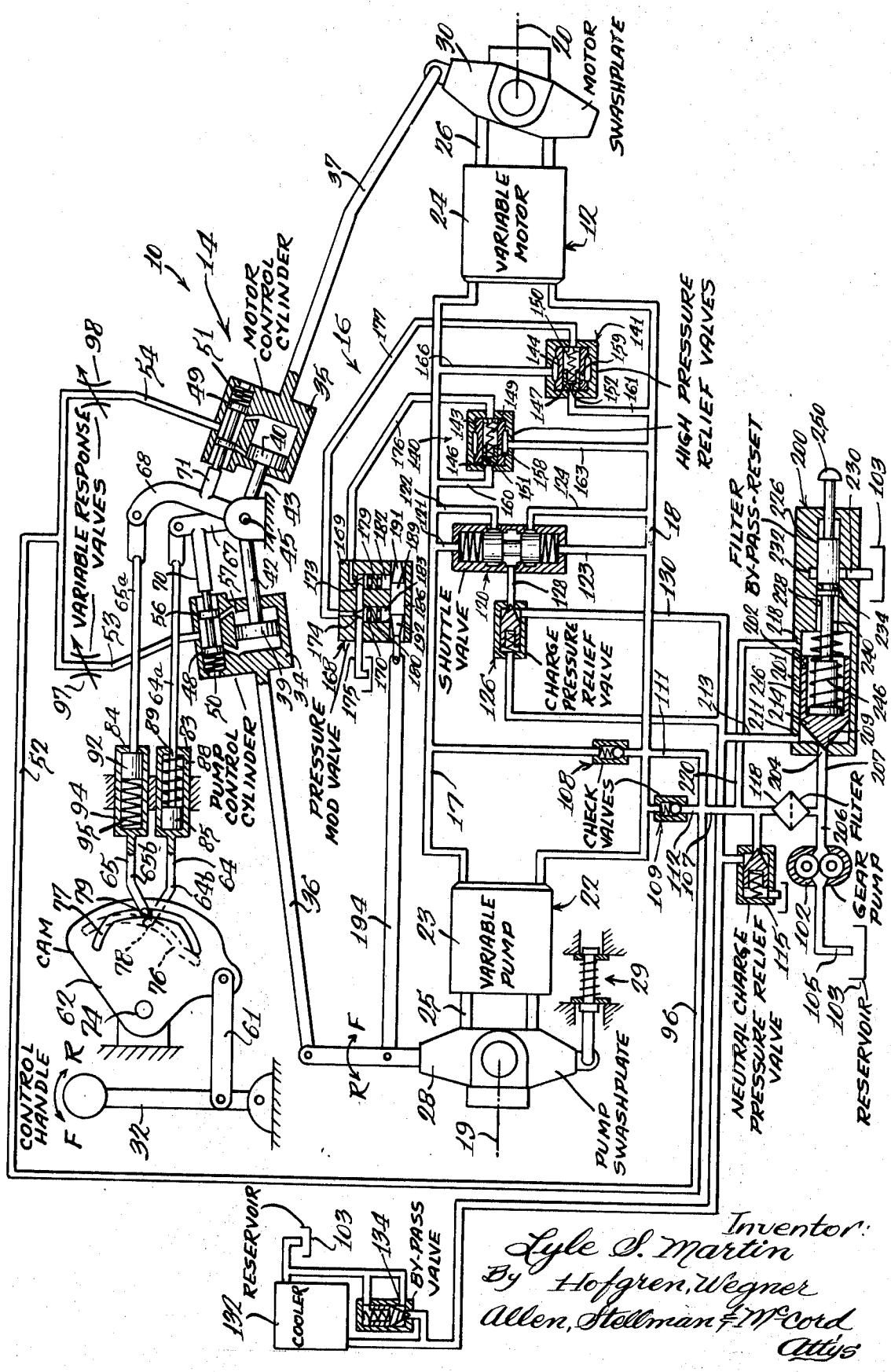
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HYDROSTATIC TRANSMISSION

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HYDROSTATIC TRANSMISSION

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ABSTRACT OF THE DISCLOSURE

A filter bypass valve for bypassing fluid from the charge and control pump of a hydrostatic transmission around a clogged filter to a drain including a differential pressure valve member normally blocking communication between the charge pump and the drain and biased to its closed position by pressure downstream of the filter so that the differential pressures acting on the valve when the filter becomes clogged cause valve opening with the valve remaining in its open position directing fluid to the drain to prevent contamination of the associated hydraulic circuits.

BACKGROUND OF THE INVENTION

Hydrostatic transmissions are known to include hydraulic pumps which supply fluid through a closed hydraulic circuit to a hydraulic motor connected to drive an output shaft. It is conventional in this field to provide a charge pump, such as a small gear pump, for supplying make-up fluid to the hydraulic circuit interconnecting the pump and the motor to replace leakage fluid. The transmission ratio of these hydrostatic transmission is oftentimes controlled by varying the displacement of one or both of the pump and motor, and this is frequently done through the use of a hydraulic control circuit. The control circuit is usually supplied control fluid from the same pump that supplies make-up fluid to the main hydraulic circuit.

To prevent contamination of these hydraulic circuits a filter is provided for cleaning the fluid prior to delivery to these circuits. In the past it has been conventional to provide a filter on the inlet side of this charge pump. When the filter became clogged, the pressure at the pump inlet would drop and this pressure drop has been used in various ways to indicate or signal that a change in filter was necessary. This arrangement has several disadvantages. Firstly, the contamination from the charge pump itself is never filtered since the filters are on the low pressure side of the pump. Secondly, on cold days these pump inlet filters, sometimes referred to as vacuum filters, present too much resistance to the flow of charge control fluid to the pump. Another disadvantage is that the placement of a filter on the low pressure side of the pump requires the use of a larger filter than required in circuits where the filter is placed on the outlet or high pressure side of the charge or control pump.

Therefore, it is preferable to locate the charge and control pressure filter on the outlet side of the pump. The prior circuits which have done this have either had no bypass circuitry at all or have had a bypass directly to the control and main circuit. This has the obvious disadvantage of taking dirt and other foreign particles from directly behind the filter through the bypass and into the control and hydraulic circuits when the filter becomes clogged.

SUMMARY OF THE PRESENT INVENTION

In accordance with the present invention, a filter bypass valve is provided which directs the flow from a charge and control pump to drain when a filter in the pump outlet becomes clogged. It becomes effective in response to an increase in pressure at the charge pump outlet between the pump and the filter. The valve includes a movable valve member which operates on a differential pressure principle, and is biased in a valve opening direction by fluid pressure upstream of the filter and is normally biased to a closed position by fluid pressure downstream of the filter. When the pressure at the charge pump outlet rises and the pressure downstream of the filter drops to values indicating a clogged filter, the force acting on the opening side of the valve increases and opens the valve. This exposes an increased area of the valve to fluid pressure and causes further valve opening movement to communicate the charge pump flow with drain.

DESCRIPTION OF THE DRAWINGS

The drawing is a schematic illustration of a hydrostatic transmission according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings a hydrostatic transmission **10** is seen to include a reversible variable displacement pump **11**, a variable displacement motor **12**, a displacement control **14** for the pump and the motor, and a system pressure control **16**. The pump **11** and motor **12** are interconnected by a closed hydraulic circuit including main conduits or passages **17** and **18**. The pump **11** is adapted to be driven by a shaft indicated schematically at **19** connected with the prime mover of the associated vehicle (not shown). The variable displacement motor drives an output shaft **20** which is adapted to be connected through suitable gearing to the vehicle's propelling wheels or tracks.

Preferably both the pump and the motor are of an axial piston type having rotatable cylinder blocks **23** and **24**, respectively, each with a plurality of cylinders in annular array and reciprocal pistons **25** and **26** (indicated schematically), respectively, having ends reciprocating in the cylinders. The pump **11** has a variable angle reversible swashplate **28** engaged by the projecting ends of pistons **25** for controlling the speed as well as direction of rotation of the output shaft **20**. The swashplate **28** is urged to a neutral center position by a spring mechanism **29**. The motor has a variable angle swashplate **30** movable only on one side of a minimum displacement position.

The displacement control **14** selects the displacement of the pump and the motor, and hence transmission ratio, in accordance with the manually adjusted position of a control handle **32**. The swashplates **28** and **30** are positioned by control cylinders **34** and **35** through links **36** and **37**, respectively. These cylinders are slidable on pistons **39** and **40** having rods **42** and **43** pivoted at **45**. For supplying fluid to the cylinders **34** and **35** control valves **48** and **49** are provided slidable in suitable valve bores formed in the cylinders **34** and **35**, respectively. Control fluid under pressure is delivered to the valves **48** and **49** through control passage **52** and branch passages **53** and **54**. As the valves **48** and **49** shift from the position shown in FIG. 1 fluid will be ported from one of the control fluid lines to one or the other side of the associated pistons in the cylinders causing corresponding movement of the cylinders and the swashplates connected thereto. Both of the control cylinders **34** and **35** act as follow-up mechanisms relative to their servo valves **48** and **49**. As the cylinders move in response to the porting of fluid across their associated control valves, they will travel to a position where one of the lands as at **56** will close a control passage **57** arresting movement of the control cylinder and the swashplate associated therewith. Since the control cylinders act as follow-up mechanisms, as system pressure changes cause variations in force on the

swashplates, the control valves 48 and 49 will automatically adjust the pressure in their associated control cylinders to hold the swashplates in their preselected positions.

The control valves 48 and 49 are positioned by the control handle 32 through link 61, pivotally mounted cam 62, longitudinally slidable links 64 and 65, and pivotally mounted links 67 and 68 pivotal about pivot 45 and arranged to control the valves 48 and 49 by arms 70 and 71, which abut the ends of the valve stems. Springs 50 and 51 bias the valve stems 48 and 49 to follow abutments 70 and 71.

The cam 62 is pivotally mounted at 74 and has a pump control slot 76 and a motor control slot 77 receiving followers 78 and 79 on the ends of links 64 and 65, respectively. As the cam 62 is pivoted by movement of the control handle 32 the links 64 and 65 are moved longitudinally in accordance with the shape of the cam slots 76 and 77. These slots have a configuration such that as the control handle is moved from its neutral position shown towards maximum displacement in either direction the pump swashplate 28 will move towards maximum displacement with the motor swashplate remaining in its maximum displacement position, and with further movement of the control handle in the same direction the motor swashplate 30 will begin movement towards minimum displacement when the pump swashplate 28 reaches or nears its maximum displacement position.

Ovrride assemblies 83 and 84 are provided in the links 64 and 65, respectively, to allow the operator to rapidly move the control handle 32 from full forward to full reverse and vice versa. In the event of a loss of control pressure the override springs will also serve to protect the links from damage. The override assembly 83 includes a piston 85 fixed to the end of link 64*a*, and link portion 64*b* has a cylinder 88 formed on the end thereof receiving piston 85. A spring 89 within the cylinder 88 biases the piston 85 to the end of cylinder 88 opposite the link 64*a*. Spring 89 permits rapid movement of link 64*b* to the left, while abutment 70 and spring 50 permit rapid movement to the right.

The override assembly 84 includes a piston 92 fixed to the end of link portion 65*a* slidable in a cylinder 94 carried on the end of link portion 65*b*, and a spring 95 within the cylinder 94 biasing the piston 92 to the end of the cylinder adjacent the link 65*a*. Spring 95 permits rapid movement of link 65*b* to the right, while abutment 71 and spring 51 permit rapid movement toward the left.

Thus, if the pump control link 64 is moved too rapidly to the left tending to move valve 48 to the left beyond a position which can be accommodated by the associated valve bore in cylinder 34 the link 64 will resiliently extend. At the same time, abutment 71 leaves stem 49, and spring 51 urges the stem leftward. Conversely, if the link 65 is moved too rapidly to the right tending to cause movement of the control valve 49 to the right beyond a position which can be accommodated by the associated valve bore in cylinder 35, the link 65 will yield. At the same time, abutment 70 may leave stem 48 to be moved by spring 50. While the cam slots 76 and 77 normally stage the displacements of the pump and the motor, it is possible when the handle is moved rapidly and the override assemblies 83 and 84 come into play, for the pump and motor control cylinders 34 and 35 to act simultaneously along with the swashplates 28 and 30.

Variable restrictions 97 and 98 are provided in branch lines 53 and 54, respectively, for selectively controlling the response rate of the servo cylinders 34 and 35.

A positive displacement gear-type replenishing and cooling pump 102 is provided and is driven by suitable means by the engine or prime mover in the associated transmission. This pump is in communication with a reservoir 103 through a conduit 105 for supplying replenishing and cooling fluid to the system through a replenishing and control fluid conduit 107. The capacity of the pump is sufficient to replace leakage fluid, to supply control fluid to the valves 48 and 49 through passage 96, and to supply cooling fluid to the circuit in excess of that required for the aforementioned purposes in order to maintain the transmission at a relatively cool temperature.

A pair of spring biased check valves 108 and 109 are in communication with conduit 107 through branch passages 111 and 112 in turn communicating with main conduits 17 and 18, respectively. The pump 102 thus supplies replenishing and cooling fluid to the low pressure side of the circuit i.e., the low pressure one of the conduits 17 and 18, when the pressure in one of the branch passages 111 and 112 exceeds that in the associated main conduit. When the pressure in one of the main conduits is at a high level the check valves 108, 109 associated therewith will be maintained closed. A spring biased make-up relief valve 115 communicates with the passage 107 and serves to relieve fluid under excessive pressure.

A suitable filter 118 is provided at the outlet of gear pump 102.

For the purpose of removing heated fluid from the low pressure side of the circuit a shuttle valve 120 is provided. The shuttle valve is in communication with the conduits 17 and 18 by means of the conduits 121, 122, 123 and 124 and provides a means for removing heated oil displaced by cool oil supplied by replenishing pump 102. The fluid pressure in the conduits 17 and 18 acts through the conduits 121 and 123, respectively, to appropriately position the shuttle valve so that communication is established between a low pressure relief valve 126 and the low pressure side of the circuit through either conduit 122 or conduit 124 and a central passage 128 connected to the relief valve. The heated fluid passing through the low pressure relief valve 126 goes to the reservoir 103 through line 130. Line 130 conveys this heated fluid to a cooler 132. A bypass valve 134 is provided so that the heated fluid may bypass the cooler 132 in the event of a malfunction therein. The shuttle valve 120 is spring centered to a closed position so that during the transition of reversing pressure in the main conduits none of the high pressure oil is lost from the circuit.

An important aspect of the present invention is the system pressure control circuit 16, referred to generally above, provided for limiting pressure in the main conduits 17 and 18 by dumping oil from the high pressure conduit to the low pressure conduit during rapid acceleration, abrupt braking and sudden application of the load.

Included in this pressure control are relief valves 140 and 141, identical in construction, for limiting the pressure in the main conduits 17 and 18, respectively. The valves include stationary valve sleeves 143, 144 in which movable valve members 146, 147 are slidable. The valve members 146, 147 are biased to their closed position shown by springs 149, 150 as well as fluid pressure acting on the rear side of the valve member. Orifices 151, 152 are provided in the movable valve members 146, 147. The valve members when in an open position communicate a portion of ports 158, 159 to the interior of the sleeves. The forward side of the valve member 146 communicates with the fluid in main conduit 17 through line 160 and the forward side of valve member 147 communicates with main conduit 18 through line 161. When sufficient pressure is achieved in conduit 17 valve member 146 will move to the right permitting fluid to pass from conduit 17 through passage 160 and out port 158 and pasage 163 to main conduit 18 (which would then be the low pressure conduit). Likewise when the pressure limit of valve 141 is exceeded, fluid from main conduit 18 will flow through passage 161 opening valve member 147 passing through port 159 and passage 166 to the main conduit 17 (which would then be the low pressure conduit).

The valve members 146 and 147 are biased to their closed position by fluid pressure acting on the rear side

of these valves which is provided by the bleed orifices **151** and **152** in the valve members **146** and **147**, respectively. By modulating the fluid pressure on the rear side of these valve members the pressure relief setting thereof may be controlled. For this purpose a pressure modulating valve **168** is provided including pilot valves **169** and **170** for controlling the pressure behind valve members **146** and **147**, respectively.

The valves **169** and **170** include movable valve members **173**, **174** (FIG. 2) which when open provide communication between the rear side of the valve members **146** and **147** and a suitable drain passage **175** through passages **176** and **177**, respectively. The valve members **173** and **174** are biased to the closed position shown in the drawings by springs **179** and **180** variably biased by plungers **182** and **183**.

The plungers are positioned by an axially slidable spool cam **186** including a cylindrical central portion **189** which when in a neutral position places both of the plungers **182** and **183** in their uppermost positions effecting a maximum bias for the valve members **173** and **174**. Extending from the central cylindrical portion **189** are tapered end portions **191** and **192**.

The cam member **186** is positioned in response to the position of swashplate **28** by a link **194** which shifts the cam **186** to the right in response to a forward displacement of the swashplate **28** and shifts the cam to the left in response to a reverse displacement of swashplate **28**. As the cam **186** shifts to the right from the neutral position shown in FIG. 1 plunger **182** will ride on cylindrical portion **189** maintaining valve **173** in its maximum pressure relief setting and the plunger **183** will ride down tapered cam portion **192** decreasing the biasing force on pilot valve member **174**. Conversely when the cam **186** is shifted to the left from the neutral position shown plunger **183** will ride on cylindrical cam portion **189** maintaining a predetermined maximum biasing force on valve member **174** while the plunger **182** will ride down on cam portion **191** decreasing the biasing force on valve member **173** in accordance with the position of cam member **186**.

In this manner the cracking pressure of the pilot valve members **173** and **174** is mechanically modulated by the position of swashplate **28** between a low value, e.g. 2,000 p.s.i., and a predetermined high value, e.g., 5,000 p.s.i. Thus, the biasing force on the relief valves **140** and **141** is modulated between these high and low pressure values thereby variably limiting the pressure in the main conduits **17** and **18**. When the pressure in one of the main conduits exceeds that modulated on the opposite side of the valve members **146** and **147** by the pilot valves the valve members **146** and **147** will open permitting fluid to bypass to the low pressure conduit.

The operation of the system pressure control **16** is as follows. With the vehicle standing still, the operator begins acceleration by pivoting the control handle **32** in the forward direction (F) shifting link **64** to the right with control valve **48** thereby porting fluid to the right side of cylinder **34**. This causes clockwise pivotal movement of the pump swashplate **28** putting the pump into stroke. The pump delivers high pressure fluid through main conduit **17** to the motor **12** causing rotation of the motor propelling the vehicle in a forward direction. As the cam swashplate **28** pivots clockwise, the valve plunger **182** rides on the cylindrical high portion **189** of the cam maintaining the pilot valve **169** at its maximum pressure setting which biases relief valve **140** to its maximum pressure relief setting. If the operator attempts to accelerate the vehicle too rapidly, or if a load is suddenly encountered the pressure in main conduit **17** may exceed the maximum pressure relief setting of valve **140**, e.g. 5,000 p.s.i. In this event valve member **173** yields, and valve member **146** will open porting fluid from conduit **17** to conduit **18** until the pressure in conduit **17** returns below the maximum pressure relief setting of valve **140**.

When the cam **28** is on the forward side of neutral the relief valve **141** is modulated to provide variable low pressure relief for the main conduit **18**, then the return conduit, in accordance with pump displacement. If during the forward travel of the vehicle the operator reduces the displacement of the pump **11** by moving the control **32** toward neutral, the motor **12** will act as a pump driven by the inertia of the associated vehicle tending to drive the pump **11** as a motor. The pump thus acts as a metering device for flow from the motor and inherently tends to have an increased braking effect on the motor as the displacement of the pump **11** is reduced. The pressure relief valve **141** smoothes out the braking effect and prevents very abrupt braking which would otherwise be possible.

With the motor **12** acting as a pump with the cam **28** in a forward displacement position, the pressure in the main conduits reverses with conduit **18** becoming the high pressure conduit and conduit **17** becoming the low pressure conduit. If the cam **28** is initially in its maximum forward displacement position and then moved toward neutral the pressure setting of pilot valve **170** will be modulated by cam portion **192** from a minimum pressure setting, e.g. 2,000 p.s.i., towards its maximum pressure setting, e.g. 5,000 p.s.i. If the pressure in conduit **18** at this time exceeds the modulated low pressure setting of valve **141**, valve member **147** will open permitting relief of fluid in conduit **18** through line **161** to main conduit **17** thereby reducing the braking effect. The shape of the cam **192**, as well as **191**, is determined so that the amount of modulation of the pilot valve is matched to the specific braking characteristics of the engine of the associated vehicle. In this manner the valve **141** when modulated maintains an acceptable torque level into the engine and yet provides an increased braking capability as the vehicle speed decreases.

As the operator moves the control handle **32** further towards neutral moving the displacement cam **28** nearer neutral, the pilot valve **170** will approach its high pressure setting as will the pressure relief valve **141** thereby permitting increased pressures in conduit **18**. This thereby increases the braking effect.

The pressure control circuit **16** operates in an identical manner when the transmission and the vehicle are operating in reverse. In this case the functions of the valves **140** and **141** are reversed. Reverse drive is effected by movement of the operating handle **32** to the right causing the displacement servo-cylinder **34** to move the pump swash-plate counterclockwise delivering fluid under pressure through conduit **18** to the motor with the motor returning fluid at low pressure through conduit **17** to the pump **11**.

As the swashplate **28** moves from neutral the cam **186** is shifted to the left from its neutral position shown maintaining the pilot valve **170** in its maximum pressure setting and modulating pilot valve **169** to an increasingly lower pressure setting as the pump cam moves toward maximum reverse displacement. Thus, relief valve **141** is biased to a maximum pressure relief setting to limit pressure in conduit **18** during acceleration of the abrupt application of load, and pressure relief valve **140** is modulated at a lower pressure relief setting in accordance with pump displacement to control the braking effect in reverse by limiting pressure in conduit **17**. This proceeds in the same manner as described above except that the function of the conduits **17** and **18** is reversed when the pump displacement is reversed.

While the movement of the control in one direction has been designated "forward" and movement in the opposite direction designated "reverse," it should be understood that either direction may be forward, depending on the direction of rotation of the input shaft **19**.

A filter bypass valve **200** is provided for connecting the charge and control pump outlet upstream of the filter **118** to low pressure drain line **130** when the filter becomes clogged. Thereafter no charge or control fluid

is supplied to the hydraulic system and the transmission should be shut down.

The bypass valve **200** includes a valve housing member **201** having a main bore **202** therein with a high pressure port **204** at one end of the bore communicating with gear pump outlet passage **206** through passage **207**. Port **204** defines a valve seat **209** at one end of valve bore **202**.

A drain port **211** is provided adjacent the same end of the bore and communicates with the low pressure drain passage **130** through passage **213**. A conically ended valve member **214** blocks communication between port **204** and port **211** in its closed position shown in the drawing and permits communication between these ports when moved to an opened position permitting flow from the pump **102** to be directed to the drain passage **130**.

Valve member **214** has a rearwardly extending sleeve portion **216** which is adapted to close a port **218** in the valve housing when the valve member **214** moves away from seat **209** to its fully open position. Port **218** communicates with the downstream side of filter **118** through passage **220**. When the valve member **214** is in its closed position shown with the filter **118** working properly, fluid pressure in line **107** is applied through passage **220** to the rear side of the valve member **214** urging the valve member to the closed position shown.

Valve member **214** carries a biasing piston with a rearwardly extending stem **226** slidable in a bore **228** which is centrally disposed with respect to the valve bore **202**. When the valve member **214** is in its closed position fluid flow along stem **226** in bore **228** is prevented by sealing ring **234**; but when the valve member is in its open position, fluid flow along the stem is permitted through reduced portion **240** reducing the pressure in valve bore **202** behind the valve member **214**. Toward this end, a drain port **230** is provided in valve housing **201** communicating with the valve bore **228** through an annular recess **232**. The reduced portion **240** adjacent seal member **234** is adapted to communicate with the drain port **230** when the valve member **214** moves to its open position. Thus, when the valve is open, fluid flows along stem **226** and may pass easily out drain port **230** and the pressure in bore **202** will be reduced to a low value.

The filter bypass valve **200** operates as follows. When the filter **118** is operating normally and not presenting an unreasonable resistance to flow from the pump outlet passage **206** to the passage **107**, the pressure of charge fluid in passage **107** acting through passage **220** biases the valve member **214** to a closed position with the assistance of a spring **246** against the lesser force of fluid pressure acting on the other side of the valve member through passage **207**. While the pressure in line **206** at the charge pump outlet is equal to or slightly greater than the pressure in line **107**, it acts on a much smaller area of the valve member **214**, i.e., the area of the seat **209**, than the area upon which the pressure in line **107** acts, i.e., the area of bore **202** less the area of stem portion **226**. At this time, the seal **234** prevents any leakage from bore **202** through the smaller bore **228**. When the filter **118** becomes sufficiently clogged, the resulting back pressure on pump **102** will produce a higher pressure in line **207** and a reduction in pressure in line **107** sufficient to move valve member **214** from its seat **209**. As the valve memmoves from its seat, an additional area on the left side of the valve member **214** is exposed to high pressure fluid in line **207** increasing the force on this side of the valve member and rapidly opening the valve member further so that the sleeve portion **216** will abut the right end of bore **202** and close the biasing port **218**. The biasing effect provided through port **218** then is eliminated. Note that when the valve member opens a greater effective area is provided on the left side of the valve member than on the right (closing side).

At the same time, fluid flow from bore **202** permits draining of the residual fluid therein and the reduction in pressure in line **220**. In this open position of the valve member **214**, only a relatively low pressure from the charge and control pump **102** is required to maintain the valve member in its open position even though the filter **118** may become partly unclogged.

If it is desired to again deliver control and charge fluid to the system, the valve member **214** may be manually reset by an operator **250** fixed to the end of the valve stem **226**. However, if the filter **118** continues to be clogged, the valve member **214** will open as soon as the operator **250** is released, again directing charge and control fluid to drain line **130**. If the charge and control pump **102** is shut down, then the spring **246** returns the valve member **214** to its closed position.

It is seen that the present filter bypass valve directs charge and control fluid to the drain so long as the filter **118** remains clogged, requiring cleaning or replacement of the filter before operation of the transmission may be continued, thereby preventing damaging contamination of the control and main hydraulic circuits.

I claim:

1. A hydraulic transmission comprising: a hydraulic pump unit, a hydraulic motor unit, means for varying the displacement of one of the units, conduit means connecting the pump unit to deliver fluid to the motor unit and connecting the motor unit to return fluid to the pump unit, a charge pump for supplying make-up fluid to said conduit means to replace leakage fluid, passage means connecting the charge pump to deliver make-up fluid to said conduit means, filter means in said passage, and valve means responsive to an increase in fluid pressure between said charge pump and said filter means for directing the make-up fluid from said charge pump away from said conduit means to prevent contamination thereof.

2. A hydraulic transmission comprising: a hydraulic pump unit, a hydraulic motor unit, means for varying the displacement of one of the units, conduit means connecting the pump unit to deliver fluid to the motor unit and connecting the motor unit to return fluid to the pump unit. said displacement varying means including a displacement control valve, a control fluid pump for supplying control fluid to said displacement control valve, passage means connecting the control pump to supply fluid to said valve, a filter in said passage means, and bypass valve means responsive to an increase in fluid pressure between said control pump and said filter for directing control fluid from said control pump away from said filter and away from said displacement control valve to prevent contamination of the latter.

3. A hydraulic transmission as defined in claim **1**, wherein said valve means is a bypass valve for directing charge fluid to a tank, said valve means including a differential pressure movable valve member, one end of said valve member communicating with said passage means between said charge pump and said filter and biasing said valve member in an opening direction, the other end of said valve member communicating when the valve is closed with the passage means between the filter and the conduit means and biasing said valve member in a closing direction, said valve member decreasing pressure on the other end thereof when the valve member is open whereby when the pressure increases on said one end of the valve member when the filter becomes clogged the valve member will open rapidly as fluid pressure on the other end of the valve member decreases.

4. A hydraulic transmission as defined in claim **1**, wherein said valve means includes a valve bore having a seat therein, one end of said bore having a high pressure port communicating with said seat and said passage means between said charge pump and said filter, said one end of said bore having a drain port therein on the opposite side of the valve seat from said high pressure port, a movable valve member slidable in said bore and having a portion engageable with said seat to block communication between said high pressure port and said drain port when the valve member is closed, a biasing port in the

other end of said bore, second passage means between the filter and said conduit means communicating with the biasing port for biasing the valve member to a closed position, said valve member being constructed to reduce communication between the bias port and the interior of the valve bore as the valve member opens.

5. A hydraulic transmission as defined in claim 4, including valve means for communicating the other end of said bore with the drain when the valve member opens and valve member remains in the open position, said latter valve means including a second bore aligned with said valve bore and communicating therewith, said valve member having a portion thereof slidable in said second bore, port means in said second bore communicating with drain, said valve member portion having a reduced stem portion communicating with said drain port means in the second bore when the valve member is open, and seal means in said second bore between said reduced portion and drain port means in the second bore when the valve member is closed.

6. A hydrostatic transmission, comprising: an input shaft, a hydraulic pump driven by said input shaft, an output shaft, a hydraulic motor connected to drive said output shaft, fluid operable means for varying the displacement of at least one of the pump and motor, displacement control valve means for directing fluid to said fluid operable means, first conduit means connecting the pump to deliver fluid to the motor and second conduit means for delivering fluid from the motor to the pump, a charge and control fluid pump, passage means connecting said charge and control fluid pump to said conduit means and to said displacement control valve means, filter means in said passage means, and a filter bypass valve for directing fluid from said charge pump to a drain when the filter becomes clogged including a valve housing having a valve bore therein, one end of said bore having a high pressure port communicating with said passage means between said charge pump and said filter, said one end of said bore having a drain port therein on the opposite side of the valve seat from said high pressure port, a movable valve member slidable in said bore and having a portion engageable with said seat to block communication between said high pressure port and said drain port when the valve member is closed, a biasing port in the other end of said bore, said biasing port communicating with passage means between the filter and said conduit means for biasing the valve member to a closed position when the valve member is against the valve seat, said valve member being constructed to reduce communication between the biasing port and the interior of the valve bore as the valve member opens, means for draining the other end of the valve bore when the valve member opens thereby reducing the biasing force on said one end of the valve member, and manually operable means for resetting said valve member to a closed position.

7. A hydraulic transmission comprising: a hydraulic pump unit, a hydraulic motor unit, means for varying the displacement of one of the units, conduit means connecting the pump unit to deliver fluid to the motor unit and connecting the motor unit to return fluid to the pump unit, a charge pump for supplying make-up fluid to said conduit means to replace leakage fluid, passage means connecting the charge pump to deliver make-up fluid to said conduit means, filter means in said passage, valve means responsive to an increase in fluid pressure between said charge pump and said filter means for directing the make-up fluid from said charge pump away from said conduit means to prevent contamination thereof, and means responsive to fluid pressure downstream of said filter means for biasing said valve means toward a closed position.

8. A hydraulic transmission comprising: a hydraulic pump unit, a hydraulic motor unit, means for varying the displacement of one of the units, conduit means connecting the pump unit to deliver fluid to the motor unit and connecting the motor unit to return fluid to the pump unit, said displacement varying means including a displacement control valve, a control fluid pump for supplying control fluid to said displacement control valve, passage means connecting the control pump to supply fluid to said valve, a filter in said passage means, bypass valve means responsive to an increase in fluid pressure between said control pump and said filter for directing control fluid from said control pump away from said filter and away from said displacement control valve to prevent contamination of the latter, and means responsive to fluid pressure downstream of said filter for biasing said bypass valve means toward a closed position.

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Disclaimer

3,522,704.—*Lyle S. Martin,* La Salle, Ill. HYDROSTATIC TRANSMISSION. Patent dated Aug. 4, 1970. Disclaimer filed May 20, 1981, by the assignee, *Sundstrand Corp.*

Hereby enters this disclaimer to claims 1 and 2 of said patent.

[*Official Gazette September 7, 1982.*]