# United States Patent

[11] 3,597,921


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[21] Appl. No. 877,934
[22] Filed Nov. 19, 1969
[45] Patented Aug. 10, 1971
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[54] **PRIORITY FLOW CONTROL VALVE**
**10 Claims, 1 Drawing Fig.**


[52] U.S. Cl. ..... 60/52 VS, 60/52 S
[51] Int. Cl. ..... F15b 11/16
[50] Field of Search ..... 60/52 VS, 52 S



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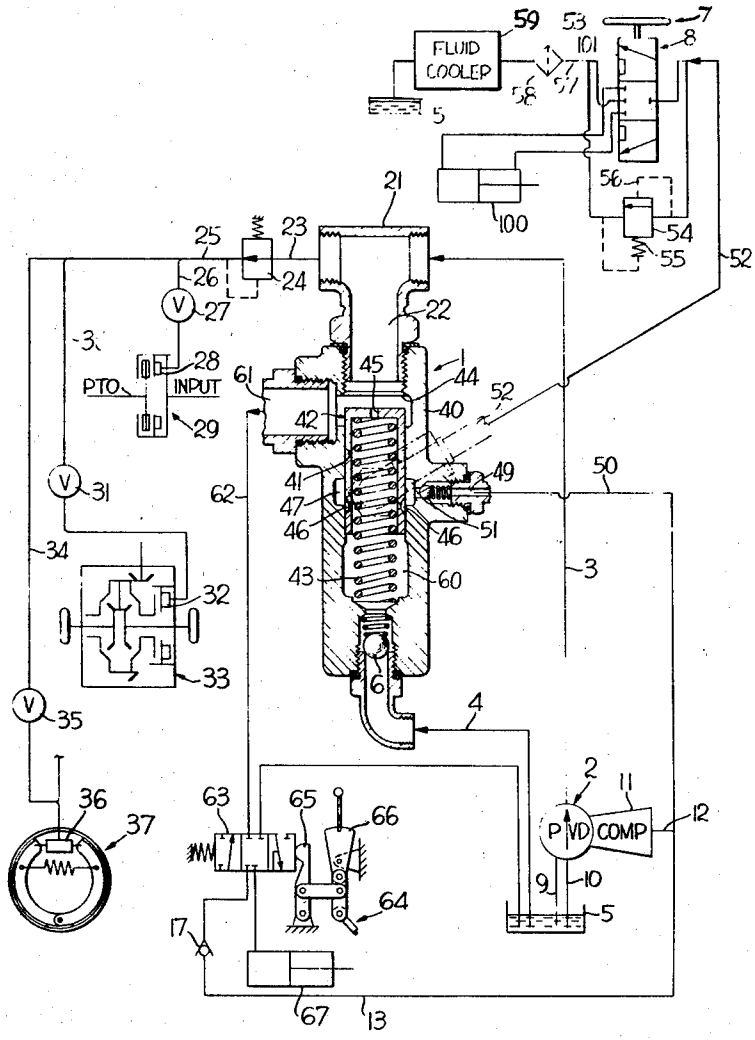
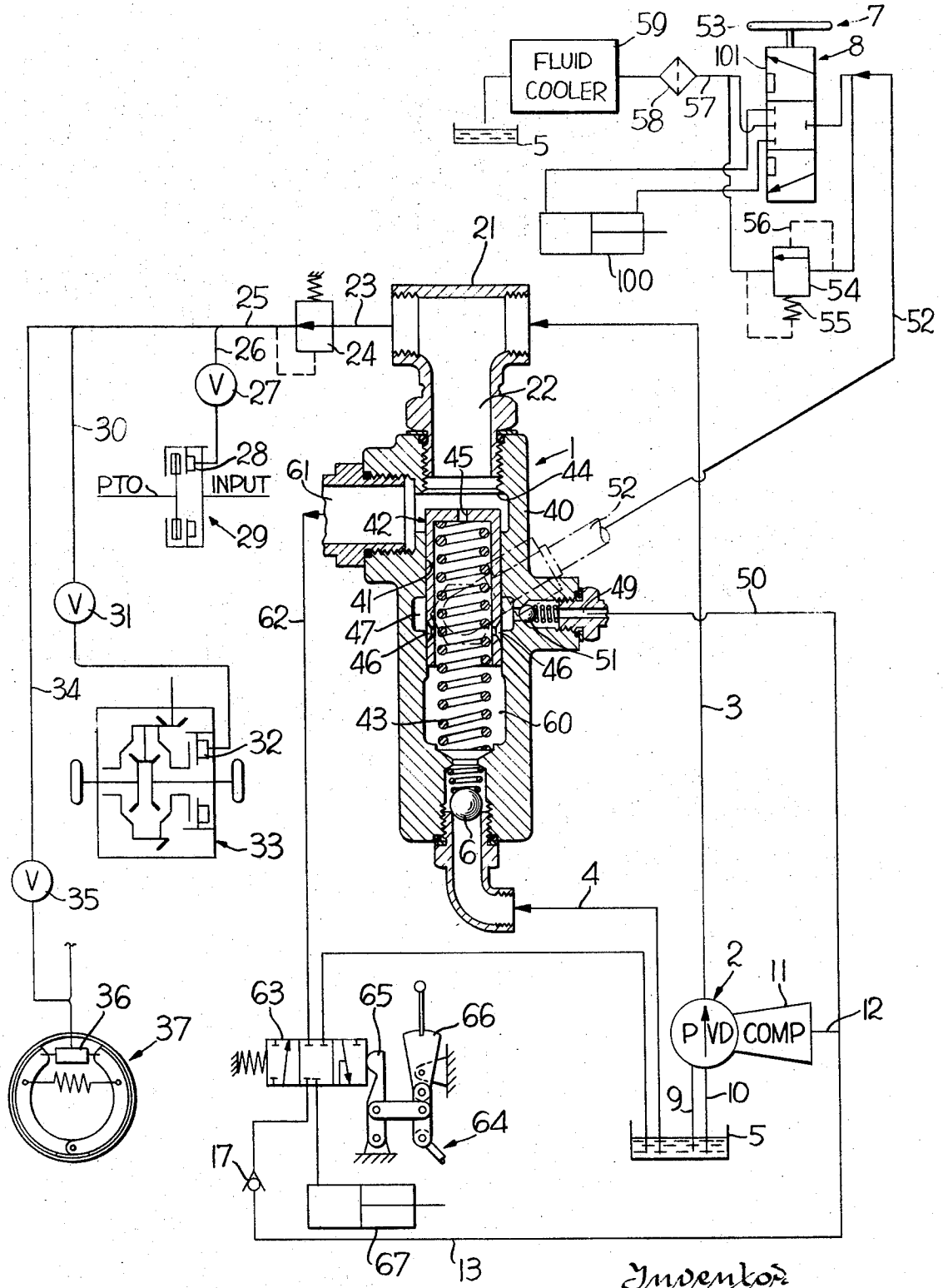
**ABSTRACT:** A flow control valve in a hydraulic system having a single source of pressurized fluid. The flow control valve provides priority of flow for predetermined actuators and pressure control for a plurality of hydraulic actuators.


FLUID COOLER
PTO
INPUT
P VD COMP
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# PRIORITY FLOW CONTROL VALVE

This invention relates to a hydraulic system and more particularly to a priority flow and pressure control for hydraulic actuators in a normally closed center load sensitive system.

Hydraulic systems on tractors include hydraulic actuators for operating wheel brakes, power takeoff clutch and brake, differential lock, steering means, and implement lift or weight distribution of the tractor relative to the implement. Generally a plurality of pumps are used to supply pressurized fluid to one or more of the fluid actuators in the system. A plurality of pumps are generally used primarily because of the various flow rates and various pressures demanded by the hydraulic actuators in the system. A plurality of pumps may become costly as well as presenting a space problem, or a drive problem in operating the various pumps. Accordingly, a single source of pressurized fluid may be used if provisions are made for priority of flow to the actuators which require priority to maintain safety in operation of the vehicle and also a pressure control must also be used to provide the required pressure for operating each hydraulic actuator in the system.

Accordingly this invention provides a single source of pressurized fluid. Preferably the source of pressurized fluid is a variable displacement pump having a compensator to sense pressure and load demands in the system. A compensator is in communication with a plurality of pilot lines sensing the load of each hydraulic actuator in the system which is fed back to the compensator which regulates the pump to provide the highest pressure demanded in the system. The priority of flow is controlled through a priority control valve to maintain priority of flow for safety in operation of the vehicle. Accordingly, along with priority of flow the provision of supplying pressurized fluid at the proper pressure for any operation demanded is also included.

It is an object of this invention to provide a single source of pressurized fluid in a hydraulic system serving a plurality of hydraulic actuators at a plurality of pressures.

It is another object of this invention to provide a flow and pressure control valve in a closed center load sensitive hydraulic system.

It is a further object of this invention to provide a priority flow and pressure control valve with a reducing valve to provide the desired pressure as well as priority of flow to a plurality of hydraulic fluid actuators.

It is a further object of this invention to provide priority of flow at a predetermined pressure to the power takeoff, differential lock, and the brake actuators and priority of flow to the steering hydraulic actuator at a predetermined second pressure and simultaneously provide pressurized fluid to a draft control valve in a load sensitive closed center hydraulic fluid system.

The objects of this invention are accomplished with a variable displacement pump having a compensator sensing the load requirements of a draft control valve and a remote valve such as power steering. The variable displacement pump, although operating in a hydraulic system normally considered a closed center system, provides continuous circulation to the steering hydraulic actuator with a bypass valve delivering pressurized fluid through a brake cooling means to thereby provide cooler operation and filtering of the hydraulic fluid. A priority valve is connected to the variable displacement pump delivering priority of flow to the power takeoff, the brake, and differential lock operating through a pressure limiting valve. The priority flow control valve also includes a pressure responsive plunger continuously supplying pressurized fluid through an orifice to the power steering circuit at the predetermined pressure demanded by the hydraulic actuator. The hydraulic actuator of the steering circuit also has a control to operate the steering manually in the event of power failure which requires communication to a fluid reservoir or sump. The draft control valve has a low priority and receives fluid in response to operation at the pressure responsive plunger.



The pilot line from the plurality of actuators controls the displacement of the pump and supplies the pressure requirements of the highest load operated by any of the hydraulic actuators in the system.

The preferred embodiments of this invention will be illustrated and described. The attached drawing illustrates the priority flow control valve with the hydraulic actuators and the pump illustrated schematically.

Referring to drawing the priority control valve **1** is illustrated in cross section. The valve **1** is connected to the variable displacement pump **2** by the conduit **3**. The priority flow control valve is also connected by the conduit **4** to the sump **5**. The conduit **4** receives fluid from the sump **5** which can flow through the check valve **6** in event of power failure. The fluid flowing through the conduit **4** supplies fluid to the steering mechanism **7** including a manually operated hydraulic valve **8**. The valve **8** is of the type illustrated in the originally copending application of the same assignee entitled "Hydraulic Steering System" now issued as U.S. Pat. No. 3,528,521.

The pump **2** also is connected by a drain conduit **9** which is immersed under the oil level of the sump **5**. A supply conduit **10** is connected to the pump **2** and supplies fluid to the pump **2** as the pump is operating. The pump **2** also includes a compensator **11** which senses a pressure signal and strokes or destrokes the pump in accordance with the load demands of the various hydraulic actuators in the system. A compensator **11** is connected to these various hydraulic actuators through the pilot line **12**. The draft control pilot line **13**, steering pilot line **50**, a check valve **17** in the draft control pilot line **13**, and check valve **51**, all permit transmission of a pilot pressure signal from the hydraulic actuators. The highest pilot signal controls the operation of the compensator **11** which in turn control the stroking and destroking of the pump and accordingly the demands of the hydraulic system are met.

The discharge side of the pump **2** delivers pressurized fluid to the conduit **3** and the connection **21** of the priority flow control valve. The passage **22** delivers pressurized fluid to the priority flow control valve **1** while the connection **21** is also connected to the conduit **23** which in turn delivers pressurized fluid to the pressure limiting valve **24**. The pressure limiting valve is set for a predetermined pressure required by the actuators on the downstream side of the pressure limiting valve **24**. For the purpose of illustration it will be assumed that the hydraulic actuators downstream from the pressure limiting valve **24** will operate at approximately 250 p.s.i.

The conduit **25** delivers pressurized fluid from the pressure limiting valve **24** to the conduit **26**. The valve **27** and the conduit **26** controls the flow of pressurized fluid to the hydraulic actuators **28** in the power takeoff assembly **29**. The valve **27** is schematically illustrated although a more complete illustration and description of this type of valve and its operation with the power takeoff may be had by referring to the originally copending patent application of the same assignee now U.S Pat. No. 3,507,372 which covers a hydraulic clutch an brake system for a power takeoff assembly. The operation of the power takeoff assembly is provided through a clutch and a brake which control the delivery of power to the power takeoff shaft and are operated in response to a valve means to provide the desired function.

Conduit **25** is also connected to conduit **30** which includes a valve **31** and delivers pressurized fluid to the actuator **32** in the differential assembly **33**. A more complete illustration of the differential assembly and its operation may be had be referring to the U.S. Pat. No. 3,446,320 which covers a differential lock and the means for controlling the actuation of the differential lock through a relay valve operated in response to braking of the vehicle.

The conduit **25** is also connected to a conduit **34** which includes a valve **35** which controls the actuation of the hydraulic actuator **36** of the brake assembly **37**.

The pressure limiting valve **24** limits the pressure of the pressurized fluid delivered to the power takeoff, the differential lock, and the brake. Normally the pressurized fluid

applied to these circuits is in a standby condition and hydraulic fluid is not flowing to the hydraulic actuators. The pressurized fluid, however, must be available in event that it is needed to operate any of the actuators in these three operations.

The priority flow control valve **1** includes a housing **40** having a central opening **41** receiving the plunger **42**. The plunger **42** is biased to an upward position by the spring **43** to seat against the valve seat **44**. The plunger **42** defines an orifice **45** permitting the flow of pressurized flow into the hollow portion of the plunger **42**. A plurality of radial orifices **46** permit the flow of pressurized fluid into the annular chamber **47** defined by the housing **40** of the flow control valve. The annular chamber **47** is in communication with the pilot passage **49** which is connected by the pilot line **50** to the pilot line **12**. The check valve **51** permits the flow of pressurized fluid to the pilot line **50** when the pilot pressure in the chamber **47** exceeds the pilot pressures of the remote hydraulic actuators previously described.

The steering supply line **52** also is in communication with the annular chamber **47** and supplies pressurized fluid to the hydraulic steering valve **8** and actuator **100**. The hydraulic steering valve is connected to the steering mechanism in such a manner whereby the steering wheel **53** controls a valve element **101** for driving the steering mechanism in either direction in response to direction of rotation of the steering wheel **53**. This in turn provides power steering of the steering mechanism of the vehicle.

When pressurized fluid is in the steering supply conduit **52** a predetermined amount of pressurized fluid flows through the orifice **45** and the orifices **46** to supply the steering valve **8**. For the purpose of illustration the flow rate will be considered to be 4 gallons per minute which is adequate for steering of the vehicle. The bypass valve **54** shunts the steering valve **8** and bypasses fluid around the valve **8** when the fluid is not required to operate the motor **100**. The bypass valve **54** is biased to a closed position by the spring **55** and opened in response to pressurized fluid operating in the passage **56**. Fluid flowing through bypass valve **54** passes through the conduit **57** and through the filter **58**. A fluid cooling device **59** cools the fluid and returns i to the sump **5**. The filter and cooler have bypass means to prevent pressure buildup and lack of pressure drop across the steering motor. A constant circulation through the steering circuit is provided even though pressurized fluid is not demanded for steering. It provides cooler operation of the pump **2** and cools and filters the hydraulic fluid in the system for better operation.

The valve **8** is mechanically connected to the wheel **53** and in event of power failure rotation of the wheel itself will operate the valve as a pump as long as fluid is present in the steering supply conduit **52**. Fluid in the steering conduit **52** and chamber **47** is connected to the chamber **60** which receives fluid through the check valve **6** from conduit **4**. The conduit **4** may be connected to any low-pressure source of fluid merely to maintain the presence of fluid in the system for manual operation in the event of power failure.

The flow control valve **1** further defines a passage **61** connected to the conduit **62** and the draft control valve **63**. The draft control valve **63** is operated in response to a draft load sensed on the linkage **64**. This load produces a force signal transmitted through the linkage to the lever **65** which in turn operates the valve **63**. A manual lever **66** can also operate the draft control valve **63** when desired such as for lifting the implement and changing the implement from field operating position to the transport position. The draft control valve **63** supplies pressurized fluid to the hydraulic actuator **67** for weight distribution of the tractor and implement and also will provide for lifting of the implement to the transport position when desired. The load on the hydraulic actuator **67** is sensed by the pilot line **13** and transmitted to the pilot line **12** where it is sensed by the compensator **11**.

A detailed and complete illustration and description may be had for a draft control valve and its operation relative to the implement by reference to the Strehlow U.S. Pat. No. 2,679,199. **Essentially the Strehlow device operates in a manner as briefly described above, which sets forth the function in relation to the priority control valve.**

A preferred embodiment of this invention has been illustrated and described and operation will be set forth in the following paragraphs.

Referring to the drawing a typical illustration of the valve is shown in the normal operating position. Before the engine is started the plunger **42** is in its uppermost position blocking the oil passage to the draft control valve. Oil for manual steering operation is provided through the conduit **4** to the manual steering check valve **6** through the variable orifice **46** and finally through the steering supply line **52**. The steering wheel operates a motor which will provide steering of the vehicle and the motor will operate as a pump to operate the hydraulic actuator connected to the steering linkage.

When the engine is started the pump **2** pressurizes fluid which flows through the orifice **45** until the pressure drop across the orifice **45** in the plunger **42** is sufficient to begin to move the plunger downwardly against the spring **43**. The flow rate at this time will be slightly less than the desired steering flow rate of approximately 4 gallons per minute. As the flow rate continues to increase due to increasing speed of the engine the flow rate through the orifice **45** will continue to increase until the pressure drop across the orifice **45** plus the pressure drop across the orifice **46** is approximately 250 p.s.i. At this point the pump **2** will always adjust its displacement to maintain this flow rate independent of speed. The typical position of plunger **42** will be that shown in the drawing. Notice that the oil passages to the draft control valve and the remote valves are open even though no fluid is flowing to these valves at this time. The flow rate to the steering circuit is also independent of required steering pressure. This pressure is monitored by the steering pilot signal line. The flow rate to the steering circuit is also independent of the draft control or remote pressures whether these pressures are higher or lower than the pressure required for steering. If these pressures are higher than required steering pressure plunger **42** will shift downwardly in its bore and throttle the excess pressure across the variable orifice **46**. If these pressures are lower than required steering pressure, the plunger will shift upward in its bore and throttle the oil flow to the draft control valve.

The draft control operates in response to a pressure signal received from the draft sensing unit through the linkage **64**. The linkage **64** provides automatic operation of the draft control valve **63**. The pressure in the system required by the draft control valve **63** and hydraulic actuator **67** is sensed by the pilot line **13** and fed back to the compensator **11** through the conduit **12**. The compensator senses the pressure and will increase or decrease the operating pressure as demanded by the draft control valve **63** to provide sufficient flow of pressurized fluid for the system.

The power takeoff actuator, the differential lock actuator, and the brake actuator all operate independently through the pressure limiting valve **24** which is set for the purpose of illustration at 250 p.s.i. This is the standby pressure at which the hydraulic actuators in these remote operations will normally operate. Their operation is in response to actuation of the valve controlling their operation. The valves are illustrated schematically and will be normally controlled by the operator of the vehicle. When a valve is open the fluid flowing through the valve operates the hydraulic actuator it controls while the pressure limiting valve **24** admits the flow of fluid and maintains the pressure at the preset value.

It can be seen that the hydraulic system with the priority flow control valve as set forth above eliminates any need for additional gear pumps to operate the plural functions set forth in this system. The steering circuit is supplied with pressurized fluid at all times and also has the provision for filtering and cooling. This provides a cooler running pump in the hydraulic circuit and provides greater overall efficiency in the system. A minimum pressure level of 250 p.s.i. is assured for the power

takeoff, the differential lock, and the brakes even when high flow is demanded by the draft control or remote valves. The system is simple and yet flexible in providing a plurality of auxiliary operations from a single load sensitive variable displacement pump.

The preferred embodiments of this invention have been illustrated and described.

The embodiments of the invention in which I claim an exclusive property or privilege is claimed and defined as follows:

1. A pressure and flow control device for use in a hydraulic system, including a variable displacement pump with a compensator sensing load pressure, said device comprising, a priority flow control valve, inlet conduit means on said flow control valve adapted for connection to said pump, a pressure-limiting valve connected to said inlet conduit means and adapted for connection on the downstream side of said pressure limiting valve to a plurality of remote hydraulic actuators, a draft control valve connected to said priority flow control valve, a steering circuit having a hydraulic control and actuator connected to said priority flow control valve, a pressure responsive element normally limiting communication between said pump and said draft control valve, orifice means on said pressure limiting means regulating priority flow of pressurized fluid to said steering circuit, a plurality of pilot lines adapted for connection to the hydraulic actuators on said circuit and connected to the compensator of said pump sensing load pressures and controlling displacement of said pump through said compensator and controlling the flow and pressure of pressurized fluid in said system, said priority flow control valve thereby providing regulated priority flow to said steering circuit and standby pressure with flow control to said remote hydraulic actuators and said draft control valve.

2. A pressure and flow control device as set forth in claim 1 wherein one of said remote hydraulic actuators includes an actuator for a power takeoff assembly.

3. A pressure and flow control device as set forth in claim 1 wherein one of said remote hydraulic actuators includes a hydraulic actuator for a differential lock.

4. A pressure and flow control device as set forth in claim 1 wherein one of said remote hydraulic actuators includes an actuator for operating a brake.

5. A pressure and flow control device as set forth in claim 1 wherein said hydraulic system includes, a sump connected to said pump, a fluid supply conduit connected to said sump including a check valve connected to said priority flow control valve to permit fluid flow from said sump through said priority flow control valve to said steering circuit in event of power failure of said pump.

6. A pressure and flow control device as set forth in claim 1 wherein said pressure responsive element in said priority flow control valve defines a valve preventing communication to said draft control valve when said pump is inoperative.

7. A pressure and flow control device as set forth in claim 1 wherein said pressure responsive element of said priority flow control valve defines an orifice axially positioned in said element for throttling pressurized fluid, means on said element define radially positioned throttling orifices throttling flow of pressurized fluid to form a variable area orifice in said priority flow control valve, said housing defining a fluid chamber in communication with said radial orifices and said steering circuit to thereby provide throttling of pressurized fluid flowing through said priority valve to said steering circuit.

8. A pressure and flow control device as set forth in claim 1 wherein said steering circuit includes a filter receiving continuous flow of pressurized fluid from said pump through said steering circuit, a bypass valve and a hydraulic actuator selectively transmitting hydraulic fluid through said steering circuit.

9. A pressure and flow control device as set forth in claim 1 wherein said steering circuit includes a fluid cooler for hydraulic fluid thereby cooling hydraulic fluid flowing through said steering circuit to thereby cool the pressurized fluid in said hydraulic system.

10. A pressure and flow control device as set forth in claim 1 wherein said steering circuit includes a bypass valve operating at a predetermined pressure to bypass fluid around said steering motor to thereby permit constant flow through said steering circuit.