June 9, 1953 S. A. JACQUES 2,641,227

CREEP PREVENTION CONTROL FOR HYDRAULIC POWER UNITS

Filed Nov. 13, 1950 4 Sheets-Sheet 1

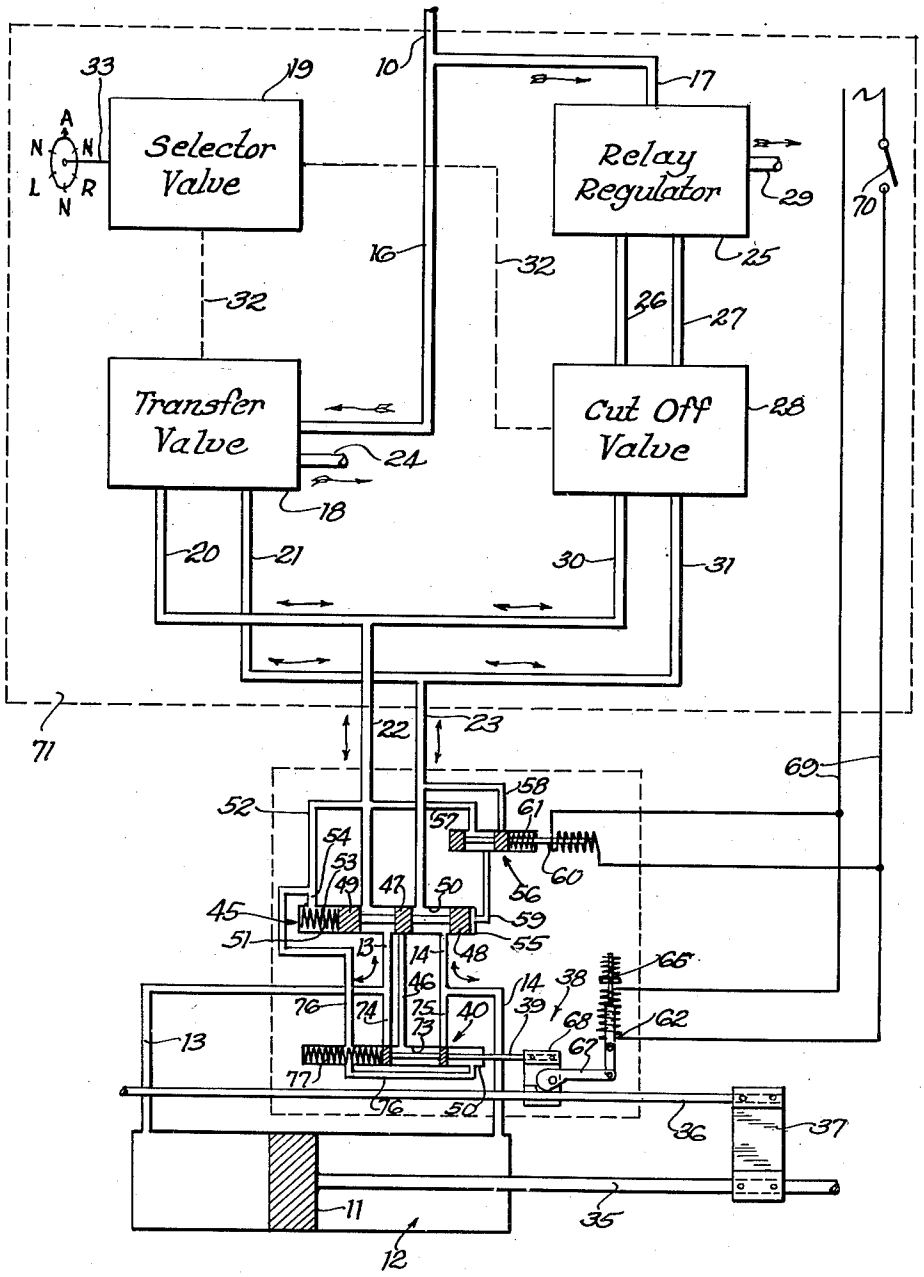

Fig. 1

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CREEP PREVENTION CONTROL FOR HYDRAULIC POWER UNITS

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Fig. 7

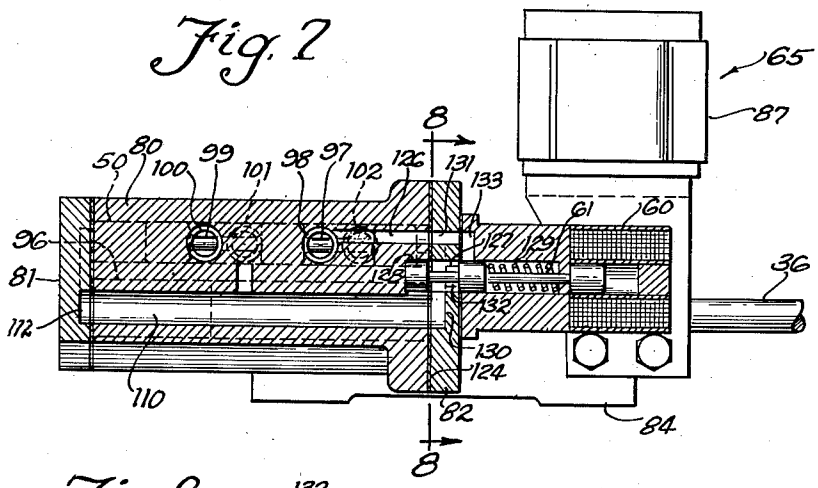


Fig. 8

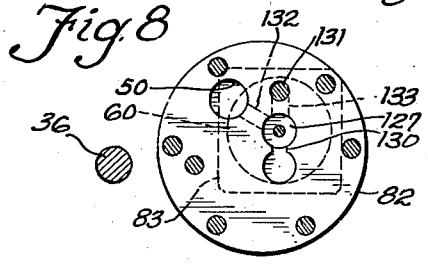
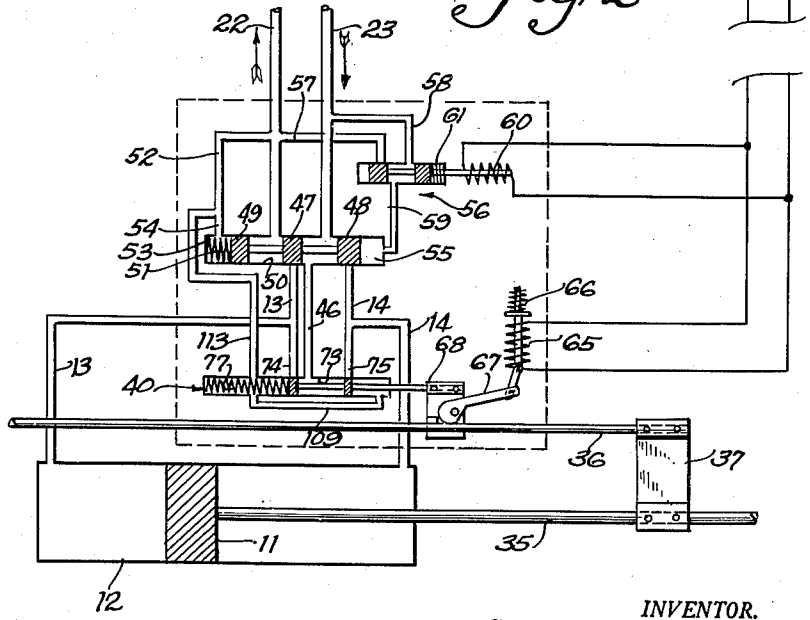


Fig. 2



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CREEP PREVENTION CONTROL FOR HYDRAULIC POWER UNITS

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Fig. 3

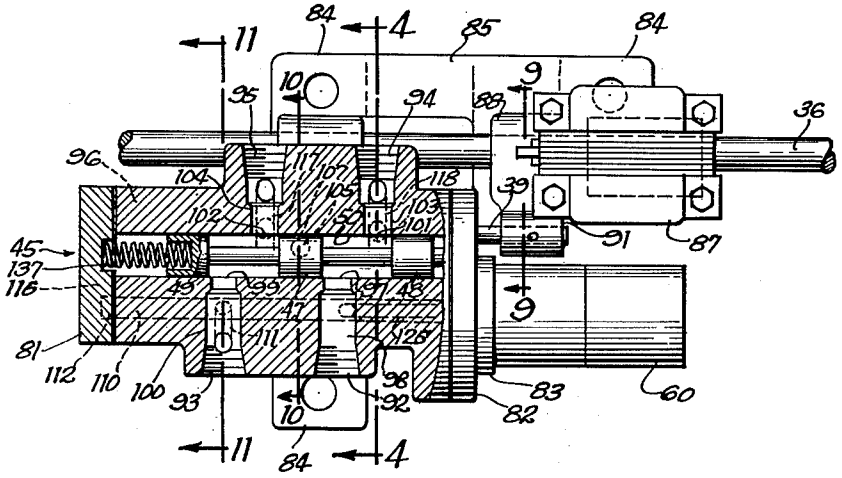


Fig. 5

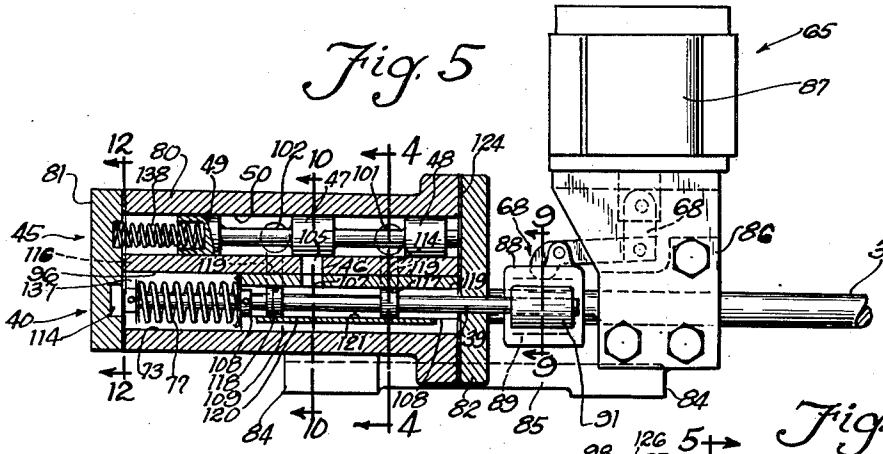


Fig. 4

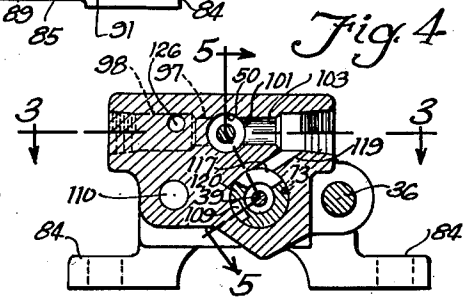
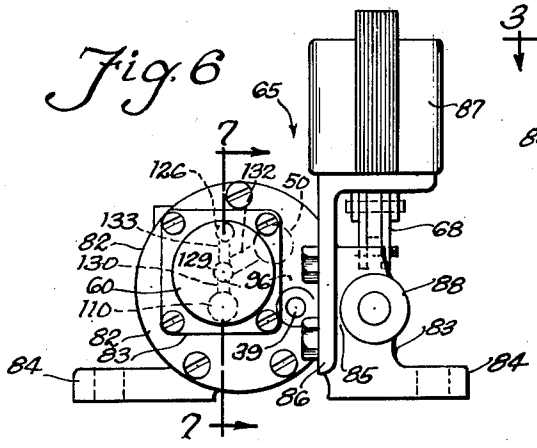


Fig. 6



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CREEP PREVENTION CONTROL FOR HYDRAULIC POWER UNITS

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Fig. 9

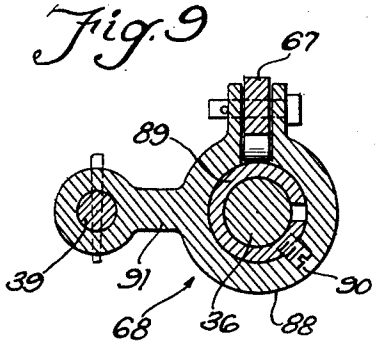


Fig. 11

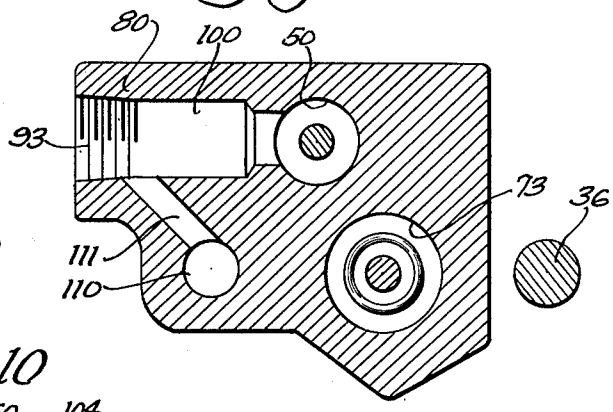


Fig. 10

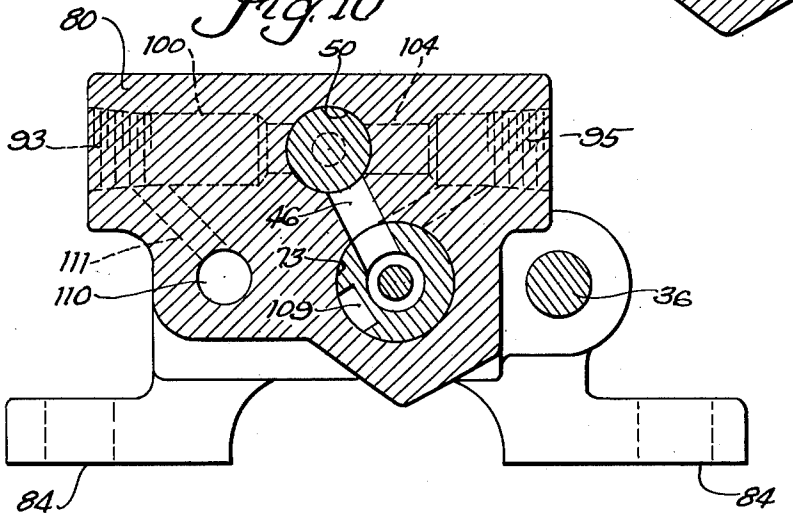
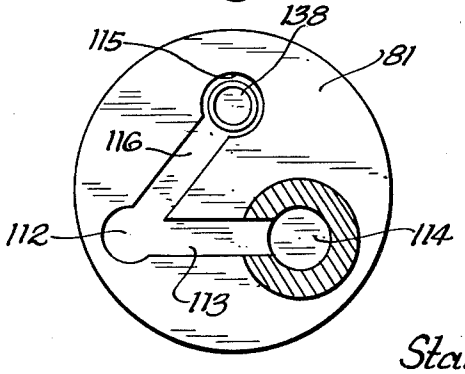


Fig. 12



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Patented June 9, 1953

2,641,227

UNITED STATES PATENT OFFICE

2,641,227

CREEP PREVENTION CONTROL FOR HYDRAULIC POWER UNITS

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Application November 13, 1950, Serial No. 195,378

9 Claims. (Cl. 121—41)

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The present invention relates to systems and mechanisms for preventing substantial creeping movement of the output member of a hydraulic power unit during cutoff of supply of operating fluid to the unit. By "creep" is meant movement of the member driven by hydraulic fluid supplied to the unit, permitted by seepage of fluid between opposed and theoretically fluid tight surfaces of the movable member and stationary structure of the unit. A cylinder and piston assembly is a typical power unit of the kind in question, and the invention is disclosed as used with such an assembly, but obviously it is readily applicable to other kinds of hydraulic power units, such as rotary fluid motors that are reversible by selectively supplying pressure fluid to one of two input ports.

In any power system having a hydraulic power output unit that is controlled by supply or cutoff of operating fluid, it may be desirable to arrest and maintain the unit in a selected position. If the load on the unit is of a kind that exerts force when arrested, the unit tends to creep by seepage of the operating fluid between opposed relatively movable surfaces, as by seepage past a piston, thereby permitting the load to drive the power unit even though its power fluid inlet is blocked from supply. The invention is directed to overcoming this condition. Previously, efforts have been made to lock hydraulic power units against creeping, by means of brakes or clutches, actuable to engage a movable unit element, thereby to lock the unit and its load in an arrested position. Various disadvantages are encountered in the employment of such brakes and clutches. The present invention provides for an auxiliary supply of operating fluid to a reversible power unit, which auxiliary supply is established when the unit is arrested by blocking of its normal operation supply, and which is controlled in response to very slight creeping of the unit output to supply operating fluid in a sense to return the unit and its load to the selected position in which it was arrested. The invention also is directed to a unitary assembly for association with a hydraulic piston and cylinder for accomplishing an anti-creep control in accordance with the broader aspect of the invention outlined above.

A primary object of the invention is the provision of a novel system for preventing substantial creeping movement of the output member of a hydraulic power unit when the latter has been arrested by blocking of its fluid supply.

Another object is the provision in a hydraulically powered relay or power amplifier system of a novel arrangement of an auxiliary power unit supply that is responsive to creeping movement of an output member of the unit to supply operating fluid to the unit to restore its output member to a selected position in which it has been arrested by blocking of its main, controlled fluid supply.

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Another object is the provision of such a system with a novel control system that automatically correlates operation of all system elements necessary to set up either a normal condition of controlled power unit operation or a second condition wherein the auxiliary, anti-creep system is in control of the power unit.

A further object is the provision of a novel system for placing an auxiliary anti-creep control valve in control of a reversible power unit when in a condition of responsiveness to movement of the output member of such power unit.

An additional object is the provision of a novel unitary assembly for association with a hydraulically operated piston and cylinder unit and containing all hydraulic valve elements and control means therefor that are necessary to act as a system for restoring the piston to a selected position in which it is to be maintained during its cut-off from its main hydraulic operating system.

Still another object is the provision of a novel hydraulic relay arrangement for actuating a two-position axially movable valve body.

In the accompanying drawings:

Fig. 1 is a schematic diagram of a complex hydraulic relay system provided with an auxiliary anti-creep or creep-control system arranged according to the invention, and showing the normal operating condition with the auxiliary system disabled.

Fig. 2 is a partial schematic diagram showing only the auxiliary anti-creep system in its effective condition.

Fig. 3 is a partially broken top plan of a unitary assembly that provides the anti-creep system of Figs. 1 and 2, and is specifically adapted for association with a piston and cylinder hydraulic power unit.

Fig. 4 is a transverse vertical section on line 4—4 of Fig. 3 and Fig. 5.

Fig. 5 is a longitudinal section on line 5—5 of Fig. 4.

Fig. 6 is an elevation of the right end of the unit as seen in Fig. 3 or Fig. 5.

Fig. 7 is a longitudinal vertical section on line 7—7 of Fig. 6.

Fig. 8 is a vertical transverse section on line 8—8 of Fig. 7.

Fig. 9 is a vertical transverse section on line 9—9 of Fig. 3.

Fig. 10 is a vertical transverse section on line 10—10 of Fig. 3 and Fig. 5.

Fig. 11 is a vertical transverse section on line 11—11 of Fig. 1.

Fig. 12 is a vertical section on line 12—12 of Fig. 5.

Reference is made to my copending application for United States patent, Serial No. 184,972, filed September 15, 1950. That application discloses and claims a hydraulic power unit control system wherein selection may be made of control by a relay regulator or by a manually operable selector valve. The regulator and manually operable valve respectively control flow of fluid between supply, the power unit and exhaust through different parallel channels. The relay controlled channel includes a cutoff valve that is actuable by the manually operable selector valve to correlate blocking and unblocking of the relay channel with operation of the selector valve to actuate and not actuate the power unit through the manual control channel. This system has been selected for disclosure of the present invention, because the manual control channel of the prior system provides a convenient arrangement for supply of the anti-creep system in situations where controls must be remote from the power unit. The prior system is schematically disclosed in Fig. 1 in such association with the anti-creep system of the present invention.

In Fig. 1 a main fluid supply line is designated 10, and is the source of supply of operating fluid delivered under pressure to actuate such a power unit as a piston 11 in a cylinder 12. Cylinder lines 13, 14 communicate with opposite ends of cylinder 12 for selective and reversible connection of one with supply line 10 and other with a system exhaust. Connected with supply line 10 are the channel supply lines 16 and 17 that respectively deliver fluid to the manual, and the relay or automatic channels that actuate piston 11 through controlling supply of fluid to cylinder lines 13, 14. The manual channel includes a transfer valve 18 that is actuable by manual operation of a selector valve 19, to connect selectively and reversely one of channel output lines 20, 21 to supply line 16 and exhaust the other to a channel exhaust 24, or to block both lines 20, 21 from both lines 16, 24. Channel output lines 20, 21 respectively are connected to system output lines 22, 23.

The relay or automatic control channel includes a relay regulator 25 that is automatically operable by some signal to selectively and reversely connect one of a pair of channel lines 26, 27, which are connected to the system output lines 22, 23, with channel supply line 17 and exhaust the other to a channel exhaust 29. The relay channel also includes a cutoff valve 28 connected in series between channel lines 26, 27 and channel output lines 30, 31 and actuable between an inactive condition connecting line 30 to line 26 and line 31 to line 27, and an active condition blocking such connections.

By relay connections represented by dotted lines 32 in Fig. 1, operation of selector valve 19 by a hand operator 33 actuates transfer valve 18 and cutoff valve 28 in correlated manner, to block the manual channel and unblock the automatic channel by movement of operator 33 to an "automatic" position designated A, to block both channels and thereby stop the power unit by movement of the operator to a "neutral" position, three of which are designated N, or to block the automatic channel and unblock the manual channel by connecting a selected one of channel output lines 20, 21 to supply and the other to exhaust, accomplished by moving operator 33 to positions designated L and R which respectively indicate leftward or rightward movement of piston 11.

The present invention relates to an auxiliary anti-creep system that may be made effective, after stopping a hydraulic power unit as by moving operator 33 of Fig. 1 to an N position, to respond to creeping of the power unit from the position in which it is stopped to return the power unit to that position.

Referring to Figs. 1 and 2, it will be seen that a piston rod 35 is secured to piston 11, and this rod serves as the output member of the power unit. Basically, the anti-creep system of the invention comprises an auxiliary fluid supply and exhaust, an auxiliary control valve for selectively connecting one input port of a reversible hydraulic power unit to an auxiliary power fluid supply and the other to exhaust, and valve and clutch mechanisms actuated in correlated relation respectively to establish the auxiliary supply to the auxiliary control valve, and to couple the latter to the movable power unit output member for actuation by it, in a sense to supply the power unit in a sense to actuate the unit in the opposite direction to the creeping movement actuating the auxiliary control valve.

Returning to Figs. 1 and 2, an auxiliary rod member 36 is attached to piston rod 35 at a point that always is beyond the adjacent end structure of cylinder 12, as by a simple clamp 37, for movement with and parallel to piston rod 35. A gripping device 38 is selectively actuable to release, or to clutch itself to rod member 36 for movement with it. Gripping device 38 is, by a transmission rod 39, connected to operate an auxiliary control valve 40. This valve 40 constitutes the control device of the anti-creep system and acts, during clutching of device 38 to rod 36, and upon movement of rod 36, to connect to an auxiliary control valve fluid supply line an end of cylinder 11 toward which the piston has moved, or is moving, and to connect the other cylinder end to an auxiliary control valve exhaust line.

While practice of the invention as so far described may be accomplished by supply of fluid to the auxiliary control valve supply line by a fluid system that is completely auxiliary to, and turned on and off independently of the main power unit supply and control system, for minimizing piping connections and positively correlating the element actuations necessary to fully activate either the anti-creep or main system, and to place the activated system in sole control of the power unit, it is desirable to provide for supply to the auxiliary control valve through the main system. The system now to be described exemplifies a system type forming a second important aspect of the invention.

An auxiliary transfer valve 45 is connected between the system output lines 22, 23 and the cylinder lines 13, 14. Transfer valve 45 is actuable between a normal condition, shown in Fig. 1, connecting line 13 to line 22 and 14 to 23, and an anti-creep position, shown in Fig. 2, blocking such connections, thereby cutting off the cylinder from direct communication with the main

control system, but also connecting an auxiliary control valve supply line 46 with a preselected one of the main system output lines 22, 23. In the arrangement shown in Figs. 1 and 2, the preselected main system output line is 23, and it is contemplated that, for activation of the auxiliary anti-creep system now being described, the main system will be conditioned by appropriate positioning of operator 33 and actuation of transfer valve 18, to connect line 23 with supply line 16 and line 22 with exhaust line 24. In the arrangement shown, the body of auxiliary transfer valve 45 is movable from a normal-operation position, shown in Fig. 1, leftward to an anti-creep position shown in Fig. 2. The spool body of valve 45 comprises a center land 47 that is movable between the Fig. 1 position blocking auxiliary control valve line 46 and providing communication of cylinder line 13 with system line 22, and the Fig. 2 position providing communication of auxiliary control valve supply line 46 with system line 23. A second land 48 is movable between the Fig. 1 position providing communication of cylinder line 14 with system line 23 and the Fig. 2 position blocking cylinder line 14. A third land 49, and land 48, both block the end portions of the bore 50 in which the spool body is slidable. The body of transfer valve 45 is biased to one of its positions, preferably the normal operating Fig. 1 position as shown, by a spring 51. While an auxiliary system exhaust might be arranged similar to the supply system for establishment and disabling of the auxiliary transfer valve, for simplicity an auxiliary exhaust system is permanently in communication through a line 52 with the main system line, here 22, that is connected to exhaust for anti-creep operation. The end portion 53 of the transfer valve bore 50 beyond land 49, wherein the latter is slidable as a piston, is connected to line 52 by a bleeder connection 54. The opposite end portion 55 of the auxiliary transfer valve bore 50, wherein part 48 is slidable as a piston, is selectively connectible, for normal operation to the same system line, here 22, as is bore portion 53, and for anti-creep operation to the other system line, here 23. By this means, in normal operation, a condition wherein the pressure differential between lines 22, 23 frequently is varyingly unbalanced and static pressure in line 22 is fluctuating, equal pressures act oppositely on the outside ends of lands 48, 49, effectively cancelling out each other and permitting bias spring 51 to maintain the transfer valve body in its position for normal main system operation of the power unit. When the two bore ends 53, 55 are connected to the different system lines 22, 23, and the latter are connected to act respectively as supply and exhaust lines for anti-creep operation, the resulting unbalanced pressures on the outer ends of lands 48, 49 move the valve body to its second position. Connection of the two bore ends 53, 55 to the same one of lines 22, 23 provides bleed paths for fluid that may escape to the bore ends by seepage past lands 48, 49 during normal operation. For selectively connecting the second end 55 of bore 50 to lines 22, 23, a three-way relay valve 56 is provided, in arrangement to select the one of lines 57, 58, which respectively communicate with system lines 22, 23, is connected to a controlled line 59 that leads to the valve bore portion 55. A solenoid 60 is arranged to move the body of relay valve 56 to one position when energized, connecting controlled line 59 to one of lines 57, 58, and a bias spring 61 is arranged to move the valve body when solenoid 60 is deenergized to a second position connecting the other of lines 57, 58 to line 59. In the arrangement shown, the deenergized solenoid condition of Fig. 1 provides normal operation by connecting system output lines 22, 23 with cylinder lines 13, 14. The solenoid and relay valve arrangement 50, 56, 61 is employed to provide adequate force for operating from a remote control station of an auxiliary transfer valve located at the power unit and included in an assembly arranged for installation at the power unit and which is to be described later.

Gripping device 38, for similar remote control purposes, preferably is solenoid operated also. Any electrically actuated clutch device may be employed as device 38. As shown schematically by Figs. 1 and 2, a solenoid 65 and a biasing spring 66 are arranged to move an actuating lever 67 that is fulcrumed in a carriage 68 for gripping or releasing rod member 35. In the form shown, spring 66 and solenoid 65 are arranged to grip and release member 35 respectively as the solenoid is energized and deenergized. A link 63 pivoted at its opposite ends to the armature of solenoid 65 and lever 67 permits movement of the latter with rod member 35 when the solenoid is mounted stationary. Such movement is limited, but is sufficient to operate the auxiliary control valve 40, the valve operating rod 39 being secured to carriage 68. For correlating actuation of auxiliary transfer valve 45 and gripping device 38, solenoids 60, 65 preferably are connected by common circuit means 69 to a control switch 70. Switch 70 may be located at an operating station 71 and associated with manual operator 33 in a desired manner.

Auxiliary control valve 40 comprises a conventional three-way spool assembly of which the valve body is movable in a valve bore 73, from a neutral position shown in Fig. 1 and blocking communication between output lines 74, 75 from communication with both auxiliary control valve supply line 46 and an auxiliary control valve exhaust line 76, in opposite directions to connect one output line with line 46 and the other with line 76. Auxiliary control valve output lines 74, 75 constitute auxiliary cylinder lines and are connected with main cylinder lines 13, 14 in proper relation to supply fluid to the end portion of cylinder 11 toward which piston 12 moves while auxiliary transfer valve 45 is in its anti-creep position and lever 67 is in rod member-gripping condition. A return spring 77 biases the auxiliary control valve body to its neutral position.

A second aspect of the invention relates to a mechanical arrangement of an auxiliary anti-creep system, such as that shown in Figs. 1 and 2, as a unit designed to be associated with a piston and cylinder unit for cooperation therewith in the indicated manner. Such a unit, arranged in accordance with this second aspect of the invention, is shown in Figs. 3 to 12.

The unit comprises a main structure including a body member 80 that contains the auxiliary transfer and auxiliary control valve bores 50, 73, and passage bores providing the majority of the lines of the anti-creep system, the remainder of such lines being provided by bores and grooves in end caps 81, 82 and in a base structure 83 of the assembly containing solenoid 60 that actu-

ates relay valve 56. Body 80 advantageously has feet 84 for attachment of the unit to a cylinder structure forming part of a power unit provided with a rod, as 36, that is moved by the piston of such assembly.

As shown by Figs. 3, 5 and 6, the main structure includes a support portion 85 that extends laterally of body 80 and projects longitudinally thereof beyond end cap 82. To this support portion 85 is secured a bracket 86 that supports the coil 87 of the gripping device-actuating solenoid 65.

In the form of gripping device 38 shown in Figs. 3, 5, 6 and 9, the carriage 68 comprises a body 88 having therein a bore in which a resilient split ring 89 is mounted and secured against axial movement relative to the body, as by set screw 90. Split ring 89 encircles rod member 36 and the ring and the bore containing it are so formed that in its undistorted condition the ring and the rod member relatively are freely slidable. Lever 67 is fulcrumed to carriage body 88 to compress ring 89 upon rod member 36 when lever 67 is actuated to its anti-creep position, thereby clutching to member 36 the carriage and auxiliary control valve rod 39. The latter has its end secured in a lateral extension 91 of the carriage body. Only a small gripping force is necessary to accomplish operation of an auxiliary control valve from rod 36, and adequate force can be developed from a conventional solenoid by properly proportioning the lengths of arms of lever 67.

In one lateral surface of the main body member 80 are two input openings 92, 93 for connection to output lines, as 22, 23, of a hydraulic regulator or other control system, such as that of Fig. 1, that is capable of being conditioned to supply fluid under pressure to opening 92 and to connect opening 93 to exhaust. In the opposite lateral surface of body member 80 are two output openings 94, 95 for connection to power unit cylinder lines, as 14, 13 of Figs. 1 and 2. A first main input port 97 in transfer valve bore 50 is formed by the end of a main passageway 98 that communicates with input opening 92, and a second transfer valve main input port 99, axially spaced from port 97, is formed by the end of a main passageway 100 that communicates with input opening 93. Since passageways 98, 100 are connected to supply and exhaust lines for anti-creep system operation, hereafter they will be called main "supply and exhaust line passageways." In axially spaced relation to each other and to input ports 97, 99, a pair of main controlled ports 101, 102 enter transfer valve bore 50 and communicate respectively with main output openings 94, 95 by passageways 103, 104 that are termed "main power unit supply and exhaust" passageways. An auxiliary controlled port 105, formed by the end of the auxiliary control valve supply passage 46, enters transfer valve bore 50 in such axially spaced relation to all of ports 97, 99, 101, 102, and to valve body land 47, as to be blocked when lands 47, 48 provide communication between ports 97, 101 and ports 99, 102, and to be placed in communication with port 97 when the valve body has been shifted to its anti-creep position wherein lands 47, 48 respectively block main output ports 102, 101.

Auxiliary control valve supply passage 46, which comprises a transverse bore in body 80, forms a supply port 107 in auxiliary control valve bore 73. A pair of exhaust ports 108 enter auxiliary control valve bore 73 at points axially spaced to opposite sides of supply port 107, and communicate with a longitudinal passage bore 109 that forms a branch of an auxiliary exhaust system and that enters the end portion of auxiliary control valve bore 73 containing return spring 77. An auxiliary exhaust passage bore 110 that extends longitudinally through body member 80 is connected with main exhaust passageway 100 by a passage 111 that may be taken as corresponding to auxiliary exhaust line 52 of Figs. 1 and 2. A pocket 112 in end cap 81 registers with one end of auxiliary exhaust passage bore 110, and is connected, by a bleeder groove 113 cut into the inner surface of end cap 81, with a pocket 114 that registers with auxiliary control valve bore 73. Pocket 112 also is connected with a pocket 115 in end cap 81 that registers with transfer valve bore 50 by a bleeder groove 116 that corresponds to bleeder line 54 of Figs. 1 and 2.

Controlled ports 117, 118 of the auxiliary control valve communicate respectively with main output passageways 101, 102 by passages 119. Advantageously, an elongate inner shell 120 is mounted in auxiliary control valve bore 73, with the auxiliary control valve body operating in a central bore 121 in the liner, and ports 107, 108, 117, 118 and passage 109 are machined in it.

Body member 80 is provided with a relay valve supply passage 126 that extends from main supply passageway 97 to the end of the body that is contacted by cap plate 82. Cap plate 82 has through it a relay valve bore 127 that is aligned with a valve pocket 128 in the adjacent end of main body member 80, and with a bore 129 in the base structure 83 of solenoid 60. Return spring 61 is mounted in bore 129 to bias the body of transfer relay valve 56 as described above. Cap plate 82 also has cut into its surface that faces body 80 an exhaust passage groove 130 that registers with the end of exhaust passage 110 and that enters bore 127. It also has a supply bore 131 extended through it in registration with the relay valve supply passage 126. A supply groove 133 cut into the inner surface of solenoid base structure 83 registers with bore 131 and enters bore 129 in axially spaced relation to groove 130. A controlled passage groove 132 cut into the outer surface of cap plate 82, and covered by base structure 83, opens at one end into bore 127 between the openings of exhaust and supply grooves 130 and 133, and its other end registers with the end of transfer valve bore 50. Groove 132 corresponds to controlled line 59 of Fig. 1. The relay valve body is of spool type, connecting controlled groove 132 to supply groove 133 or to exhaust groove 130, depending on its position, and conseqently on the energization or deenergization of solenoid 60. This arrangement provides the type of transfer valve operation described above, the lands 48, 49 acting in the end portions 53, 55 of bore 50 as pistons. When the relay valve body is in its normal operating position of Fig. 7, bore portion 55 is connected to passageway 100 through controlled groove 132, exhaust groove 130, passage 110, and bore 111, while bore portion 53 is connected to the same passageway 100 by groove 113 in end cap 81, passage 110, and bore 111. Thus, although in normal operation, passageway 100 may fluctuate between supply and exhaust as selected by the regulator or control system, and static pressure of fluid in it may vary, pressures applied to valve lands 48, 49 are equal and bias spring 51 is effec-

tive to position the valve body. In anti-creep position of the relay valve, when passageway 98 is connected to a fluid pressure supply and passageway 100 is connected to exhaust, transfer valve bore portion 55 is connected to supply passageway 98 through controlled groove 132, supply groove 133, and supply bores 131 and 126, while bore portion 53 remains connected to passageway 100. The pressures in bore portions 53, 55 thereby are unbalanced and the transfer valve body is moved to its anti-creep position.

From the foregoing it will be seen that many changes may be made in the details of system and apparatus arrangement within the scope of the invention as defined by the claims.

I claim:

1. A hydraulic system comprising a reversible power unit provided with an external output member movable in opposite directions by delivery of hydraulic power fluid to one or the other of two power unit inputs, a pair of control lines respectively connected to said inputs, a regulator device for selectively delivering power fluid to one or the other of said lines, a creep-controlling auxiliary hydraulic supply system including an input supply line, a pair of output lines connected respectively with said power unit inputs and an auxiliary regulator device having outputs respectively connected with said output lines and a control element movable in opposite directions from a neutral position blocking communication between said input supply line and both said output lines to positions wherein respectively it connects the different ones of said output lines with said input supply line, a transfer valve selectively actuable between a normal-operation condition connecting said control lines with said power unit inputs and blocking said auxiliary system input supply line from communication with said control lines, and a creep-control condition blocking communication between said control lines and power unit inputs and connecting said input supply line with a preselected one of said control lines, and a clutching device connected with said auxiliary regulator device control element and selectively actuable between a disengaged condition and an engaging condition mechanically connecting said control element to said power unit output element for movement of the former with the latter and in a direction to supply fluid to the power unit input, in a sense to move said output element opposite to that in which the output element moves in, so actuating said control element.

2. A hydraulic system according to claim 1, including common actuating means for said transfer valve and clutching device and arranged to correlate transfer valve actuation to its normal-operation and creep-controlling conditions with actuation of the clutching device to its disengaging and engaging conditions.

3. In a hydraulic system that includes a piston and cylinder power unit provided with an external member that moves with the piston of the unit, a pair of main hydraulic flow lines communicating with opposite ends of the cylinder of the unit, and a regulator device connected with said lines and actuable between conditions for respectively connecting said lines in reversed senses to a fluid supply and an exhaust; means for preventing substantial creep of the piston from a selected position, comprising means for connecting a preselected one of said main lines to supply, an auxiliary fluid delivery control system comprising an auxiliary input supply line, a pair of controlled lines respectively connected with the power unit cylinder ends, and a control valve including a body movable in opposite directions from a neutral position blocking said controlled lines from said auxiliary input supply line and exhaust to positions respectively connecting the different controlled lines to said input supply line and exhaust line in reversed senses, a transfer valve including a valve body axially movable between a normal operation position connecting said main lines respectively with opposite ends of the power unit cylinder and blocking said auxiliary input supply line and a creep-control position blocking said main lines from the cylinder ends and connecting the auxiliary input supply line with said preselected main line, actuating means for said transfer valve comprising a piston movable in a bore and connected with the transfer valve body for moving the latter to one said position when pressure is exerted in said bore and a spring biasing said valve body to its other position, a transfer valve relay including a relay valve movable between two positions each corresponding to one of said transfer valve positions and respectively connecting said bore to said preselected main line and to exhaust, a solenoid having an armature mechanically connected to said transfer relay valve for moving it to one of its positions when energized and a spring biasing said relay valve to its other said position, a clutch device having an operator movable in opposite directions respectively to clutch and disengage said pilot valve body to and from said power unit external member, a second solenoid having its armature mechanically connected to said operator for moving the latter in one said direction when the solenoid is energized and a spring biasing the operator in the other direction, and circuit means for energizing said solenoids including switching means arranged to control such energization to correlate relay valve controlled movement of the transfer valve body to its normal-operation and creep-control positions respectively, with movement of said clutching device operation in its disengaging and clutching directions.

4. A creep-control assembly for a hydraulic power unit provided with a pair of power fluid inlets and operable in reverse directions by delivery of power fluid to one or the other inlet, said assembly comprising a body structure having therein a transfer valve bore and a control valve bore, a pair of main input passageways connecting a pair of external input openings with a pair of spaced main input valve ports opening into said transfer valve bore and a pair of main output passageways connecting a pair of main output openings with a pair of main controlled ports opening into said transfer valve bore in spaced relation to each other and to said main input ports, said body structure also having therein an auxiliary control valve supply passage connecting a controlled port entering said transfer valve bore in spaced relation to said main ports, and an exhaust passage communicating with a first one of said main input passageways, said auxiliary supply and exhaust passages respectively communicating with supply and exhaust ports entering said control valve bore in spaced relation, said body structure also having therein a pair of auxiliary output passages respectively connecting said main output passageways with controlled ports entering said

control valve bore in spaced relation to each other and to said supply and exhaust ports, a transfer valve body in said transfer valve bore movable between a normal-operation position providing communication between corresponding pairs of said main input in main controlled ports and blocking said auxiliary controlled port and a creep-control position blocking communication between all said main ports and providing communication between said auxiliary controlled port and the second main input passageway, a control valve body movable oppositely in said control valve bore from a neutral position blocking communication of said controlled ports with said supply and exhaust ports and positions respectively connecting the different said controlled ports with said supply and exhaust ports in reversed senses, said control valve body having an operator projecting from said body structure, and means connected with said operator and selectively actuable to couple and uncouple said operator to and from an external movable element actuated in opposite directions by a reversible hydraulic power unit.

5. A creep-control assembly according to claim 4, wherein said transfer valve ports are axially spaced along the transfer valve bore, said transfer valve body is axially movable in its said bore and is provided with a body portion movable as a piston in an end reach of said bore, said assembly including a relay valve having a controlled port communicating with said transfer valve end reach, said body structure being provided with a relay auxiliary supply passage communicating with the said second main input passageway and with a supply port of said relay valve, and a relay exhaust passage connecting an exhaust port of said relay valve with said auxiliary exhaust passage, said relay valve having a valve body actuable selectively to connect the relay valve controlled port with either said relay valve exhaust or supply port.

6. In a hydraulic system that comprises a power unit having two fluid inputs, a regulator for delivering pressure fluid selectively and at variable pressure to one or the other of two outputs and exhausting the other said output, and a pair of lines connecting said outputs respectively with said power unit inputs; a valve including a valve bore into which open a pair of input ports respectively connected with said lines and a pair of output ports respectively connected with said power unit inputs, said valve having a valve body movable in said bore between positions respectively providing and blocking communication between corresponding pairs of said input and output ports and having axially spaced portions slidable in end portions of said valve bore as pistons, an auxiliary device selectively actuable by a movable actuating member to and from a condition for supplying pressure fluid to a preselected one of said lines and exhausting the other, a relay valve assembly comprising structure providing a valve chamber into which open a controlled port connected with one said valve bore end portions, a supply port connected with said preselected line and an exhaust port connected with said other line, a relay valve body movable in said valve chamber between positions respectively connecting said controlled port with said supply and exhaust ports and an actuating member movable to move said relay valve body between its said positions, a hydraulic line connecting the opposite said valve bore end portion with one of said lines, and common operating means for said auxiliary device and relay valve actuating members arranged to correlate actuation of said device from and to its said condition respectively with movement of the relay valve body to connect said control port to the same line as said other valve bore end portion is connected and to connect it to the other said line.

7. In a hydraulic system that comprises a power unit having two fluid inputs, a regulator for delivering pressure fluid selectively and at variable pressure to one or the other of two outputs and exhausting the other said output, and a pair of lines connecting said outputs respectively with said power unit inputs; a valve including a valve bore into which open a pair of input ports respectively connected with said lines and a pair of output ports respectively connected with said power unit inputs, said valve having a valve body movable in said bore between positions respectively providing and blocking communication between corresponding pairs of said input and output ports and having axially spaced portions slidable in end portions of said valve bore as pistons, an auxiliary device having outputs respectively connected to said lines and selectively actuable by a movable actuating member to and from a condition for supplying pressure fluid to a selected one of said lines and exhausting the other, a cutoff valve arranged in said lines between said regulator and auxiliary device outputs and actuable by a movable actuating member between conditions respectively blocking and permitting flow of fluid between said regulator outputs and lines, a relay valve assembly comprising structure providing a valve chamber into which open a controlled port connected with one of said valve bore end portions, a supply port and an exhaust port connected with said other line, a relay valve body movable in said valve chamber between positions respectively connecting said controlled port with said supply and exhaust ports and an actuating member movable to move said relay valve body between its said positions, a hydraulic line connecting the opposite said valve bore end portion with one of said lines, and common operating means for said auxiliary device, cutoff valve and relay valve actuating members arranged to correlate actuation of said device from and to its said condition respectively with actuation of said cutoff valve to and from its flow blocking condition and with movement of the relay valve body to connect said control port to the same line as said other valve bore end portion is connected and to connect to the other said line.

8. A creep-control assembly for a hydraulic power unit provided with a pair of fluid inputs delivery of fluid to the different ones of which operates such unit in opposite directions, said assembly comprising a body structure having extended therethrough an opening through opposite end surfaces a transfer valve bore, a control valve bore and an exhaust passage, and said body structure having therein a relay valve pocket opening through one said end surface, said body structure also having therein main line supply and exhaust passageways opening through a lateral surface of said structure and through spaced line ports in said transfer valve bore and main power unit supply and exhaust passageways opening through a lateral surface of said body structure and into said transfer valve bore through power unit ports respectively corresponding to and spaced axially of said bore from said line ports, said body structure also having therein a control valve supply passage opening into said

transfer valve bore through a controlled port and into said control valve bore through a supply port, a relay valve supply passage opening through the same end surface as said relay valve pocket and into said line supply passageway, auxiliary power unit passages respectively connecting control valve controlled ports that enter said control valve bore on opposite sides of said supply port, a passage connecting said exhaust passage with said line exhaust passageway, and passageways connecting with said exhaust passage a pair of control valve exhaust ports that enter said pilot valve bore in spaced relation to said control valve supply and controlled ports, a transfer valve body axially movable in said transfer valve bore between a position connecting together said line and power unit supply ports and said line and power unit exhaust ports and blocking said transfer valve controlled port and a position blocking communication between said line and power unit ports but connecting said transfer valve controlled port with said line supply port, said transfer valve body having a pair of axially spaced portions respectively slidable as pistons in reaches of said transfer valve bore respectively adjacent said body structure and surfaces, a cap structure secured in contact with said end surface through which said valve pocket opens and closes said passages and valve bores and with said valve pocket providing a relay valve chamber, said body and cap structures being provided with opposed surfaces and grooves providing closed passageways that respectively connect the end of said transfer valve bore with a relay valve controlled port in said relay valve chamber and said supply and exhaust passages with relay valve supply and exhaust ports in said chamber, a relay valve body movable in said chamber between positions respectively connecting said relay valve controlled port with said relay valve supply and exhaust ports, a second cap structure overlying the other said body structure end surface and closing said valve bores and exhaust passageway, said body and second cap structures being provided with opposed surfaces and grooves enclosing bleeder passages that extend between said control and transfer valve bores and said exhaust passage.

9. In creep control means for a hydraulic system that includes a reversible power unit provided with an external output member movable in opposite directions by delivery of hydraulic power fluid to one or the other of two power unit inputs, and a regulator device for selectively delivering power fluid to one or the other of said inputs, said creep control means comprising, in addition to said regulating device an auxiliary valve movable in opposite directions respectively to deliver fluid to the different ones of said two inputs and a member movable between first and second conditions respectively connecting and disconnecting said control valve to and from said output member respectively to establish anti-creep and normal power unit control, supply means for delivering power fluid to said control valve, a blocking device actuable between first and second conditions wherein respectively it blocks and establishes delivery of power fluid to said control valve, cut off means actuable between first and second conditions respectively permitting and blocking delivery of fluid to said inputs by said regulator device, and common control means arranged selectively either to simultaneously actuate both said blocking and cut off devices to their said first conditions and move said member to its said second condition, or to simultaneously actuate both said devices to their said second conditions and move said member to its said first condition.

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