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MANUALLY ACTUATED POSITIONING CONTROL SYSTEM

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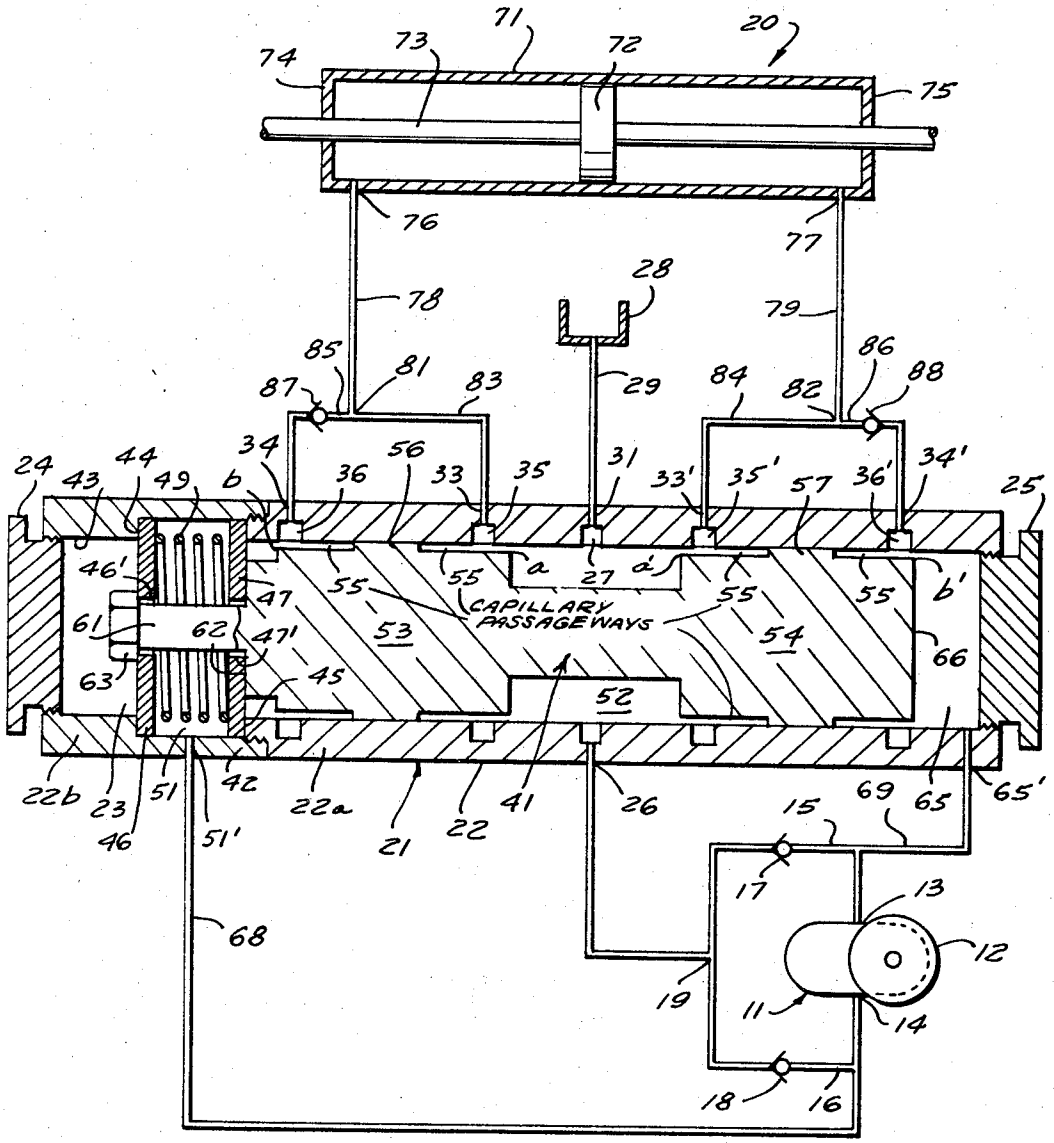

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3,402,553 MANUALLY ACTUATED POSITIONING CONTROL SYSTEM

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4 Claims. (Cl. 60—52)

This invention relates to the art of positioning controls and more particularly to a steering system.

It is among the objects of the invention to provide a positioning control system designed to effect alternate positioning of a movable member, which system may be manually actuated and which has relatively few parts which are not likely to become deranged and which when the steering wheel is not actuated will automatically cut off flow to and from the actuator effecting the steering action without changing the set position of the actuator controlled by the steering wheel.

According to the invention, these objects are accomplished by the arrangement and combination of elements hereinafter described and more particularly recited in the claims.

In the accompanying drawings the single figure illustrates one embodiment of the invention.

Referring now to the drawings, the system comprises a pump unit **11** of conventional type such as a bi-directional volumetric metering pump, put out by the Ross Gear & Tool Company of Lafayette, Ind. The pump unit **11** is controlled by a steering wheel **12** so that depending upon the direction of rotation of the steering wheel, fluid under pressure will be provided at the ports **13** or **14** respectively of said pump.

The ports **13** and **14** are connected respectively by lines **15** and **16** through one-way valves **17** and **18** to junction **19**, the one-way valves being positioned so that they will permit flow only from the junction **19** to the respective ports **13** or **14** as the case may be.

The pump **11** is designed to control a hydraulic control valve **21** which in turn controls the flow of fluid under pressure to an actuator **20**.

The distributor valve **21** comprises a cylindrical casing **22** having a bore **23** therethrough, the ends of which are closed by end plugs **24, 25**.

The casing **22** has a discharge port **26** located substantially centrally of the length thereof, said discharge port **26** being in communication with an internal annular groove **27** in the bore of said casing. A reservoir **28** is connected by line **29** to a fluid inlet port **31** also in communication with said annular groove **27**. The casing **22** also has two pairs of ports **33, 34** and **33', 34'** positioned respectively on opposite sides of the annular groove **27**, the ports **33, 33'** defining control outlet ports and the ports **34, 34'** defining control inlet ports. The bore of the casing **22** has a plurality of annular grooves **35, 36** and **35', 36'** aligned respectively and in communication with the ports **33, 34** and **33', 34'**.

Slidably mounted in the casing **22** of distributor valve **21** is a valve member or spool **41** which is normally retained in the neutral position shown. To this end, the casing **22** is formed from two parts, i.e., parts **22*a*** and **22*b***. One end of part **22*a*** is of reduced external diameter and is externally threaded to receive the correspondingly threaded end of part **22*b*** as at **42** and said part **22*b*** is of reduced diameter adjacent its free end as at **43** defining an annular shoulder **44**.

Positioned in the casing part **22*b*** and seated against annular shoulder **44** and the annular shoulder **45** defined by the reduced diameter end of part **22*a***, are washers **46** and **47**, each of which has a central opening **46'** and **47'** therein. The washers are normally retained against the associated shoulders **44** and **45** by an intervening coil spring **49**, the portion of said part **22*b*** between the washers defining a pressure chamber **51**. In addition to the chamber **51**, a second chamber **65** is provided between the end plug **25** and the adjacent end **66** of the valve member **41**.

The valve member **41** has a central annular groove **52** defining two spaced end portions **53, 54**. As is shown in the drawing, the end portions **53, 54** each has an annular groove **55** at each end thereof defining a sealing rim **56, 57** therebetween, the sealing rims **56, 57** being of outer diameter just slightly less than the inner diameter of bore **23** of the casing **22** to define a high precision sliding seal. The depth of each of the annular grooves **55** is extremely small so that said grooves define capillary passageways.

The length of each of the end portions **53, 54** is such that with the valve member **41** in the neutral position shown, the inner edges *a, a'* of each of the end portions **53, 54** respectively, will extend inwardly beyond the associated annular grooves **35, 35'** and the outer ends *b, b'* of each of said end portions **53, 54** will extend outwardly beyond the associated annular grooves **36, 36'**, the inner ends *a, a'* extending beyond the associated annular grooves **35, 35'** by an amount greater than the outer ends *b, b'* extend beyond their associated annular grooves **36, 36'**.

It is to be noted that the capillary grooves **55** are of such small size that when the valve member **41** is in neutral position shown, there will be substantially no flow through the ports **33, 34** and **33', 34'**.

The portion of the valve member **41** adjacent the end *b* thereof has an axially extending stem **61**, defining an annular shoulder **62** adapted to abut against the washer **47**. The stem **61** is of diameter considerably smaller than that of the openings **46', 47'** in the washers and extends through both of said washers with ample clearance, a nut **63** being screwed on the free end of said stem on the outer side of said washer **46** to act as an abutment in the manner hereinafter to be described.

Each of said chambers **51, 65** has a port **51', 65'** leading thereinto, said ports being connected respectively by lines **68, 69** to the ports **14** and **13** of the pump **11**.

The hydraulic actuator **20** comprises a cylindrical casing **71** having a piston **72** slidable therein. A piston rod **73** connected to said piston extends axially through both ends **74, 75** of said actuator **20** and is designed to actuate the device to be operated. The actuator **22** has two ports **76, 77** located respectively on opposed sides of the piston and connected respectively by lines **78** and **79** to junctions **81, 82**. Each of the junctions **81, 82** is connected by lines **83, 84** to the associated control outlet port **33, 33'** and by lines **85, 86** through one-way valves **87, 88** to the control inlet ports **34, 34'** respectively, the valves **87, 88** permitting flow only in direction from said control inlet ports.

In the operation of the system shown in FIG. 1, when steering wheel **12** is rotated it will create a differential between the pressure at ports **13** and **14** and, for example, a greater pressure at port **13** than at port **14**. As a result of the lower pressure at port **14**, fluid from reservoir **28** will flow through line **29** into annular groove **52** and then from discharge port **26** to junction **19** and through one-way valve **18** and line **16** into port **14** to furnish a constant supply of oil to the system. At the same time, due to the higher pressure developed at port **13**, there will be a flow of fluid under presusre through line **69** into port **65'** of the distributor valve and into pressure chamber **65** thereof to react against the end **66** of the valve member **41**.

Due to the capillary passageway **55**, there will be high pressure in such passageway, but no flow and the same

high pressure with no flow will appear in the capillary pasageway **55** on the left side of the sealing rim **57** due to the one-way valve **88** and lines **86, 84**. As a result, since the pressure on both sides of the sealing rim **57** will be the same, the end portion **54** will not be laterally displaced and hence free movement of the valve member is permitted, since friction is minimized.

When the pressure in chamber **65** rises sufficiently to overcome the force exerted by coil spring **49**, the valve member **41** will then move to the left. As soon as the end *b'* of the valve member moves slightly past annular groove **36'**, there will be a slight cracking of the annular groove **36'** so that flow will be permitted therethrough. It is to be noted that since the end *a* of the end portion **53** extends inwardly beyond annular groove **35** an amount more than the end *b'* of end portion **54** extends outwardly beyond annular groove **36'**, the annular groove **36'** will crack before the annular groove **35** will crack. Since the gas contained in the actuator **20** is generally about 10% of the volume thereof when the latter is in neutral position there will be a slight flow of fluid through port **34'**, one-way valve **88**, line **79** into port **77** of the actuator to compress the gas therein but there will be no flow of fluid from port **76** of the actuator at this time since port **33** is still closed.

With further rotation of the steering wheel **12**, there wlil be corresponding greater buildup of pressure in chamber **65** and hence further movement to the left of the valve member **41** sufficient to cause the annular groove **35** to crack slightly. As a result, the fluid in the actuator on the left side of the piston **72** thereof will then be forced through port **76**, lines **78** and **83** into annular groove **35** and thence into annular groove **52** through discharge outlet **26** to junction **19**, through one-way valve **18** and line **16** back to the port **14** of the pump **11**.

By reason of the one-way valve **88**, for example, when the annular groove **36'** is open and the piston **72** is moving to the left, if the member controlled by the piston rod **73** should strike an obstruction so that there is a momentary stoppage of movement, no back flow or reaction can occur since the valve **88** will close. As a result, there will be no transmittal of the road reaction to the steering wheel since any back flow will be restrained by the one-way valve **88**. This is particularly desirable when the tractor, for example, being steered is very heavy and slow moving. Where the tractor is light and is capable of higher speeds then road reaction would be desirable and the one-way valves **88, 87** could be removed.

It is to be noted that when the pump is turned in the reverse direction there will be a pressure buildup in chamber **51** and due to the relatively large opening **47'** in washer **47**, fluid will flow through said opening to react against the associated end of the valve member **41**. The operation, when the steering wheel is turned in the reverse direction, is identical to that previously described, except that fluid under pressure will then flow into the port **76** of the actuator **22**.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope of the claims, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. A position control system comprising a reversible hydraulic actuator having a pair of control ports, a source of fluid under pressure comprising a reversible pump having two fluid ports, a distributor valve interposed between said control ports of said actuator and said source of fluid under pressure, said distributor valve comprising a casing having a bore therethrough, a valve member slidably mounted in said bore, said valve member comprising a substantially cylindrical spool having a substantially central annular groove defining two end portions, each end portion having a reduced diameter annular portion at each of its ends defining a central rib therebetween, each of said reduced diameter portions defining a capillary passage, said distributor casing having two pairs of longitudinally positioned control ports, said reduced diameter portions on each end portion of said spool being aligned with the respective pairs of control ports when the valve member is in neutral position to close said ports, means normally retaining said valve member in neutral position to cut off flow of fluid into and out of the control ports of said valve member, said casing having a pair of control chambers operatively connected respectively to the fluid ports of said pump and in communication with opposed ends of said valve member to effect movement of the latter when the pressure in one of said chambers exceeds a predetermined amount, means connecting the control ports of each pair to an associated actuator control port, means connecting the pair of capillary passages on each of the end portions of said spool, whereby when pressure is applied from said source of fluid to said chambers, the capillary passages, when in alignment with the control ports, will prevent flow of fluid through said control ports, but provide equal pressure on both sides of the associated rib thereby to balance the ends of the spool to minimize friction between the ribs and the bore of the casing, said valve member being conformed to connect said source of fluid under pressure applied to one of said chambers to one of said control ports of said actuator when the pressure in such chamber exceeds a first predetermined amount to effect a corresponding movement of said valve member, while restraining flow of fluid under pressure from the other control port of said actuator until the pressure in such chamber has exceeded a second predetermined amount to effect further movement of said valve member.

2. The combination set forth in claim **1** in which a one-way check valve is connected between the outermost control port of each pair of control ports of the distributor valve and the associated control port of the actuator to permit flow only from the distributor valve control port to the actuator control port.

3. The combination set forth in claim **1** in which a line connects the two fluid ports of said pump, a pair of one-way check valves positioned in said line, said casing having a pair of additional ports between said control ports, said additional ports being aligned with said central groove in said spool, a reservoir connected to one of said additional ports, said other additional port of said distributor valve being connected to said line between said valves, said valves permitting flow only in direction from said other additional port to the fluid ports of said pump.

4. The combination set forth in claim **1** in which resilient means are provided normally retaining said valve member in neutral position.

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