United States Patent

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[54] HYDRAULIC UNIFLOW CONTROL UNIT

4 Claims, 6 Drawing Figs.

[52] U.S. Cl. 137/102, 91/420
[51] Int. Cl. F15b 11/08
[50] Field of Search 137/87, 102; 91/420

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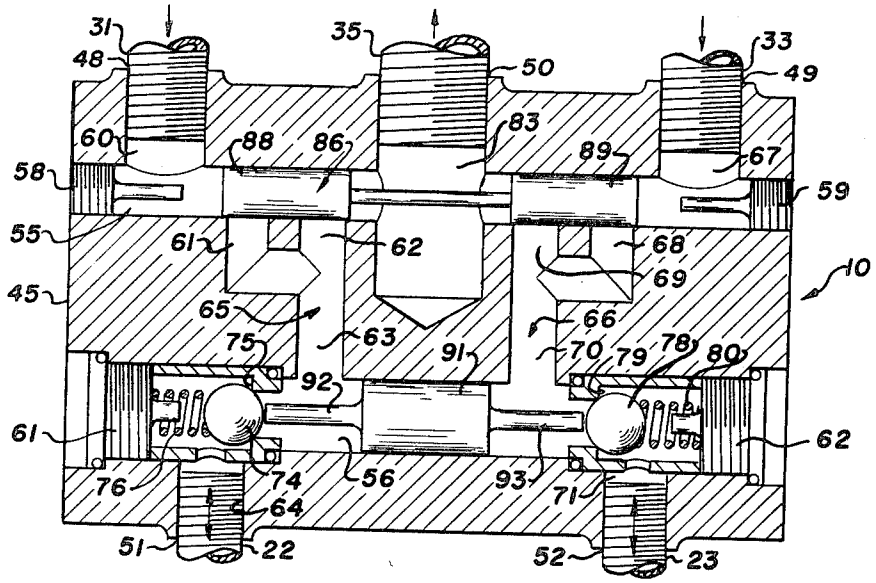
ABSTRACT: There is disclosed a hydraulic control unit particularly for use in steering apparatus for boats, and in which the hydraulic fluid always flows in the same direction. The unit has pressure passages having ends to be connected to opposite sides of a pumping unit and opposite ends to be connected to the device to be controlled, such as the opposite ends of a slave cylinder which operates the rudder of a boat. A shuttle valve normally closes off the pressure passages and shuts them off from a common return passage which is connected to the reservoir of the pumping unit. When hydraulic fluid flows through one pressure passage, it shifts the shuttle valve to open the passage and connect the other passage to the return passage. The flowing fluid also passes through a check valve in the pressure passage and shifts a lock spool to open a corresponding check valve in the other pressure passage.



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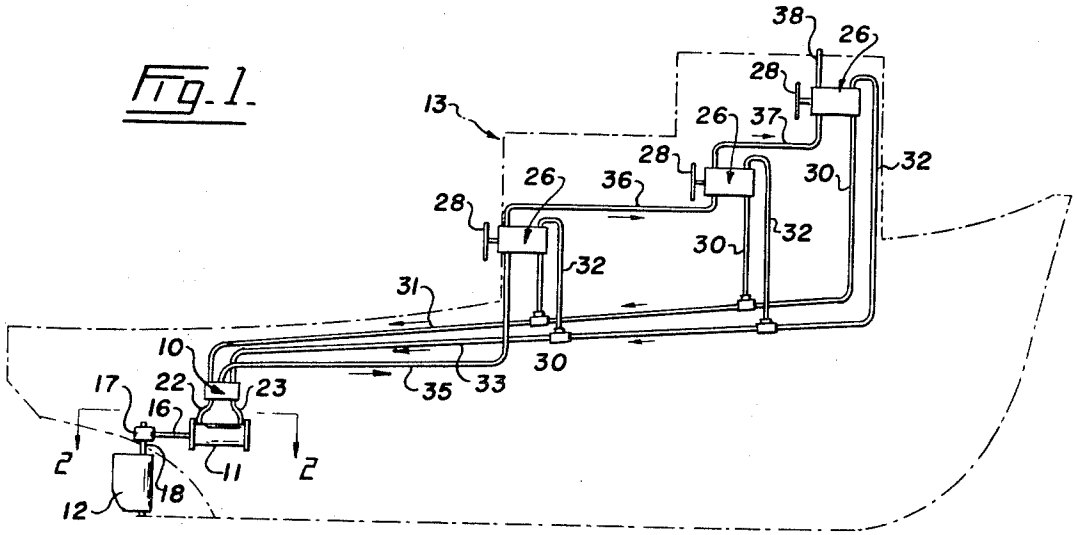
SHEET 1 OF 2

Fig. 1.



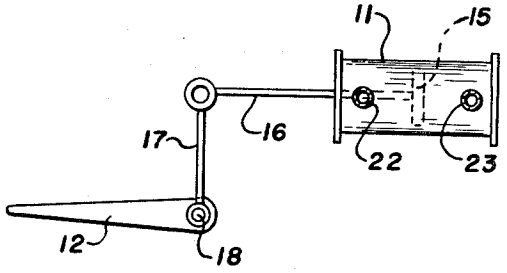
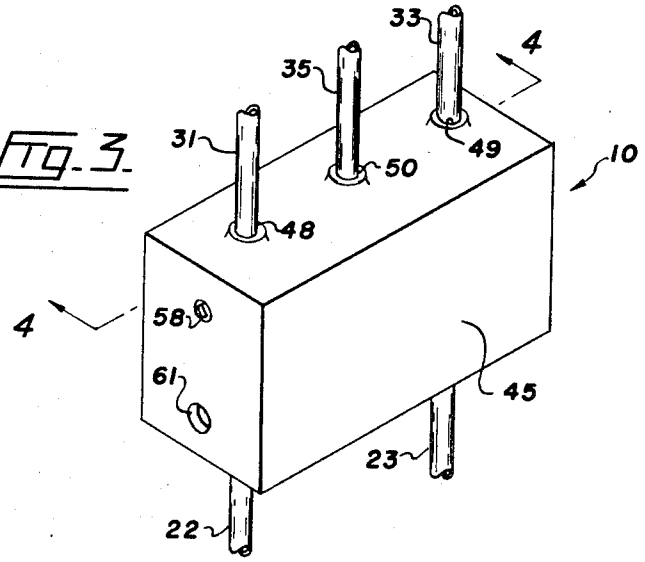


Fig. 2.

Fig. 3.



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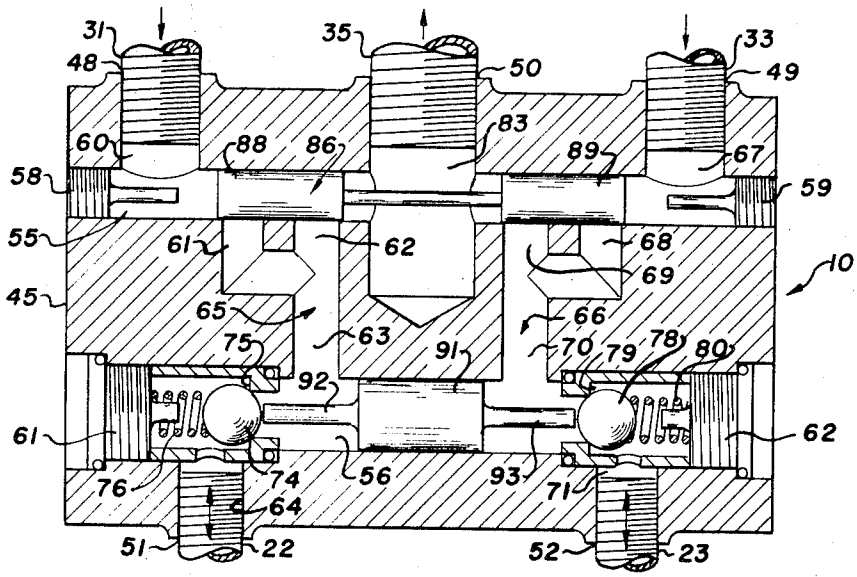

Fig. 4.

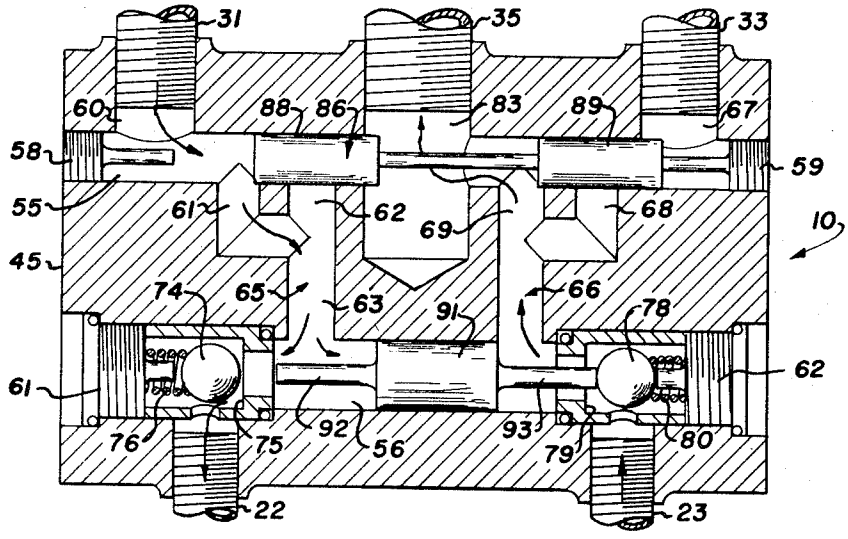

Fig. 5.

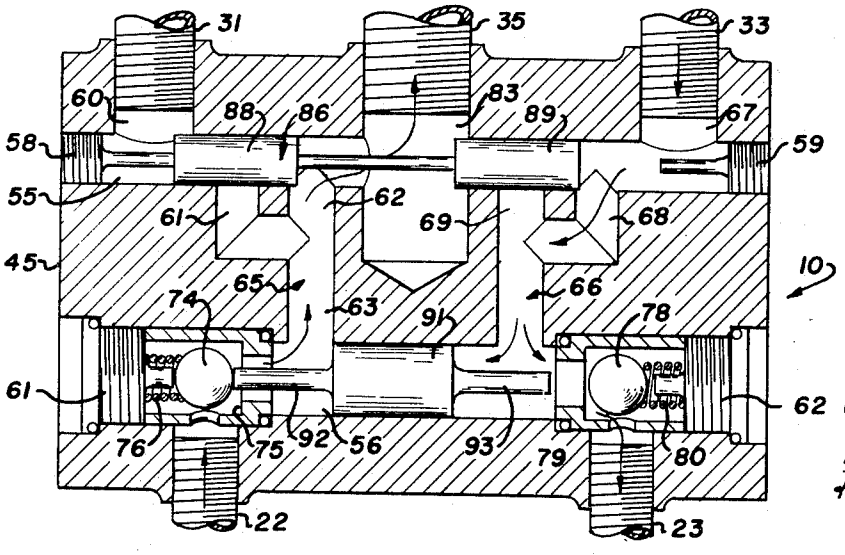

Fig. 6.

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HYDRAULIC UNIFLOW CONTROL UNIT

BACKGROUND OF THE INVENTION

This invention relates to hydraulic uniflow control units which may be used for different purposes, but which are primarily designed to be used in the steering control apparatus of a boat which includes one or more steering pump units and a slave cylinder for controlling the rudder of the boat.

It is desirable to be able to steer many different types of boats from various stations therein. Hydraulic steering systems are usually used for this purpose, and in the past, it has been difficult to get air out of the systems and to keep it out, to locate check valves that are not operating properly because of dirt of other obstructions, and to prevent loss of control when two helms are simultaneously operated in opposite directions.

One of the hydraulic control systems in common use has check valves for the pressure lines at each steering pump unit. If dirt gets into any one of these valves, it prevents the slave cylinder from being locked to hold the rudder in the desired position or setting. When this happens, it is difficult and time consuming to locate the valve that needs to be cleaned. Another difficulty results from the fact that the hydraulic fluid flows back and forth through each pressure line between the pumps and the slave cylinder so that it is very difficult to purge the lines of air. When air is trapped in the lines, the system becomes soft and unresponsive. Thus, a long time consuming operation is needed at the time of installation in order to purge the air. As the piston of the slave cylinder is connected to the rudder through a piston rod which extends through one end of the cylinder, it is necessary to provide a compensating rod from the piston to the opposite end of the cylinder in order to be sure that exactly the same amount of oil returns to the steering pump as is pumped by the latter. This necessitates extra seals at the opposite end of the cylinder. Another dangerous problem with the past control systems results from the fact that if two steering units are simultaneously rotated in opposite directions, control of the vessel is lost as the fluid circulates freely between the two steering units, leaving the slave cylinder unlocked. Furthermore, in the prior systems it is necessary to provide a continuous substantial rise in the piping from the slave cylinder to all of the steering units in order to try to prevent air from being trapped therein.

SUMMARY OF THE INVENTION

The hydraulic uniflow control units of this invention eliminate the difficulties pointed out above. Each uniflow control unit includes two check valves which eliminate the necessity of check valves in the pressure lines at each of the steering units. This not only reduces the cost, but if a check valve is held open by dirt, the trouble can be in only one place and therefore it is easy to locate and remedy it. The control system is very easy to purge free of air as the hydraulic fluid always travels in the same direction. Therefore, the system can be purged quickly and easily merely by turning each steering unit the full distance back and forth several times. This saves time when the equipment is installed, the system is always positive acting, and no expensive and complicated bleeding devices are required. As it does not matter whether the same amount of fluid is moved out of the slave cylinder as is pumped thereinto, no compensating shaft with its accompanying seals is required for the slave cylinder. This reduces cost, and it eliminates another possible source of leakage. If two steering units are simultaneously rotated in opposite directions, the one with the most force applied will operate, while the other will not. Therefore, there is no loss of control of the vessel when this occurs. The unidirectional flow of the fluid eliminates the necessity of having all of the lines upwardly inclined.

A hydraulic uniflow control unit according to the present invention includes first and second pressure passages having inlet ends to be connected to opposite sides of a reversible pump unit and outlet ends to be connected to opposite ends of a slave cylinder. A common return passage is connected to both pressure passages. A shuttle valve normally closes off both pressure passages and closes off the return passage from both pressure passages to prevent fluid from flowing through any of said passages. The shuttle valve is positioned to be moved by fluid flowing through the first pressure passage to permit said flow and to permit fluid to flow from the second passage outlet end to the return passage and vice versa. There is a check valve in each pressure passage normally preventing fluid from flowing therein from its outlet end to its inlet end. A lock spool is positioned to unseat the check valve of the second pressure passage when fluid flows through the first pressure passage, and vice versa.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 diagrammatically illustrates a uniflow control unit of this invention in use in a vessel steering system having three steering pump units and a slave cylinder controlling the rudder of the vessel,

FIG. 2 is a diagrammatical sectional view taken on the line 2–2 of FIG. 1,

FIG. 3 is a perspective view of the uniflow control unit,

FIG. 4 is a vertical section through the unit taken on the line 4–4 of FIG. 3, showing the unit in the locking position, and

FIGS. 5 and 6 are views similar to FIG. 4, but showing the unit set for turns to the left and to the right, respectively.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1 and 2 of the drawings, 10 is a hydraulic uniflow control unit in accordance with this invention which is operatively connected to a slave or operating cylinder 11 which, in turn, controls a rudder 12 of a vessel 13 in which the apparatus is located. Cylinder 11 has a piston 15 therein, and a rod 16 connected to this piston extends through suitable seals, not shown, in an end of the cylinder to an arm 17 which is connected to the rudder post 18. Movement of piston 15 back and forth in cylinder 11 moves rudder 12 to steer the vessel. Control unit 10 is connected by pressure lines 22 and 23 to the opposite ends of cylinder 11.

Vessel 13 is provided with one or more steering pump units 26, there being three of these units shown in FIG. 1. Each steering unit 26 can be any known unit for this purpose, each one having a reversible pump which is operated by a steering wheel 28. Each steering unit has a reservoir for the hydraulic fluid of the system. The opposite sides of each pump unit are connected by pressure lines 30, 31 and 32, 33 to the control unit 10. A return line 35 connects control unit 10 to the bottom of the reservoir of one of the steering units 26, while another return line 36 connects the top of said reservoir to the bottom of the reservoir of the next steering unit, and another return line 37 connects the top of the latter reservoir to the bottom of the reservoir of the next steering unit. In other words, there is a return line from control unit 10 to the bottom of the reservoir of the first steering unit of a series of these units, while the top of the reservoir of each successive steering unit is connected to the bottom of the reservoir of the following unit. The lines of this system do not have to be inclined upwardly. The top of the reservoir of the last steering unit 26 is open to atmosphere, such as by means of a pipe 38. The entire system may be filled with hydraulic fluid through this pipe 38. The pressure pumps of the steering units 26 are connected in parallel to pressure ports of control unit 10, while the reservoirs of these steering units are connected in series with a return port of the control unit.

FIGS. 3 and 6 illustrate control unit 10 in detail. This unit includes a body 45. This body has pressure ports 48 and 49 and a return port 50 opening out from one edge thereof, and lines 31, 33 and 35 are connected to body 45 so as to register with ports 48, 49 and 50, respectively. Body 45 also has outlet ports 51 and 52 opening out from an opposite edge thereof and communicating with control lines 22 and 23, respectively.

A pair of substantially horizontal bores 55 and 56 extend through body 45, the ends of bore 55 being closed by plugs 58

and 59, and the ends of bore 56 being closed by fittings 61 and 62. Pressure passages 65 and 66 are formed in the control unit body, passage 65 having an outlet end at pressure port 48 and an outlet end at outlet port 51, while passage 66 has an inlet end at pressure port 49 and an outlet end at outlet port 52. Pressure passage 65 is made up of an inlet section 60 extending from port 48 to bore 55, part of said bore, two parallel intermediate branches 61 and 62 extending from bore 55 to another section 63 which extends to bore 56, part of the latter bore, and outlet section 64 which extends from this bore to outlet port 51. Pressure passage 66 is similar to passage 65, and is made up of an inlet section 67, two substantially parallel intermediate branches 68 and 69, another section 70, and an outlet section 71.

A check valve is located in pressure passage 65 and consists of a ball 74 normally pressed onto a seat 75 in bore 56 by a spring 76. Another check valve is provided in pressure passage 66, said valve consisting of a ball 78 normally resting on a seat 79 in bore 56 and retained on said seat by a spring 80.

Return passage means is provided in body 45 and in this example consists of a return passage 83 extending inwardly of the body from return port 50 to bore 55.

A shuttle valve 86 is slidably mounted in bore 55 and has an end section 88 normally closing branches 61 and 62 of pressure passage 65, and an end section 89 normally closing branches 68 and 69 of pressure passage 66. When the shuttle valve is in the position shown in FIG. 4, no fluid can flow through either of the pressure passages 65 or 66, or from either of said passages to return passage 83.

A lock spool 91 is slidably mounted in bore 56 substantially midway between the ends thereof. Pins 92 and 93 project from opposite ends of spool 91 towards check valves 74 and 78, but these pins are of such length that the balls normally remain on their respective seats.

FIG. 4 shows the various components of control unit 10 in their neutral positions, at which time, check balls 74 and 78 prevent fluid from moving through lines 22 and 23 from the opposite ends of slave cylinder II so that rudder 12 is locked in its position. When one of the steering units 26 is operated by its wheel 28, to turn vessel 13 in one direction, for example, to port or to the left, hydraulic fluid is pumped through lines 32 and 31 into pressure passage 65. This shifts shuttle valve 86 to the right, as shown in FIG. 5, to uncover branches 61 and 69 of pressure passages 65 and 66. Branch 62 is still shut off from return passage 83 by shuttle section 88, and shuttle section 89 keeps branch 68 of passage 66 closed while the latter passage is in communication with return passage 83 through branch 69. The pressure fluid travels through passage 65, unseating check ball 74, and flowing through line 22 to one end of slave cylinder II to turn the rudder. At the same time, the pressure fluid shifts lock spool 91 to the right so that pin 93 unseats check ball 78, allowing fluid to flow from the opposite end of the slave cylinder through line 23, part of pressure passage 66, return passage 83 and thence through line 35 to the fluid reservoir of the steering unit 26 to which said line is connected.

FIG. 6 illustrates the position of the various components of control unit 10 when the steering wheel of one of the pump units 26 is rotated in the opposite direction to turn the vessel to starboard or to the right. At this time, pressure fluid flowing along pressure passage 66 shifts shuttle valve 86 and lock spool 91 to the left so that said fluid can flow through line 23 to the opposite end of the slave cylinder. At the same time, check ball 74 is unseated and, therefore, fluid can flow back from the slave cylinder through line 22, a part of pressure passage 65, return passage 83, and return pipe 35 to the fluid reservoir of the nearest steering unit.

Check valves 74 and 78 are the only ones necessary to lock the slave cylinder and, consequently, rudder 12 in any set position. This eliminates the necessity of check valves for this purpose at each of the steering units 26. As the hydraulic fluid always flows in the same direction from the steering pump units through lines 31 and 33 to the control unit, and always flows from said unit in the same direction through return line 35, 36 and 37 to the reservoirs of the steering units, the lines of the hydraulic system can be quickly and easily purged of any air therein merely by turning the steering wheels 28 back and forth to the full extent several times, since the fluid is pumped through the pressure lines, the control unit, and the return lines to the reservoirs of the steering unit which are in communication with each other so that any air in the lines eventually leaves the system through pipe 38, even if there is no gradual rise in any line. The slave cylinder II does not need an extra rod or shaft from piston 15 to compensate for rod 16 since it does not matter whether the same amount of fluid is directed out of the cylinder as is directed into it. If two of the steering wheels 28 are rotated in opposite directions at the same time, the one with the most force applied to it will pump fluid to control unit 10, and this will shift shuttle valve 86 and lock spool 91 so as to prevent fluid from being pumped through the control unit by the other steering unit. Thus, the vessel will remain under the control of the steering unit to which the most force had been applied, but it will not be out of control at any time. As a continuous rise is not necessary for the pipelines, these can be placed in a convenient place in the vessel.

We claim:

1. A hydraulic uniflow control unit comprising a body, first and second pressure passages extending through the body and having inlet ends to be connected to opposite pressure sides of at least one reversible pump unit and outlet ends to be connected to opposite ends of an operation cylinder, return passage means in the body connected to both of said pressure passages and to be connected to the return of said pump unit, a shuttle valve slidably mounted in the body and normally shutting both of said pressure passages and closing off the return passage means from both of said pressure passages to prevent fluid from flowing through said pressure passages and said passage means, said shuttle valve being moved by fluid flowing through the first passage to permit said flow and to permit fluid to flow from the second passage outlet end to the return passage means and vice versa, a check valve in each pressure passage normally preventing fluid from flowing therein from the outlet end to the inlet end thereof, and a lock spool slidable mounted in the body and positioned to unseat the check valve of the second passage when fluid flows through the first passage and vice versa.

2. A control unit as claimed in claim 1 in which each pressure passage has two parallel intermediate branches, one branch of each pressure passage being in communication with the inlet end of said each pressure passage and the other of said branches of said each pressure passage being in communication with said return passage means, said shuttle valve has two sections, said sections normally closing off both of the branches of both of said pressure passages, and when moved by fluid in the first pressure passage the shuttle valve uncovers the branch which is in communication with the inlet of the first pressure passage and uncovers the branch of the second pressure passage which is in communication with said return passage means, and vice versa.

3. A control unit as claimed in claim 2 in which said lock spool has one end exposed to fluid in the first pressure passage between the two intermediate branches thereof and the check valve therein and an opposite end exposed to fluid in the second pressure passage between the two intermediate branches thereof and the check valve therein, and including pins on opposite ends of the lock spool and extending towards adjacent check valve, and when fluid in the first pressure passage flows against the adjacent end of the lock spool, the latter is shifted to cause the pin on its opposite end to open the check valve in the second pressure passage and vice versa.

4. A control unit as claimed in claim 1 in which said lock spool has one end exposed to fluid in the first pressure passage between the inlet end thereof and the check valve therein and an opposite end exposed to fluid in the second pressure passage between the inlet end thereof and the check valve

therein, and including pins on opposite ends of the lock spool and extending towards adjacent check valves, and when fluid in the first pressure passage flows against the adjacent end of the lock spool, the latter is shifted to cause the pin on its opposite end to open the check valve in the second pressure passage and vice versa.