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Schexnayder

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[54] **VALVE ASSEMBLY HAVING A PRESSURE RESPONSIVE DETENT MECHANISM**

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[51] **Int. Cl.** **F16k 11/02,** F16k 31/143

[58] **Field of Search** 251/73, 297; 137/624.27

[56] **References Cited**

UNITED STATES PATENTS

2,757,641	8/1956	Meddock	137/624.27
2,848,014	8/1958	Tennis	137/624.27
2,985,147	5/1961	Rockwell	137/624.27
3,088,489	5/1963	Stacey	251/297 X
3,132,668	5/1964	Stacey	137/624.27
3,247,768	4/1966	Tennis	137/624.27 X
3,511,276	5/1970	Jessen et al.	137/624.27
3,680,583	8/1972	Clair	137/624.27 X

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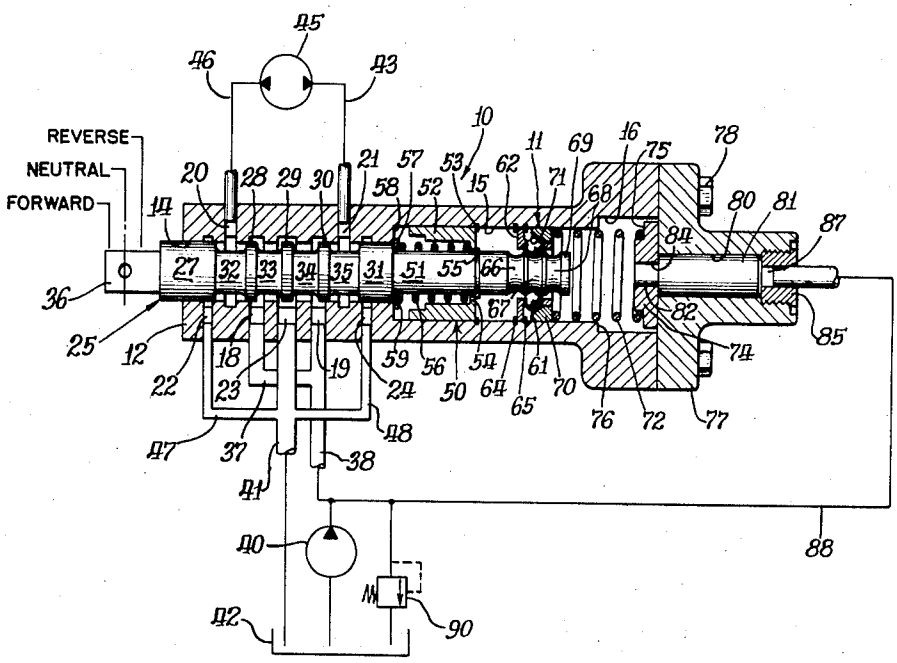
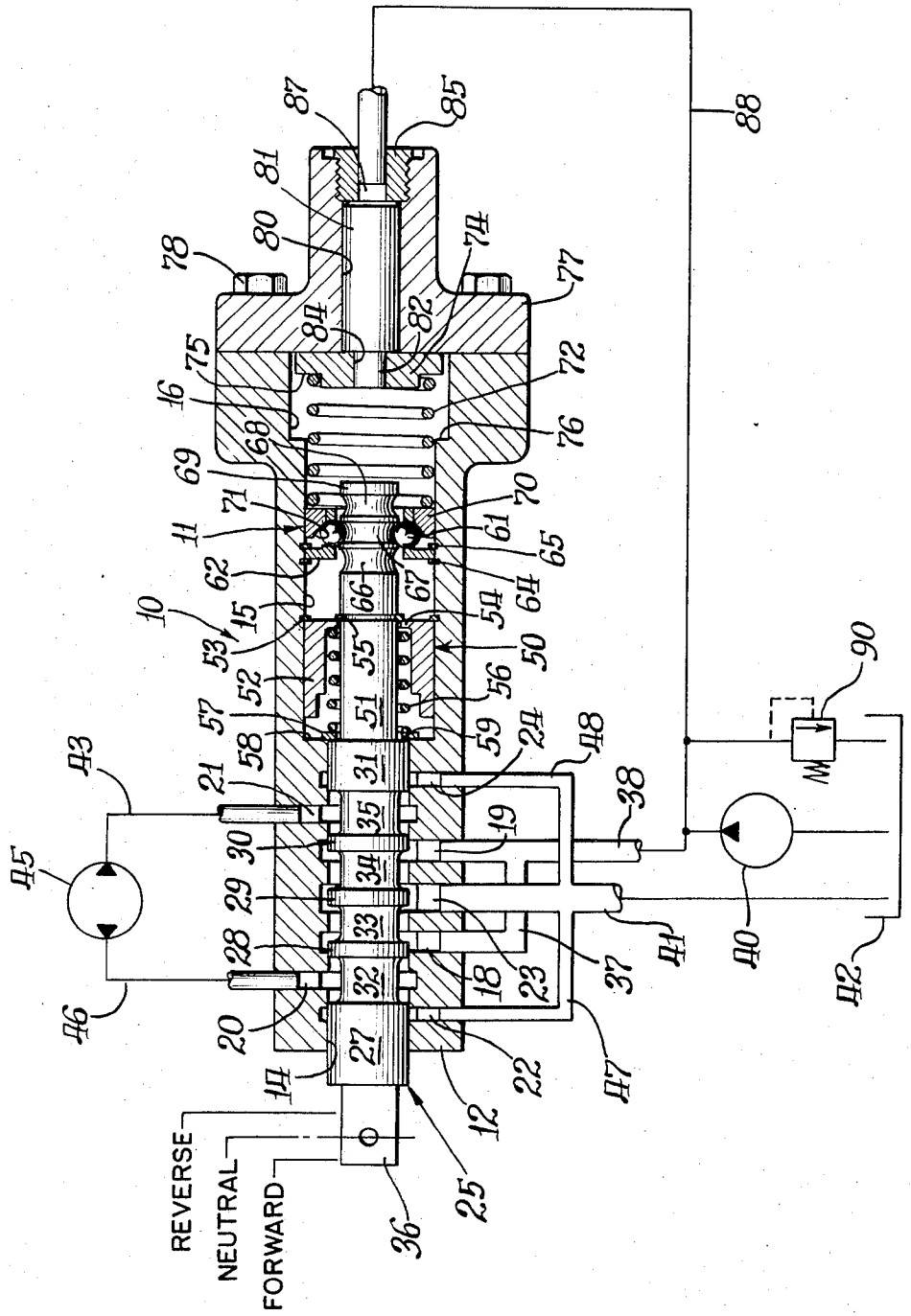
[57] **ABSTRACT**

A fluid control spool valve for directing operating fluid from a high pressure source for moving a fluid-operated motor in forward or in reverse is disclosed. The valve automatically moves to neutral position upon loss of fluid pressure by the operation of a centering spring that is adjusted to move the spool to neutral position when a pressure responsive detent becomes nonfunctional. A second spring maintains the detent operative when the operating fluid is at high pressure but makes the detent inoperative when the operating fluid is at low pressure whereupon the spool is automatically moved to a neutral position.

7 Claims, 1 Drawing Figure




REVERSE
NEUTRAL
FORWARD

VALVE ASSEMBLY HAVING A PRESSURE RESPONSIVE DETENT MECHANISM

BACKGROUND OF THE INVENTION

Fluid driven motors are controlled by fluid control systems that employ an operating fluid to effect movement of the motors. Motors driving blades of elevation scrapers, for example, must be moved up and down as well as being retained in a fixed position during operation. Accordingly, the operating fluid must be selectively routed to forward, to reverse and to neutral or non operating position for the motor. For this purpose a directional control spool valve is usually used.

The spool valves usually include a housing having a bore with internal grooves that may be either interconnected to a source of high pressure fluid or blocked from that source by axial movement of the spool which is also provided with grooves that are positioned to engage or to bridge lands separating the grooves within the housing.

In operating devices such as elevating scrapers, it is beneficial if the spool is moved to its desired position by movement of a shifting lever after which a detent mechanism will hold the spool in the desired position so that the operator's hands will be free for duties such as steering. Many such detent mechanisms which hold the spool against self-movement but are easily overcome by the force exerted by the operator's movement of a control lever are known.

The engine that drives the vehicle is usually employed as the source of power to maintain pressure in the operating fluid. If an engine stops so that fluid pressure is lost, it is more difficult to start the engine when the fluid motor is in forward or reverse because of the extra load on the engine. A more serious problem is that when the fluid motor is in operative position during start-up of an engine, the engine speed at start-up is reduced at a range where damage is done to the engine or at speeds where the resonant frequency of the drive line components is produced which often results in failure of one or more of these components.

The prior art is exemplified by the following U.S. Pat. Nos.:

Number	Date	Inventor
2,848,014	8-19-58	Tennis
3,438,399	4-15-69	Barnes
3,511,276	5-12-70	Jessen
3,602,245	8-31-71	Meisel
3,618,984	11-9-71	Cook
3,698,583	10-17-72	Niles

and the following British Specification No.: 1,311,897.

SUMMARY OF THE INVENTION

This invention comprises a directional control spool valve which overcomes the above-noted problems by providing a detent that maintains the spool of a spool valve in any selected operating position while there is adequate pressure in the operating fluid but which automatically places the spool in neutral position when the pressure of the operating fluid is inadequate, such as when the driving engine stops. The valve of this invention includes the usual valve housing having a fluid inlet and at least three fluid outlets and the internal grooves and lands that are positioned to coact with the grooves in the valve spool upon axial movement of the spool so that the high-pressure fluid from the inlet can be directed to drive the fluid-operated motor in a forward or reverse direction, or it may be directed away from the motor to effect a neutral condition.

Within the valve housing and surrounding the spool, a spool centering device that comprises a slidable spring-containing housing positioned to slide between two extreme positions of engagement with the valve housing. The spring-containing housing includes a compression spring and is engaged by the spool to move it toward one position of engagement with the valve housing when the spool is moved in one direction.

A detent mechanism is provided to hold the spool against movement by the above-described spring in a forward, a reverse or a neutral position. The detent mechanism includes means urged into receiving grooves by a spring which operates between a high spring force position and a low spring force position, and at the high spring force position the detent is urged so strongly into the detent device receiving grooves that it is locked against being moved by the centering spring. However, when there is low spring force as a result of loss of fluid pressure, the detent is not able to retain the spool against movement of the force of the centering spring. The centering spring is positioned and operative to normally bias the spool to neutral.

BRIEF DESCRIPTION OF THE DRAWING

The accommpanying Drawing illustrates a sectional view of a valve embodying the present invention shown in a schematic of a fluid circuit.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to the Drawing, a valve generally indicated by the numeral **10** includes a detent mechanism generally indicated by the numeral **11.** The valve includes a valve body or housing **12** which is provided with stepped bores **14, 15** and **16.** The housing **12** is provided with inlet ports **18** and **19** for communicating high-pressure operating fluid to the bore outlet ports **20** and **21** for distributing high-pressure operating fluid to a fluid-operated motor **45** and outlet ports **22, 23** and **24** for returning high-pressure operating fluid to a storage tank or sump **42.** A valve spool **25** is reciprocably mounted within bore **14** and is provided with lands **27,** 28, 29, 30 and **31** formed in the spool which define annular grooves **32, 33, 34** and **35** between them for controlling the communication of fluid between the inlet and outlet ports. The spool protrudes beyond the housing **12** and is provided with a stem **36** for attaching the spool to a manually actuating lever which is not shown that is suitable for use by an operator for moving the valve spool to its forward, reverse or neutral positions, indicated on the drawing.

High-pressure fluid is supplied to inlet ports **18** and **19** by a pump **40** which communicates to the inlet ports through a pair of branched conduits **37** and **38.** When the spool **25** is in neutral position, the high-pressure fluid passes through bore **14** via the annular recesses **33** and **34** and is returned to the fluid storage tank **42** through outlet port **23.** A return conduit **41** connects port **23** with the fluid storage tank **42.** When the valve spool is moved to the forward position, the annular groove **35** permits fluid at high pressure to pass from inlet port **19** to the outlet port **21** which is connected by a conduit **43** to the fluid-operated motor **45.** The motor is adapted to move in the forward direction

when operating fluid at high pressure passes through conduit **43.**

Typically, a hydraulic motor will elevate a blade of an elevating blade scraper when the spool **25** is in the forward position. Fluid exhausted from the motor passes through the motor, through a conduit **46** and enters port **20** which is in communication through annular groove **32** with the port **22** which is connected through a branch conduit **47** to conduit **41** and ultimately to the storage tank **42.** When the spool is in the forward position, fluid pressure cannot enter the housing through inlet port **18** because it is blocked by the lands **28** and **29.**

When the valve spool **29** is moved to the reverse position, fluid pressure at the inlet port **18** is communicated with the outlet port **20** through the annular groove **32** which in turn provides high-pressure fluid to the motor **45** through the conduit **46.** The motor will then move in the reverse direction, for example, lowering the blade of an elevating blade scraper. Fluid exhausted by the motor is carried through conduit **43** to the port **21,** through the spool valve **10,** through passage **24** and returns to tank **42** through a conduit **48** which connects with conduit **41.** In the reverse position the fluid pressure at inlet port **19** is blocked by lands **29** and **30.**

The centering device of this invention is generally indicated at **50.** The centering device is disposed in the bore **15,** and it surrounds a portion of the spool **25** that is of reduced diameter as compared with the portion in bore **14.** The centering device includes a slidable, spring-containing housing **52** that moves within bore **15.** A snap ring **53** is provided to limit the distance that the housing **52** may slide by causing it to engage the valve housing **12.** An inwardly extending flange **54** formed on one end of the sleeve is positioned so that its outer side engages a second snap ring **55** disposed in a groove formed in a reduced diameter portion **51** formed on the spool **25.** The inner side of the flange engages one end of a helical spring **56,** and the other end of that helical spring abuts an annular retaining ring **57** which abuts both the valve housing **12** at a shoulder **58** and the spool **25** at a shoulder **59.** As thus described, movement of the spool **25** to the reverse position causes spring **56** to be compressed because annular retaining ring **57** moves to the right, while moving the spool to the forward position causes the spring **56** to be compressed by moving spring-containing housing **52** to the left. Consequently, the spring **56** urges the spool to its neutral position from either direction of movement.

The detent mechanism generally indicated at **11** includes a number of balls **61** which are retained in the axial position by a carrier or fixed ring member **62.** The carrier **62** is rigidly held between a pair of snap rings **64** and **65** so that it is not axially movable with respect to the bore of the valve housing **12.** Three grooves **66, 67** and **68** are formed on an extension **69** of the valve spool, and these grooves are shaped to receive the balls **61** and are positioned on the extension of the valve spool to hold the valve spool in a suitable position for forward, reverse or neutral as described above. An annular camming ring **70** is slidably mounted about the extension **69** of the valve spool within the bore **15.** The ring **70** is provided with a substantially conical face defining an inclined camming surface **71** which is in contact with the balls **61** and adjacent to the carrier **62.** A compression spring **72** is positioned in the largest bore **16** and extends into bore **15** so that it exerts force against the ring **70.** The opposite end of the spring **72** is held in a retainer **74** which is positioned to slide axially within the bore **16.** The retainer **74** has a flange **75** positioned to engage the spring **72** and to maintain a snug fit within the bore **16** and also to serve as stop means. An end cap **77** is mounted to the valve body **12** by bolts **78** to close the outer end of the bore **16.** The end cap is provided with a bore **80** in which a piston **81** that works against the spring retainer **74** is maintained. A stem **82** of the piston **81** fits in an aperture **84** in the retainer **74** to aid in the alignment of these movable members. The retainer preferably is fixed on the stem **82** firmly with a press fit.

An inlet passage **87** is provided through the end cap **77,** shown herein as through a threaded plug **85.** A conduit **88** supplies pressurized fluid from the pump **40** to the inlet passage **87** so that the fluid may act against the piston **81** to compress the spring **72** when the fluid is under high pressure. A conventional pressure relief valve **90** is associated with the conduit **88** to avoid damaging pressure in the fluid system by releasing high pressure fluids back to the storage vessel **42.**

In operation, the pressure of the fluid at inlet **87** is transmitted to the piston **81** causing it to move against retainer **74** to compress the spring **72.** Spring retainer **74** is limited in its motion from its position as shown in the drawing to a position where it abuts against a shoulder **76** of the valve housing **12.** When abutting shoulder **76,** the force exerted by spring **72** against annular ring **70** is such that balls **61** are locked into one of grooves, **66, 67** or **68** with sufficient force to prevent the spool **25** from moving because of the action of the spring **56.** The detent involving balls **61** and one of the grooves **66, 67** or **68** is not held with sufficient force, however, to lock the motion of spool **25** against manual operation of a lever to change the spool's position among the forward, reverse and neutral positions. Manual operation of a shifting lever places sufficient force on the spool **25** to compress the spring **72** even further so that balls **61** may move apart enough to enter a different groove.

Upon loss of fluid pressure in line **88,** the spring **72** expands fully, and in that position it exerts insufficient force on the annular ring **70** and balls **61** to lock the spool in position against the force of the spring **56.** Spring **72** may preferably be completely relaxed when expanded fully. As mentioned hereinabove, the centering spring **56** is compressed when the spool is in either forward or reverse position. Upon loss of fluid pressure in the system, the fluid pressure in line **88** diminishes so that the spring **72** can expand against the piston **81.** It accordingly pushes retainer **74** back into contact with end cap **77** and the force exerted by the spring **72** is diminished to the point where the spool **25** is not locked against the action of the compressed spring **56.** As a result of the foregoing, upon loss of pressure in the fluid system, spring **56** expands and by this action it automatically places the spool in a neutral position so that high-pressure flud entering the valve via ports **18** or **19** is returned to the reservoir **42** via port **23** without passing through the motor **45.** This action will take place whether the spool was in forward or reverse position upon loss of fluid pressure. If the spool was in neutral position when fluid pressure was lost, it will remain in neutral.

Thus, the valve of the present invention includes a fluid pressure responsive detent mechanism that holds

the valve in forward, reverse or neutral position against any movement other than that deliberately effected by an operator when there is operational fluid pressure in the system. If the system loses fluid pressure, the spool valve automatically moves to neutral position thereby avoiding restarting problems and the problems associated with resonant frequencies in linkages. Upon restarting the engine, the detent mechanism is reactuated and holds the valve firmly in neutral position until it is moved to forward or reverse position by the deliberate act of an operator.

It will also be readily appreciated that the pressure responsive detent mechanism is a desirable safety feature in that it prevents the valve from being in an actuated position when the engine is started. Being in an actuated position presents a possible hazard to men working on or around the vehicle because the motor controlled by the valve may start unexpectantly as the engine is started.

What is claimed is:

1. A hydraulic valve assembly comprising:

a valve body having a cylindrical bore and fluid inlet and outlet openings communicating with said bore;

a spool reciprocably disposed in said bore and movable to at least a first operating position to effect communication between said inlet and outlet openings, and to a neutral position to block said communication;

centering spring means for biasing said spool to said neutral position; and

pressure responsive detent means disposed in said valve body and responsive to a predetermined operating fluid pressure to hold said spool in said operating position against the force of said centering spring, and operative in response to a drop in said fluid pressure below said predetermined pressure to release said spool for movement by said centering spring to neutral position,

said detent means comprising a plurality of annular grooves extending around the outer diameter of said spool, a plurality of balls mounted in said valve body surrounding said spool for engagement with said grooves, reciprocal annular camming means extending around said spool externally thereof for engaging and biasing said balls into said grooves, and piston means mounted in said housing and responsive to fluid pressure for biasing said annular camming means into camming engagement with said balls, including resilient means connecting said piston to said annular camming means.

2. The valve assembly of claim **1** wherein said piston means is mounted externally of said spool and axially thereof.

3. The valve assembly of claim **2** comprising a fixed ring member fixed in said bore concentric with said spool adjacent said annular grooves;

said annular camming means comprises a cam ring member having a substantially conical face on one side thereof; and

said balls are confined between said fixed ring member and said substantially conical face of said cam ring member.

4. The valve assemby of claim **3** wherein said resilient means comprises a compression spring.

5. A hydraulic valve assembly comprising:

a valve body having a cylindrical bore and fluid inlet and outlet openings communicating with said bore;

a spool reciprocably disposed in said bore and movable to at least a first operating position to effect communication between said inlet and outlet openings, and to a neutral position to block said communication;

centering spring means for biasing said spool to said neutral position;

pressure responsive detent means disposed in said valve body, responsive to a predetermined operating fluid pressure to hold said spool in said operating position against the force of said centering spring, and operative in response to a drop in said fluid pressure below said predetermined pressure to release said spool for movement by said centering spring to neutral position,

said detent means comprising a plurality of annular grooves extending around said spool, a plurality of balls mounted in said valve body surrounding said spool for engagement with said grooves, and camming means including an annular cam member reciprocably mounted in said bore and having an inclined surface engaging and biasing said balls into said grooves, a fluid pressure responsive piston mounted in said valve body, and spring means connecting said piston to said annular cam member.

6. The valve assembly of claim **5** comprising an annular shoulder disposed in said bore, and said balls confined between said shoulder, said spool and said annular cam member.

7. The valve assembly of claim **5** comprising stop means for limiting the movement of said piston.

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