

[54] **FREE FALL CIRCUIT FOR HYDRAULIC WINCH**

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[22] Filed: **Oct. 26, 1971**

[21] Appl. No.: **192,097**

[52] U.S. Cl. ... **254/187 R**, 60/53 WW, 254/150 FH

[51] Int. Cl. **B66d 1/00**

[58] Field of Search 254/150 R, 187 R, 254/150 FH; 212/55; 60/53 WW

[56] **References Cited**
UNITED STATES PATENTS

2,258,307	10/1941	Vickers.....	254/150 FH
3,578,787	5/1971	Brickett.....	212/55 X
3,249,336	5/1966	Brown et al.....	254/150 R

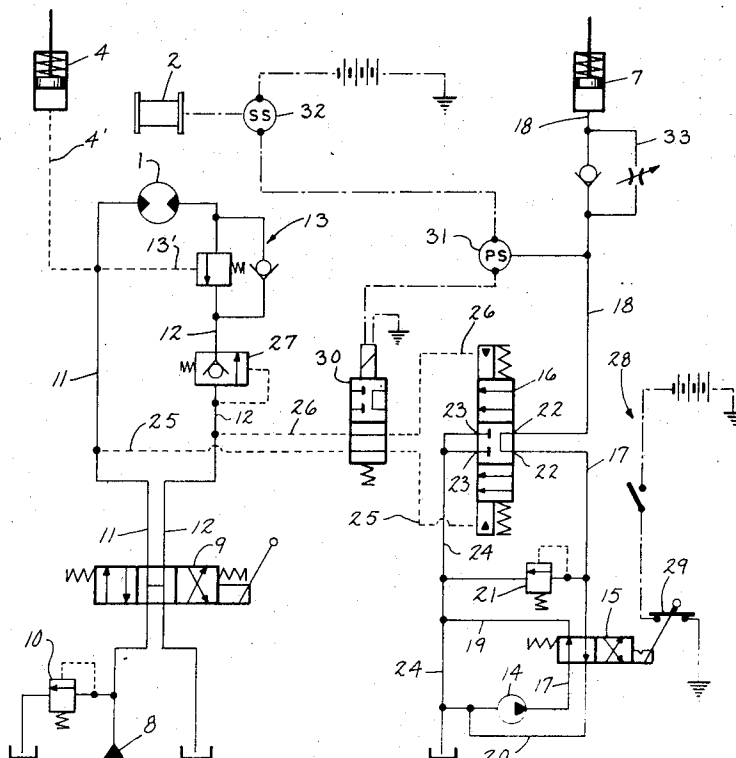
3,550,735 12/1970 Olsen 254/187 R

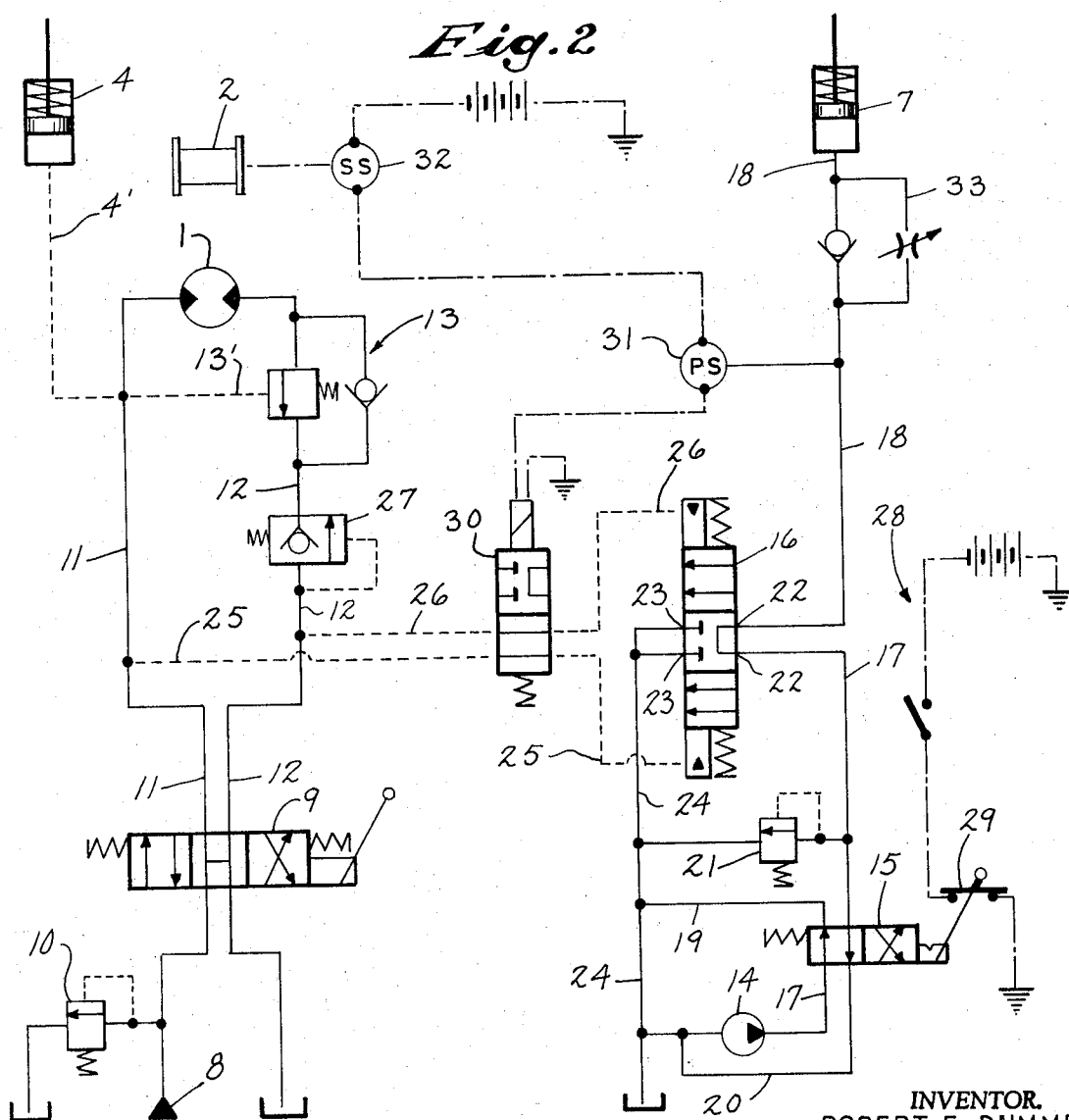
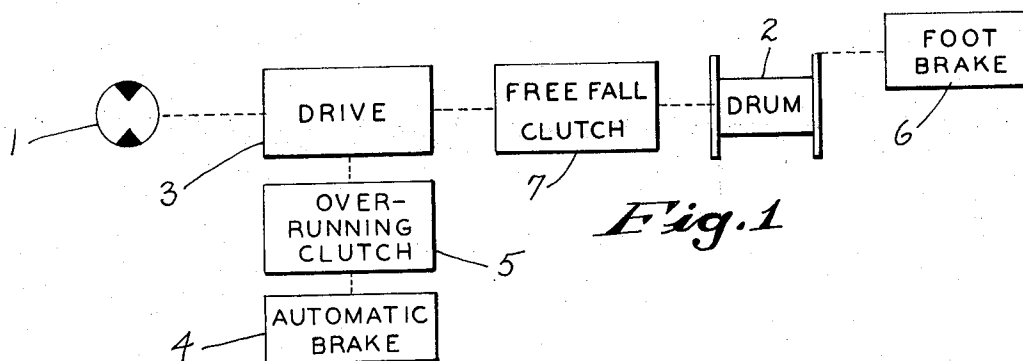
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[57] **ABSTRACT**

A free fall operating circuit for a hydraulic winch of the type including a hydraulically releasable free fall clutch includes a pump normally operable to release the clutch and a sensing valve operable to cut off the pump and allow the clutch to reset whenever there is relatively higher pressure in either main operating line for the winch motor, the net result being that there is free fall action whenever the main valve operating lever is in neutral. The circuit includes a lockout valve, and this is interlocked with the machine start circuit to prevent starting while the clutch is released. A safety valve and circuit prevent resetting of the clutch while the winch drum is in free fall motion.

11 Claims, 2 Drawing Figures





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FREE FALL CIRCUIT FOR HYDRAULIC WINCH

BACKGROUND OF THE INVENTION

Hydraulic it is have found increasing use in dragline excavators, cranes and other machines. Such winches are designed for power operation in both directions; and this constitutes a disadvantage where is desired to have a free fall in one direction, for example to allow a dragline operator to throw out his bucket or a crane operator to quickly lower a load. To overcome this problem, winches have been designed which include a spring set, hydraulically released clutch operatively interposed between the drive mechanism and the winch drum, the idea being to release the clutch whenever a free fall is desired. Prior actuating circuits for such winches have not, however, been entirely satisfactory, in part because they have been electrically operated whereas it is more desirable to have a full hydraulic operation.

SUMMARY OF THE INVENTION

It is the general object of this invention to provide hydraulic operating circuit for a hydraulic winch with a free fall clutch, the entire circuit being highly effective and reliable while remaining relatively simple and inexpensive.

One specific object of the invention is to provide an actuating circuit having a sensing valve connected to the main operating lines for the hoist motor so that there is automatically a free fall action whenever the main control valve is in neutral position. It is another specific object to provide a circuit including a lockout valve interlocked with the machine start circuit to prevent starting the machine while the free fall clutch is released. Still another specific object is to provide a circuit including a safety valve and circuit to prevent setting of the free fall clutch while the winch drum is in motion. Other specific objects and advantages will appear from the description to follow.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a block diagram illustrating schematically the type of hydraulic winch with which the circuit of this invention is intended to be used, and

FIG. 2 is a schematic circuit diagram illustrating a preferred embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The winch illustrated schematically in FIG. 1 is of a type known to those skilled in the art; and for this reason and since the invention may be used with various specific types of winches, the components of the winch are not shown and will not be described in detail. Basically, the winch includes a reversible hydraulic hoist motor 1 which is connected to a revolving cable drum 2 through a suitable drive 3. In accordance with usual practice, an automatic brake 4 is provided; this is a spring set, hydraulically released brake which, as will become apparent, in normal operation prevents the drum 2 from rotating until the operator moves the main hoist control valve from neutral position. The brake 4 operates through a one way, overrunning clutch 5 so that the brake effectively operates in only one direction — to prevent lowering of the load. In the embodiment shown, the brake 4 and clutch 5 are shown as operating in connection with the drive 3, but it will be apparent

that they may be interposed anywhere between the motor 1 and the free fall clutch to be described. A foot brake 6 is provided and acts directly on the drum 2 to allow the operator to control its rotation, particularly in free fall.

A free fall clutch 7 is operatively interposed between the drive 3 and drum 2. This is also a spring set, hydraulically released clutch, and normally provides an operative connection between the drum 2 and drive 3. When it is released as will be described, however, the drum is free to rotate in a free fall action controlled by the foot brake 6.

The hydraulic circuitry is shown in FIG. 2. The hoist motor 1 is powered by a suitable main fluid source 8 through a conventional, manually operated hoist control valve 9, which is a standard opencenter, four way directional control valve in the embodiment shown, but which can be a pressure compensated valve or any other suitable control valve. A main relief valve 10 provides overall system relief. Two main operating lines lead to the motor 1, the left line 11 being the line that is pressurized during lowering, and the right line 12 being the line that is pressurized during raising. The brake 4 is connected to the line 11 by a pilot line 4', which means that this line must be pressurized before the brake 4 will be released allowing the load to be lowered. Again, the brake 4 is not effective to prevent a raising action because of the overrunning clutch 5. The line 12 includes a conventional counterbalance valve 13 which also prevents lowering, and is piloted open by means of a connection 13' to the line 11. The circuitry as thus far described is conventional and well known to those skilled in the art.

The free fall circuit includes a free fall pump 14, which may be a separate pump as shown or other suitable fluid source, a lockout means in the form of a valve 15 and a sensing means in the form of a valve 16. An actuating line leads from the pump 14 to the clutch 7; only the actuating cylinder of which is shown in FIG. 2, and includes a first portion 17 which leads from the pump 14 through the lockout valve 15 to the sensing valve 16, and a second portion 18 which leads from the sensing valve 16 to the clutch cylinder 7.

The valve 15 is a manually operated, two position valve which is shiftable between "off" and "on" positions, preferably with a detent action. As seen in FIG. 2, the valve 15 is in its "off" position in which the actuating line portion 17 is effectively closed, with the pump side being cut off and directed to a return line 19 and the clutch side being opened to exhaust through a return line 20. When the valve 15 is shifted to the left, it is in its "on" position in which the actuating line portion 17 is open through the valve 15 for delivery of fluid from the pump 14. A pressure relief valve 21 leads from the actuating line portion 17 to provide system relief for the free fall circuit.

The sensing valve 16 is a spring centered, three position, four way, hydraulically piloted directional control valve of standard design. It has two inlets 22 and outlet port means in the form of two outlets 23 which are connected to a common return line 24. It is spring biased toward a normal, centered position as shown, and in this position the two inlet ports 22 are interconnected, which serves to connect the lines 17 and 18 and thus open the actuating line between the pump 14 and clutch cylinder 7. It may, however, be piloted either upwardly or downwardly to opposite bypass positions in

both of which the inlets 22 are connected to respective outlets 23. In either bypass position, the pump side, or in other words the actuating line portion 17, is cut off and bypassed to the line 24, and the clutch side — the portion 18 — is opened to exhaust through the line 24. To effect shifting of the valve 16, there is a first pilot line 25 leading from the main line 11 to one end of the valve 16 and a second pilot line 26 leading from the main line 12 to the other end of the valve 16.

Assuming that the lockout valve 15 has been shifted to its "on" position, the pump 16 operates as a release means which is normally operable to release the clutch 7, and thus 7, and thus provide a free fall action. This is possible, however, only if the valve 16 is in its centered position. The centered position of the valve 16 will be assumed whenever there is no pressure differential between the lines 11 and 12, which occurs whenever the main control valve 9 is in its neutral position. Whenever the control valve 9 is shifted, however, either the line 11 or the line 12 will have a higher pressure. This will cause the valve 16 to shift to one or the other of its bypass positions in which the pump 14 is cut off and the line 18 is opened to effectively as the result of which the release means is effectively deactivated and the clutch cylinder 7 will automatically reset. The pilot connections 4' and 13' off the line 11 insure sufficient pilot pressure for the line 25, and to insure that there will be sufficient pressure in the line 12 for the line 26 a low level pressure relief valve 27 is interposed between the motor 1 and the connection of the pilot line 26. That is, while the ordinary operating pressure in the lines 11 and 12 would often be sufficient to shift the valve 16, it is possible that the pressure would be insufficient under light load or other conditions; and the pilot lines 13' and 14' and valve 27 serve in effect as signal pressure generating means interposed in the lines 11 and 12 between the point of connection of the respective pilot line 25 and 26 and the motor 1, which means insure sufficient pilot pressure for the valve 16 under all conditions. The signal pressure generating means serve another desirable purpose in that they insure that there will be sufficient pressure to shift the valve 16 before there is sufficient pressure to operate the motor 1. As a result, the clutch 7 will reset before the motor 1 moves, thus providing for smooth, jerk-free operation. While the arrangement shown is quite satisfactory, other signal pressure generating means known to those skilled in the art could be substituted.

The circuit as thus far described provides a fully hydraulic free flow control circuit which is highly effective and reliable while being quite simple. It should be noted in this connection that, once the valve 15 has been shifted, the operator can actuate the free fall circuit simply by shifting the valve 9 to neutral position, thus removing the necessity for any additional controls.

While the free fall circuit is fully functional as thus far described, certain safety features are provided in the preferred embodiment. First, it is desirable to be able to prevent the machine from being started while the free fall circuit is actuated. That is, the operator may choose to turn off the entire machine with a load suspended, and might then restart the machine without remembering to deactivate the free fall circuit first. To prevent this, the valve 15 is interlocked with the overall start circuit for the machine. The start circuit is shown schematically at 28, and includes the usual main switch and other elements. In addition, the operating lever for

the valve 15 physically carries a switch means in the form of a bridging contact 29 which is in the start circuit so that the start circuit is completed only when the valve 15 is in the "off" position shown in FIG. 2.

It is also desirable to prevent resetting of the clutch cylinder 7 during free fall movement. That is, free fall movement is intended to be controlled by the foot brake 6, and resetting of the clutch cylinder 7 while the drum 2 is running free could result in a sudden stop which could very easily severe damage to the winch or boom, or cable breakage. To prevent this, the preferred embodiment includes a safety means in the form of a valve 30 which is interposed in the pilot lines 25 and 26. The valve 30 is biased toward a normal open position shown in FIG. 2 in which the lines 25 and 26 are fully open and the valve 16 is operable in the manner described above. The valve 30 can, however, be shifted downwardly as seen in FIG. 2 to a closed position in which the main operating line sides of the lines 25 and 26 are blocked and the sensing valve sides are connected to one another. In closed position, the pressure differential between the opposite ends of the valve 16 is equalized, so that the valve 16 is rendered inoperable and remains in its normal centered position. As a result, the pump 14 cannot be deactivated as in normal operation and the clutch cylinder 7 remains released.

The valve 30 is solenoid actuated, and its actuating coil is included in a series safety circuit which also includes a pressure sensing switch 31 connected to the actuating line portion 18 and a speed sensing switch 32 associated with the drum 2. The pressure switch 31 is normally open, but is set to close whenever there is at least a minimum selected pressure in the line 18, which indicates release of the clutch 7. The speed switch 32 is also normally open, but is arranged to close whenever the output shaft is rotating in either direction at or above a preselected minimum speed, which can be zero if desired.

The fact that the drum 2 is operating in a free fall mode is indicated by its rotation and by the existence of minimum operating pressure in the line 18, and whenever these two conditions occur the valve 30 will be shifted to effectively prevent the operator from shifting the valve 16 by shifting the valve 9, which would result in resetting. As soon as either condition ceases, however, the operator will be able to shift the valve 16 in the usual manner.

While the safety circuit described will protect against undesired resetting during normal operation, it would not be effective, for example, in the event of a power failure. To prevent damage that might occur as the result of rapid resetting of the clutch cylinder 7 because of such a power failure or other reasons, a dashpot valve 33 is interposed in the line 18. This allows free flow into the cylinder 7 but the outward flow is adjustably metered to provide a cushioning effect.

The preferred embodiment of the invention shown and described herein is highly effective, not only from the standpoint of basic operation as described above, but also because it includes important additional safety features. While a preferred embodiment has been shown and described, however, it will be apparent that various modifications in structure and application might be made without departure from the spirit of the invention. Other particular forms of sensing valves, lockout valves, or safety valves could be substituted, for example, or the safety circuit or the start interlock

could be wholly or partially hydraulic rather than electrical. The invention can of course be used with other suitable winches, and in a wide variety of applications. In view of the possible modifications, the invention is not intended to be limited by the showing herein, or in any other way, except insofar as may specifically be required.

I claim:

1. In a free fall actuating circuit for a hydraulic winch of the type including a reversible hydraulic motor, a pair of opposite main fluid lines connected to the motor, control valve means in the main fluid lines movable between a first position in which there is relatively higher pressure in one main fluid line and a second position in which there is relatively higher pressure in the other main fluid line and a neutral position in which the pressures in the main fluid lines are substantially equal, a rotatable drum driven by the motor, and a normally set, hydraulically releasable free fall clutch operatively associated with the drum,

the combination comprising: hydraulic release means operative to release the clutch only when the control valve means is in neutral position; and hydraulically operable sensing means interposed between the main fluid lines and release means and automatically operable to deactivate the which means to allow the clutch to operatively engage the drum in response to relatively higher pressure in either main fluid line caused by shifting of the control valve means to either first or second position.

2. The combination of claim 1 wherein: there is a safety means associated with the sensing means, said safety means having a normal open position in which the sensing means is operable and being movable to a closed position in which the sensing means is inoperable; and there is a safety circuit that is operable when completed to move the safety means from open to closed position, said safety circuit including a first element which is operatively associated with the drum and which is operable to complete the safety circuit only when the drum is rotating at or above a selected minimum speed, and a second element in series with the first element which is operatively associated with the clutch and which is operable to complete the safety circuit only when the clutch is released.

3. The combination of claim 1 wherein the elements thereof are incorporated in an apparatus having a start circuit and wherein: there is a lockout means associated with the release means that is movable between an "on" position in which the release means is operative and an "off" position in which the release means is not operative; and there is a switch means associated with the lockout means which completes the start circuit only when the lockout means is in its "off" position.

4. The combination of claim 3 wherein: there is a safety means associated with the sensing means, said safety means having a normal open position in which the sensing means is operable and being movable to a closed position in which the sensing means is inoperable; and there is a safety circuit that is operable when completed to move the safety means from open to closed position, said safety circuit including a first element which is operatively associated with the drum and which is operable to complete the safety circuit only when the drum is rotating at or above a selected minimum speed, and a second element in series with the first element which is operatively associated with the

clutch and which is operable to complete the safety circuit only when the clutch is released.

5. The combination of claim 1 wherein: the release means includes a free fall fluid source and an actuating line leading from the fluid source to the clutch, the fluid source being operable to deliver fluid through the actuating line to release the clutch whenever the actuating line is open; and the sensing means includes a sensing valve in the actuating line, said sensing valve being biased toward a normal, centered position in which the actuating line is open therethrough and being hydraulically pilotable to opposite bypass positions in both of which the fluid source side of the actuating line is cut off and the clutch side is opened to exhaust; and there are a pair of hydraulic pilot lines, one connected between each main fluid line and a respective end of the sensing valve so that the sensing valve is shifted to one of its bypass positions when there is relatively higher pressure in either main fluid line.

6. The combination of claim 5 wherein: the sensing valve is a normally centered, three position valve with two inlet ports and outlet port means; and the actuating line includes a first portion leading from the fluid source to one inlet and a second portion between the clutch and the other inlet; and in the centered position of the sensing valve the inlets are connected to one another; and in both bypass positions the inlets are connected to the outlet port means; and the outlet port means is connected to a return line.

7. The combination of claim 5 wherein: there is a safety valve interposed in both of the pilot lines, said safety valve being biased toward an open position in which the pilot lines are open and being shiftable to a closed position in which the main fluid line sides of the pilot lines are cut off and the sensing valve sides are communicated with one another equalize pilot pressure on the opposite sides of the sensing valve; and the safety valve is shifted from open to closed position in response to completion of an electrical safety circuit including a speed sensing electric switch operatively associated with the winch drum, said switch being normally open and being adapted to close in response to rotation of the drum at or above a selected minimum speed, and a pressure sensing electric switch connected in series with the speed sensing switch that is associated with the actuating line, said pressure sensing switch being normally open and adapted to close in response to a selected minimum operating pressure in the actuating line.

8. The combination of claim 5 wherein the elements thereof are incorporated in an apparatus including an electrical start circuit and wherein: there is a lockout valve in the actuating line between the fluid source and sensing valve, said lockout valve being movable between "off" position in which the fluid source side of the actuating line is cut off and the clutch side is opened to exhaust and an "on" position in which the actuating line is open through the lockout valve; and there is an electrical switch means operatively associated with the lockout valve to be actuatable in response to movement of the lockout valve, said switch means serving to complete the start circuit only when the lockout valve is in its "off" position.

9. The combination of claim 8 wherein: there is a safety valve interposed in both of the pilot lines, said safety valve being biased toward an open position in which the pilot lines are open and being shiftable to a

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closed position in which the main fluid line sides of the pilot lines are cut off and the sensing valve sides are communicated with one another to equalize pilot pressure on the opposite sides of the sensing valve; and the safety valve is shifted from open to closed position in response to completion of an electrical safety circuit including a speed sensing electric switch operatively associated with the winch drum, and switch being normally open and being adapted to close in response to rotation of the drum at or above a selected minimum speed, and a pressure sensing electric switch connected in series with the speed sensing switch that is associated with the actuating line, said pressure sensing switch being normally open and adapted to close in response to a selected minimum operating pressure in the actuating line.

10. The combination of claim 9 wherein: the sensing

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valve is a normally centered, three position valve with two inlet ports and outlet port means; and the actuating line includes a first portion leading from the fluid source to one inlet and a second portion between the clutch and the other inlet; and in the centered position of the sensing valve the inlets are connected to one another; and in both bypass positions the inlets are connected to the outlet port means; and the outlet port means is connected to a return line.

11. The combination of claim 10 wherein: there is a signal pressure generating means in each main fluid line between the motor and the point of connection of the associated pilot line, said signal pressure generating means serving to develop a pilot pressure sufficient to shift the sensing valve before there is an operating pressure sufficient to operate the motor.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,764,111 Dated October 9, 1973

Inventor(s) Robert E. Dummer

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

- Column 1, line 4, "it is" should read -- winches --
- Column 1, line 7, -- it -- should be inserted before "is"
- Column 1, line 22, -- a -- should be inserted after "provide"
- Column 2, line 16, "opencenter" should be -- open-center --
- Column 3, line 13, "and thus 7," should be deleted
- Column 3, line 23, "effectively" should read -- exhaust, --
- Column 3, line 38, "25 and 26" should read -- 25 or 26 --
- Column 3, line 44, "before" should be underscored
- Column 4, line 10, -- cause -- should be inserted after "easily"
- Column 5, line 26, "which" should read -- release --
- Column 6, line 12, "hdraulically" should be -- hydraulically --
- Column 6, line 36, -- to -- should be inserted before "equalize"
- Column 7, line 8, "and" should read -- said --

Signed and sealed this 26th day of March 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents