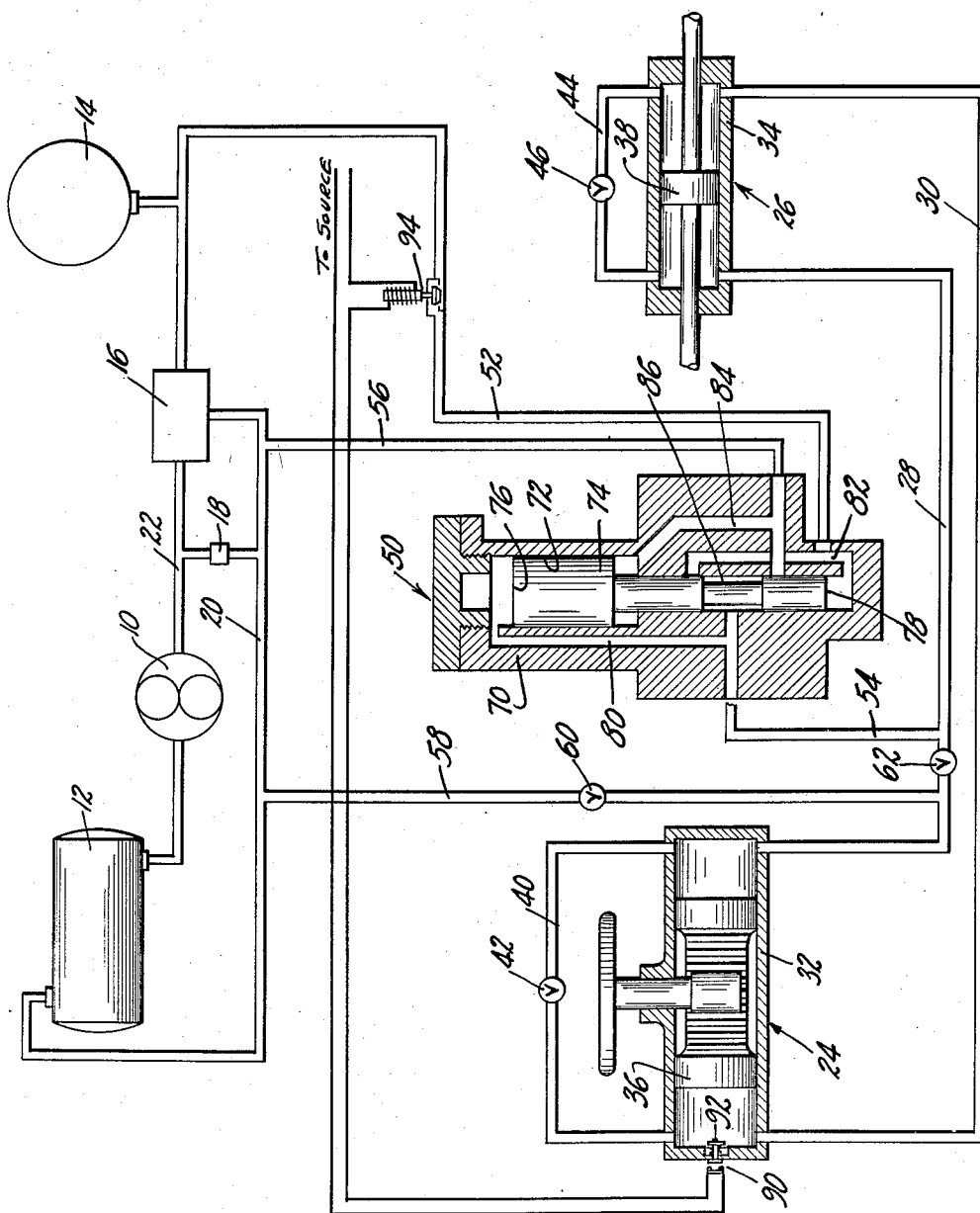


Feb. 16, 1954

S. I. MacDUFF
TEMPERATURE COMPENSATED FORCE AND
MOTION TRANSMITTING SYSTEM
Filed March 1, 1950

2,669,096



INVENTOR.
STANLEY I. MACDUFF
BY Cecil J. Arens

ATTORNEY

UNITED STATES PATENT OFFICE

2,669,096

TEMPERATURE COMPENSATED FORCE
AND MOTION TRANSMITTING SYSTEMStanley I. MacDuff, South Bend, Ind., assignor to
Bendix Aviation Corporation, South Bend, Ind.,
a corporation of Delaware

Application March 1, 1950, Serial No. 147,025

10 Claims. (Cl. 60—54.5)

1

This invention relates to a hydraulic mechanism and more particularly to a device which compensates for temperature variations in a force and motion transmitting system.

An important object of the invention resides in the provision of a device capable of maintaining a predetermined pressure in a closed hydraulic system.

Another object of the invention is to provide a device for use in a hydraulic system of the force and motion type for maintaining the pressure in said system at a fixed ratio with respect to the pressure of the source.

It is still further important object of the invention to provide a device to be interposed between a fluid pressure source and a force and motion transmitting system for maintaining a fixed pressure ratio between the source and the system by connecting the system to the source at times when the pressure in the system drops below a preselected value and exhausting fluid from said system when the pressure therein exceeds a preselected value.

The above and other objects and features of the invention will be apparent from the following description of the apparatus taken in connection with the accompanying drawing which forms a part of this specification and in which the single figure represents diagrammatically the preferred form of invention.

Referring now to the drawing I will first describe a fluid pressure source which comprises a pump 10 having its inlet side connected to a fluid reservoir 12 and its outlet side connected to an accumulator 14 via a regulator or unloading valve 16, the latter of which is capable of bypassing fluid to the reservoir when the accumulator pressure reaches a predetermined value determined by the unloading valve setting. A relief valve 18 is interposed between the discharge side of the pump 10 and a return line 20 to prevent excessive pressures from building up in line 22 which connects the outlet of the pump to the unloading valve. The return line 20 connects the unloading valve to the reservoir for returning fluid to the same when the predetermined accumulator pressure is attained.

The fluid pressure source hereinabove is connected to a force and motion transmitting system having a transmitter unit 24 and receiver unit 26 interconnected with pipe lines 28 and 30 for supplying fluid to opposite ends of cylinders 32 and 34 respectively. This force and motion transmitting system may serve in a number of capacities, such for example as a hydraulic steer-

2

ing device. Pistons 36 and 38, located in the transmitter and receiver units respectively divide the cylinders of these units into opposed chambers. A conduit 40, having a manually controlled valve 42 therein, communicates the opposed chambers of the transmitter unit with each other when the valve is open. A conduit 44, having a manually controlled valve 46 therein, communicates the opposed chambers of the receiver unit with each other when the valve 46 is open.

It is a purpose of this invention to provide a valve device 50 which will maintain the fluid pressure in the closed system a fixed ratio with respect to the fluid pressure source. Variations of pressure in the closed system might, for example, be caused by temperature variations. The valve device is connected to the source by a pipe line 52, and to the pipe line 28, of the closed hydraulic system by a conduit 54. A fluid connection 56 extends from the valve device to the return line 20. A pipe 58, having a hand valve 60 therein communicates the pipe line 28, of the force and transmitting system, to the return line 20. A hand valve 62 is located in the line 28 to be closed when the system is purged in a manner to be hereinafter described. Under normal operating conditions the valve 62 is open to permit communication between the transmitter and receiver units.

The valve device 50 comprises a housing 70 provided with a stepped bore 72, in which a piston or plunger 74 is positioned for controlling the pressure in the force and motion transmitting system. The plunger is formed so that the area of the large end 76 of the piston bears a definite ratio to the area of the small end 78. This ratio is chosen to meet the requirements of the system depending upon the maximum pressure available at the source and the pressure desired in the closed system. A passage 80, which communicates the intermediate section of the bore with one end of the large bore, is connected to the line 28 through the pipe 54. A passage 82, which has one end terminating in the intermediate section of the bore and the other end of the passage connected to the opposite end of the bore, is adapted to communicate with the fluid pressure source via the pipe line 52. A passage 84, which has one end terminating in the opposite end of the large bore and the other end of the passage terminating in the intermediate section of the bore, is adapted to communicate with the return line 20, of the fluid pressure source, through pipe 56. The

small portion of the plunger is reduced at 86 so that when the valve device is in balance, as shown in the figure, the small piston covers one end of the passages 82 and 84, thus cutting off communication between the fluid pressure source and the force and motion transmitting system.

Unwanted movement of the piston 38 of the receiver unit may cause serious damage, if the force and motion transmitting system is used in connection with steering a vehicle, for example. Under certain circumstances, such for example, if line 30 should be broken, the pistons 36 and 38 would be forced to the left and right ends of the cylinders 32 and 34 respectively thus moving the load to which the piston 38 is connected. Since the load on the piston 38 will offer a greater resistance to its movement than will the unloaded piston 36, the latter will be the first to move to the extreme position in their respective cylinders. To guard against this aforementioned danger novel means is installed for interrupting the supply of fluid to line 28. The novel means includes a normally open switch 90 secured to the left end of the cylinder 32. A stem 92, for actuating the switch, extends through the cylinder wall for engagement with the piston 36 when forced to the extreme left end of the transmitter unit to thereby close an electrical circuit which energizes a normally open solenoid valve 94 located in the line 52, between the accumulator 14 and the reducing valve 50. When energized the solenoid valve cuts off communication to line 28. The electrical circuit for energizing the solenoid is connected to any suitable source of current, not shown.

Operation and function of the apparatus

When replenishing or adding fluid to the force and motion transmitting system valve 62 is closed, and valves 42, 46, and 60 are opened. Under these conditions the piston 74 is urged toward the top under the influence of the fluid pressure source acting on the small end 78 of the piston, as viewed in the drawing, thus communicating passage 82 with the pipe line 54. It can thus be seen that circulation through the entire closed hydraulic system is accomplished, thereby purging the system of air, etc. After completion of the purging operation the valve 60 is closed first followed by closing valves 42 and 46 after centering the pistons 36 and 38, and finally opening the valve 62, thus preparing the system for use.

For the purpose of exemplification only, assume that the fluid pressure source delivers fluid under 3,000# p. s. i. and the pressure in the force and motion transmitting system is to be maintained at 600# p. s. i. With this requirement of the system in mind the piston is now formed so that the large end 76 is five times the area of the small end 78 or a ratio of 5 to 1. Hence a pressure of 600# p. s. i. acting on the large end of the piston will just balance 3,000# p. s. i. acting on the small end of the piston. This condition of balance is illustrated in the figure.

Assume an unbalance across the ends of the piston created by a reduction in pressure in line 28. The reduction in pressure might be caused by a reduction in temperature or a leak in line 28 or 30. This will mean that the pressure of the fluid acting on the large end of the piston will have been reduced, thus allowing the piston to move upwardly due to an unbalance, uncovering the passage 82, and communicating the passage 80, line 54, and line 28 with the 3,000# p. s. i. source via the reduced portion 86. Obviously this

will move the piston downwardly so that the reduced portion 86 is now centered in the bore in a manner to cut off communication between the passages 82 and 80.

If the pressure in the line 28 due to a rise in temperature exceeds the 600# p. s. i. the piston 74 will be forced downwardly from the neutral position shown in the drawing, to thereby cause the reduced portion 86 of the piston to communicate the line 28 with the return line 56 thus releasing the excess pressure on the large end of the piston. The piston now moves upwardly under the influence of the 3,000# p. s. i. pressure source until the total forces acting on the opposite ends of the piston are balanced, at which time the piston will again assume the position shown.

Although this invention has been described in connection with certain specific embodiments, the principles are susceptible of numerous other applications that will readily occur to persons skilled in the art.

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

1. In combination, a fluid pressure source, a double acting fluid force and motion transmitting system including a pair of conduits connecting the transmitter and receiver units, and means interposed between said source and one of said conduits for maintaining the fluid pressure in said system at a fixed ratio with respect to the pressure source.

2. In combination, a fluid pressure source, a fluid force and motion transmitting system including a pair of conduits connecting transmitter and receiver units, and a valve device capable of admitting fluid under pressure to one of said conduits from said source and also of releasing fluid from said one conduit to thereby maintain the pressure in the system at a predetermined value.

3. In combination, a fluid pressure source, a fluid force and motion transmitting system including a pair of conduits connecting the transmitter and receiver units, and a valve device conscious to the pressures of said source and in one of said conduits for automatically maintaining the pressure in the system at a preselected value.

4. In combination, a fluid pressure source, a fluid force and motion transmitting system including transmitter and receiver units connected together by a pair of pipe lines, and a valve device having connections to said source and to one of said pipe lines, said valve device including a moveable member for controlling flow between said source and said system and responsive to a predetermined unbalance in pressures existing at said source and in said system for maintaining the pressure relationship therebetween at a prescribed ratio.

5. In combination, a fluid pressure source, a fluid force and motion transmitting system including transmitter and receiver units connected together by a pair of pipe lines, and a valve device for keeping the fluid in one of said pipe lines at a predetermined pressure with respect to said pressure source and having connections to said source, to a return, and to said one pipe line, said valve device comprising valve means conscious to the pressures of the source and in said one pipe line for communicating said one pipe line with either said source or said return.

6. In combination, a fluid pressure source, a fluid force and motion transmitting system including transmitter and receiver units connected together by a pair of pipe lines, and a valve device

5

for keeping the fluid in one of said pipe lines at a predetermined pressure with respect to said pressure source and having connections to said source, to a return, and to said one pipe line, said valve device including a member constructed and arranged to control the fluid in said connections and responsive to the difference in pressure of the source and in said one pipe line.

7. In combination, a fluid pressure source, a fluid force and motion transmitting system including transmitter and receiver units each provided with a piston, a connection between said source and system, and means in said connection for controlling fluid under pressure to said system, said means being responsive to movement of the transmitter unit piston to an extreme position for cutting off the system from said source.

8. In combination, a fluid pressure source, a fluid force and motion transmitting system including transmitter and receiver units each provided with a piston, means for controlling communication between the system and the pressure source comprising means carried by said transmitter unit and connected to said first named means for causing actuation thereof upon movement of said transmitter piston to an extreme position, to thereby cut off the pressure source.

9. In combination, a fluid pressure source, a fluid force and motion transmitting system including transmitter and receiver units, a fluid control device interposed between the source and system, and means carried by said transmitter unit and connected to said control unit for ac-

6

tuating the same upon predetermined movement of said transmitter, whereby the system is cut off from the source.

10. The combination with a fluid force and motion transmitting system including transmitter and receiver units interconnected by two fluid passages, of means connectable to a fluid pressure source, to a return, and to one of said fluid passages for maintaining the fluid pressure in said system at a fixed ratio with respect to said source, said means including a valve device provided with a moveable member on which the pressure from the source acts in one direction and on which the pressure existing in said one fluid passage acts in the opposite direction, said member being responsive to a predetermined unbalance in pressure thereacross for controlling flow between said one of the fluid passages and the source on the one hand and between the said one fluid passage and the return on the other hand.

STANLEY I. MACDUFF.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,207,944	Richardson	July 16, 1940
2,229,109	Martin	Jan. 21, 1941
2,431,032	Ernst	Nov. 18, 1947
2,432,305	Geiger	Dec. 9, 1947
2,487,716	Majneri	Nov. 8, 1949
2,506,093	MacDuff	May 2, 1950
2,551,274	MacDuff	May 1, 1951