, the gear pump 14 delivers a constant volume of pressure fluid to the hydraulic pressure line 18, through the open by-pass valve 21 and back to the reservoir 17 via the hydraulic discharge line 25. At this time, the pressure gage 19 registers no pressure and the pump is merely circulating a free-flowing fluid under "no load" conditions since the port of the by-pass valve 21 will pass freely all fluid supplied by the pump.

As an example of the boom actuation, let it be assumed that the workman desires to rise to a vertical position directly above the truck chassis. To accomplish such a movement, the boom 1 must pivot about the horizontal axle 11 and move in the direction shown by the arrows of Fig. 1. This movement will be accomplished by means of the hydraulic motor 6, the control valve 36, and one of the solenoids 44, 45. As the workman depresses the switch 57 with the toe of his shoe, two valves are moved, concurrently. Thus, the solenoid 44 is grounded moving the spool valve 43 to the right as shown in Fig. 3. At the same time, the spool valve 32 (the by-pass valve) is moved to the right by means of the solenoid 35 (see Fig. 4). When this solenoid actuated by-pass valve (21) is closed, the hydraulic mechanism is pressurized. That is to say, when the by-pass valve 21 is closed, pressure fluid is no longer diverted from the hydraulic pressure line 18 to the hydraulic discharge line 25 across the valve 21. Instead, the pressure fluid is fed, via the pressure line 18, to the solenoid-actuated control valve 36. At the control valve 36, the fluid passes to the control line 40 to move the hydraulic motor 6 to the left as seen in Fig. 6. At the same time, pressure fluid is exhausted from the left side of the hydraulic motor 6 via the control line 39, the control valve 36, and the discharge line 25 back to the reservoir 17. The movements of the hydraulic motor 6 are, at this time, imparted to the boom 1 which moves vertically into the air as shown by the arrows in Fig. 1.

If the workman holds the switch 57 depressed after the boom has swung to the vertical position, the pressure relief valve 20 comes into play. This is for the reason that the hydraulic motor 6 can move no farther than the end of an operating stroke. When the end of this operating stroke is reached and if the control valve 36 is still open, the constant volume pump 14 will build up an excess pressure in the hydraulic mechanism. When this pressure exceeds a predetermined figure, the relief valve 20 opens against the bias of the spring 26 (see Fig. 5). Thus, the function of the pressure relief valve is to relieve excess pressure when the boom reaches the limit of an operating stroke.

If, for any reason, the workman desires to shut off the hydraulic mechanism, he need only depress the emergency switch 56 to short-circuit the magneto or coil 15 and stop the gasoline engine 13. This stops the constant volume pump 14 and thereafter, no pressure fluid is supplied to the hydraulic pressure line 18. Thus, while the workman can no longer move up, extend the boom, or move from side to side, he can move down or move the boom inward since the electric circuit is still operable and the force of gravity will help return the boom to its lowermost position. This return is accomplished by actuating one of the control valves 36, 37, or 38 to allow pressure fluid to exhaust therethrough. Until one of the control valves is actuated, the boom is locked in position and the workman is safe since all the ports through the control valves are closed (see Fig. 3).

In accord with the objects of my invention, I have provided a hydraulic boom control mechanism which supplies a constant volume of operating fluid yet which will operate under "no load" conditions except when the boom is actually moving. Such a provision is saving of fuel and allows the motor driven pump to operate over long periods of time without damaging the pump or overheating the motor associated therewith. Furthermore, I have provided a dual system of control switches for an electro-hydraulic boom operating circuit wherein the first series of switches is carried adjacent the terminal end of the boom and the second series of switches is carried adjacent the base of the boom to allow control of the boom movements from either location. Such an arrangement of switches and control mechanism allows the boom to be used either as a work platform or as a hoist or crane. Experience has shown that my invention reduces materially, for the public utility companies of America, the cost of tree-trimming operations, mid-span line repair and reinsulation, street light moving and servicing, high position painting, telephone pole maintenance and other high position work. Expensive pole climbing can be eliminated entirely.

I claim:

1. In combination with a portable hydraulic element having telescoping extensible sections, a first expansible hydraulic motor means carried within said element selectively to extend and retract the telescopic sections thereof, second and third expansible hydraulic motor means joined operatively to said element to actuate the same in rotation and in up and down movements, respectively, a hydraulic system including a plurality of electrically actuated control valve means, one of said valve means being connected hydraulically with each motor and being movable to open and closed positions, selectively, to control the movements of the corresponding motor, a pump means for supplying a constant volume of fluid to said hydraulic system, said hydraulic system also including an electrically actuated by-pass valve means for diverting said constant volume from or passing said volume to said plurality of control valve means, selectively, and an electric control circuit means including a series of switches joined, in common, to said electrically actuated by-pass valve and joined to mated ones of said electrically actuated control valves for actuating the by-pass valve when any one of the control valves is actuated whereby the former passes said constant volume only when any one of said control valves is actuated.

2. In combination with a portable hydraulic element having a plurality of solenoid valve means movable to open and closed positions, selectively, to control the element movements, a motor driven pump means for supplying a constant volume of fluid thereto, a solenoid actuated by-pass means for diverting said constant volume from or passing said volume to said valve means, selectively, and an electric control circuit including a first series of switches and a second series of switches joined, in common, to said solenoid by-pass and joined in pairs to mated ones of said solenoid valves whereby the former passes said constant volume when any one of said solenoid valves is moved to said open position, said first series of switches being carried adjacent the terminal end of said element and said second series of switches being carried adjacent the base of said element whereby the element movements may be controlled from either location.

3. In a portable hydraulic boom having a plurality of solenoid valve means movable to open and closed positions, selectively, to control the boom movements, and having a motor driven pump means for supplying a constant volume of fluid thereto, the improvement comprising; a solenoid actuated by-pass means for diverting said constant volume from or passing said volume to said valve means, selectively, and an electric control circuit including a series of switches joined, in common, to said solenoid by-pass and joined to mated ones of said solenoid valves whereby the former passes said constant volume when any one of said solenoid valves is moved to said open position, said series of switches including an emergency means joined to said motor driven pump, selectively, to stop the supply of said constant volume.

4. In combination with a telescopically extensible portable hydraulic element having an electro-hydraulic control system which includes a plurality of solenoid actuated valve means individually movable to open and closed positions, selectively, to move the element in three separate directions including extension and retraction, a motor driven pump means for supplying a constant volume of fluid to a pressure line joined in common to said valves, a solenoid actuated by-pass means interposed in said pressure line for diverting said constant volume from or passing said volume to said valve means, selectively, and an electric control circuit means including a first series of switches and a second series of switches joined, in common, to said solenoid by-pass and joined in pairs to mated ones of said solenoid valves to move said by-pass means to pass said constant volume when any one of said solenoid valves is moved to said open position, said first series of switches being carried adjacent the terminal end of said telescopic element and said second series of switches being carried adjacent the base of said element whereby the element movements may be controlled from either location, that series of switches which is carried adjacent the end of the element including an emergency means joined to said motor-driven pump, selectively, to stop the supply of said constant volume.

5. A hydraulically operated expansible motor, comprising a solenoid actuated control valve means movable between open and closed positions, selectively, for actuating and for locking said expansible motor in place, a pump means for supplying a constant volume of fluid to a hydraulic line joined with said control valve, a normally open, solenoid actuated, by-pass valve movable to a closed position and operatively joined to said hydraulic line intermediate said pump and control valve to divert said constant volume from the latter while defining said normally open position, and operable electric circuit means interconnecting the solenoids actuating said control and by-pass valves to open the former valve and close the latter valve, concurrently, whereby said pump merely circulates free-flowing fluid through said by-pass valve except when said expansible motor is actuated.

6. In combination with a hydraulically operated expansible motor, a solenoid actuated control valve means movable between two open positions and one closed position, selectively, to actuate the expansible motor for movement in either of two directions or to lock the motor against movement, a pump means for supplying a constant volume of fluid to a hydraulic line joined with said control valve, a normally open, solenoid actuated, by-pass valve movable to a closed position and operatively joined to said hydraulic line intermediate said pump and control valve to divert said constant volume from the latter while defining said normally open position, a pressure relief valve means joined to said hydraulic line to relieve excess pressure built up therein, and operable electric circuit means interconnecting the solenoids actuating said control and by-pass valves to open the former valve and close the latter valve, concurrently, whereby said pump merely circulates free-flowing fluid through said by-pass valve except when said expansible motor is actuated, said electric circuit means including an electric switch mated to said control valve solenoid and said by-pass valve solenoid in common.

7. In combination with a plurality of hydraulically operated expansible motors, each said expansible motor having an electrically actuated control valve means biased to a closed position,

each said valve being individually and selectively movable from said closed position to an open position to actuate said expansible motor, a pump means for supplying a constant volume of fluid to a hydraulic line joined in common with each of said control valves, a normally open, electrically actuated, by-pass valve movable to a closed position and operatively joined to said hydraulic line intermediate said pump and control valves to divert said constant volume from the latter while defining said normally open position, and operable electric circuit means interconnecting each said electrically actuated control valve and said electrically actuated by-pass valve, selectively, to close the latter valve in response to the opening of one or more of the former valves whereby said pump merely circulates free-flowing fluid through said by-pass valve except when one of said expansible motors is actuated.

8. In combination with a plurality of hydraulically operated expansible motors, each said motor having a solenoid-actuated control valve means movable between open and closed positions, respectively, to actuate and to stop the motor, a pump means for supplying a constant volume of fluid to a hydraulic line which is joined in common to all of said control valves, a normally open, solenoid actuated, by-pass valve movable to a closed position and operatively joined to said hydraulic line intermediate said pump and control valves to divert said constant volume from the latter while defining said normally open position, a pressure relief means joined to said hydraulic line to relieve excess pressure built up therein when one of the expansible motors reaches the limit of an operating stroke, and operable electric circuit means interconnecting the solenoids actuating each said control valve and said by-pass valve, selectively, to open one or more of the former valves and close the latter valve concurrently, whereby said pump merely circulates free-flowing fluid through said by-pass valve except when one of said expansible motors is actuated, said electric circuit means including a plurality of electric switches mated to corresponding ones of said control valve solenoids and joined to said by-pass solenoid in common.

9. In combination with a constant volume pump

adapted to pressurize a hydraulic operating mechanism, said mechanism being solenoid actuated for movement from a closed to an open position, selectively, a normally open, solenoid actuated, by-pass valve movable to a closed position and joined to said operating mechanism normally to divert the constant volume output of said pump, and operable electric circuit means interconnecting the solenoids actuating said mechanism and by-pass valve, concurrently, to move the former to said open position and the latter to said closed position whereby said hydraulic operating mechanism is pressurized only while defining said open position.

10. An electric control for an expansible motor system, comprising a plurality of expansible motors, a source of pressure fluid, a common pressure line joining said source to each of said motors, a plurality of electrically actuated control valves, one of said control valves being mated and joined to each motor intermediate said pressure line and the motor, a normally open electrically actuated by-pass valve means joined to said pressure line intermediate said source and said control valves normally to divert pressure fluid from the control valves, said electrically actuated by-pass valve being movable to a closed position to pressurize the motor system in response to an electric signal, an electric switch mated to each electrically actuated control valve, and an electric circuit means interconnecting each switch with the corresponding electrically actuated control valve and with said electrically actuated by-pass valve to transmit an electric signal to the latter when any one of the control valves is actuated.

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