April 15, 1952 W. E. RENICK 2,593,185

FLOW PROPORTIONING APPARATUS

Filed Sept. 26, 1945

FIG. 1.

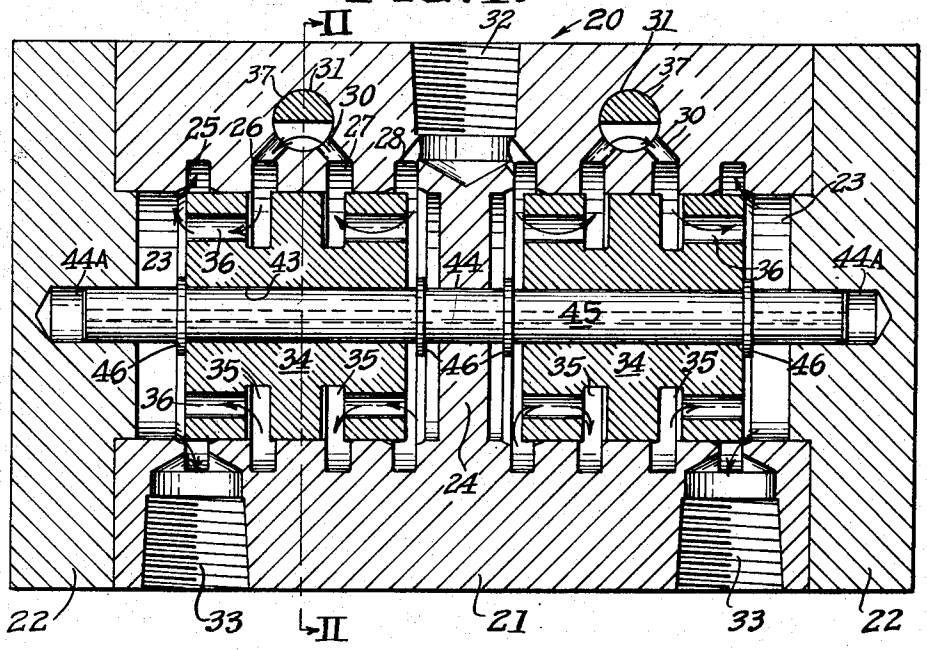
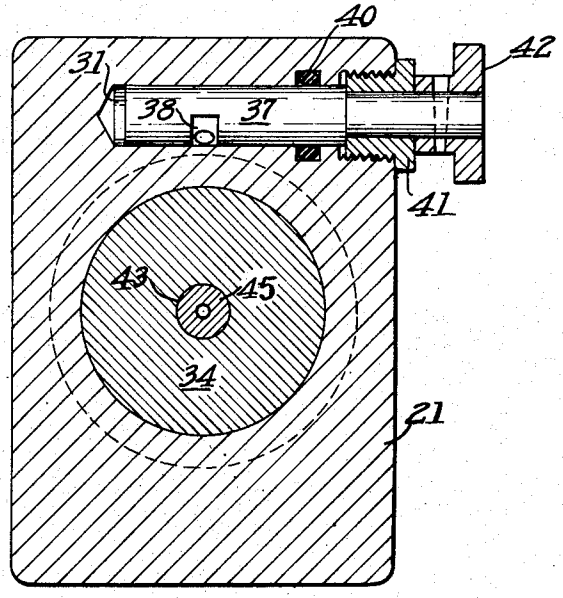


FIG. 2.



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FLOW PROPORTIONING APPARATUS

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1 Claim. (Cl. 137—165)

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This invention relates to hydraulic apparatus; it is more particularly directed to flow control devices which operate automatically to proportion flow from a single source of fluid to a plurality of points of use, such devices being generally known to the hydraulic industry as flow dividers.

One object of the invention is to provide a flow divider which will be operative to direct fluid from a single source to a plurality of system branches in predetermined ratios, these ratios being maintained independently of the variations in resistance to flow developed in either of the branches.

Another object of the invention is to provide a device of the character mentioned in which the ratios of fluid directed into the system branches may be adjusted at will and the adjustment maintained automatically thereafter even though the flow conditions in the branches vary from that existing at the time any particular ratio was selected.

Still another object is to provide a flow divider which will be operative when fluid flow is reversed through the device to maintain a definite ratio between fluids flowing into the device through a plurality of ports which fluids are combined within the device and flow therefrom through a single port.

A further object of the invention is to provide a flow divider having a pair of passages extending from a single port to a pair of separate ports and having valve means for controlling fluid flow through the passages, the valve means in one passage acting counter to the action of the valve means in the other passage, that is, one valve moving toward open position when the other moves toward closed position and vice versa, the valves being operated by means responsive to pressure differentials existing between certain regions in the passages, there being restrictions in the passages which operate to oppose fluid flow therethrough in such manner as to create pressure differentials in proper regions of the passages to effect the operation of the valve means when fluid flow takes place through the passage in either direction.

A still further object is to provide a flow divider having a casing with a plurality of passages starting at a common port and ending in separate ports, the casing having chambers with end portions forming parts of the passages, the chambers receiving pistons which function, in response to pressure differentials existing between the chamber ends due to restricting communication therebetween, as valves to throttle fluid flow

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through the passages, there being connecting means between the piston in the chambers so that force will be transmitted from one to the other and the pistons will operate as a unit.

Another object of the invention is to provide a flow divider of the character mentioned in the preceding paragraph in which the connection between the pistons will permit some relative motion therebetween whereby the pistons may move a sufficient distance away from certain throttling positions to avoid interfering with flow through portions of the passages and toward other throttling positions to control the flow through other portions of the passages, the pistons thus having a plurality of operating positions which adapts the device to reverse operation.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred form of embodiment of the invention is clearly shown.

In the drawings:

Fig. 1 is a vertical longitudinal sectional view taken through a flow divider or flow proportioner formed in accordance with the present invention; and

Fig. 2 is a vertical transverse sectional view taken through the device shown in Fig. 1 on the plane indicated by the line II—II of Fig. 1.

Referring more particularly to the drawings, the flow divider is designated generally by the numeral 20. In the form of the invention illustrated, this device includes a body 21 and a pair of end caps 22. Each end of the body 21 has a piston chamber 23 formed therein, these chambers being separated at their inner ends by a partition 24. The body or casing 21 is also provided with a plurality of annular grooves or recesses 25 to 28, inclusive, spaced longitudinally of each chamber 23. The recesses 25 and 28 are disposed adjacent the ends of the chambers 23, being slightly spaced therefrom for purposes to be hereinafter set forth.

Recesses 26 and 27 are located adjacent points disposed midway of the length of the chambers 23, grooves 26 and 27 being in communication through passages 30 which include, or are intersected by, bores 31 extending into the body 21 from one side thereof. Annular grooves 28 are disposed adjacent the inner ends of the chambers 23 and each communicates with a port 32 extending into the casing 21 from the top side. The grooves 25 which are located adjacent the outer ends of the chambers 23 are intersected by openings 33 formed in the lower side of the casing 21,

these openings 33, as well as the opening 32, being threaded for the reception of conduits.

Each chamber 23 slidably receives a piston member 34 which in the present instance is provided with spaced annular grooves 35 which are adapted to communicate with grooves 26 and 27 in any position of the pistons 34 in the chambers 23. Each piston has a plurality of axial holes 36 extending from the end to the nearest groove 35. The holes 36 together with the grooves 35, 26, 27, and passages 30 establish communication between the ends of the chambers 23 at opposite ends of the piston 34.

It will be apparent from the preceding description that fluid may flow through the casing 21 in either direction between ports 32 and ports 33, passages being provided by the grooves 25, 26, 27, 28 and passages 30. Fluid flow through passages 30 may be restricted by adjustable plugs 37 rotatably disposed in the bores 31. In registration with the passages 30, the plugs 37 have a transverse groove 38 formed therein, opposite edges of these grooves serving in connection with the edges of the bores 30, to provide adjustable orifices in the passages. Suitable packing means 40 may be employed around the plugs 37 to prevent the escape of fluid under pressure. These plugs may be retained in any suitable manner such as by the threaded retaining collar 41 as shown in Fig. 2. The outer ends of the plugs 37 have adjusting knobs 42 secured thereto for the purpose of varying the effective size of the passages 30.

The pistons 34 have central axial openings 43 which, when the pistons are disposed in the chambers 23, are in axial alignment with similar openings 44 and 44A formed in the partition 24 and the end caps 22, respectively. These openings slidably receive a connecting rod 45 employed to transmit force from one piston to another. The rod 45 has a longitudinal opening formed therein to establish communication between the sockets 44A formed in the end walls 22. At each end of the pistons 34, the rod 45 is provided with a collar 46, the collars in each chamber 23 being spaced slightly greater than the length of the pistons in that chamber so that the piston will be capable of some sliding movement on the rod 45. This movement is desirable to permit the end edges of the pistons to move away from the adjacent edges of the annular grooves at the ends of the chamber whereby fluid flow between the end of the chamber and the groove adjacent thereto will be unobstructed at certain times. When such movement of either piston takes place the end edge of a piston will cooperate with the edge of the groove at the end of the chamber toward which the piston moves to throttle communication between that groove and the end of the piston chamber. Fluid flow through the passage will thus be controlled. The collars 46 are so spaced on the rod 45 that when the pistons move in opposite directions in the casing 21, the collars will be engaged by the piston before communication between the grooves 25 and the ends of the piston chambers is interrupted.

In the operation of the device, the piston and the rod 45 operate as a unit moving simultaneously in response to differentials in pressures existing between corresponding ends of the piston chambers. The spacing of the collars on the shaft or rod 45 provides a lost motion connection between the pistons which will permit a certain degree of relative movement therebetween. The pistons may thus cooperate with the casing to serve as throttle valves between grooves 25 and the outer ends of the piston chambers and between grooves 28 and the inner ends of the piston chambers depending upon the direction of fluid flow between port 32 and ports 33.

When fluid is introduced through the port 32, it will flow into the grooves 28 and into the inner ends of the chambers 23. From there it will flow through the holes 36 in the inner sections of the pistons to the inner grooves 35 and to the grooves 27 communicating therewith. This fluid will then flow through the passages 30 to the grooves 26 and into the communicating grooves 35 from which it will flow through outer holes 36 in pistons 34 to the outer ends of the chambers 23. Fluid will then flow into grooves 25 and from these grooves into the ports 33, suitable conduits being connected with the ports 33 to conduct the fluid to points of use.

In actual operation of the flow divider, the plugs 37 are adjusted to offer some resistance to fluid flow through the passages 30. This resistance creates pressure differentials between the inner and outer ends of the chambers 23 when fluid is introduced through ports 32 or when fluid is introduced through ports 33. When 32 is used as the inlet port, the higher pressures will prevail in the inner end of the chambers 23 and when fluid flow is reversed through the casing 21, the higher pressures will exist in the outer ends of the chambers 23. In the event the pressures between corresponding ends of the piston chambers vary, the piston assembly, that is, the pistons and the rod 45, will be moved as a unit by the higher pressure toward the chamber end containing the lower pressure. For example, let us assume that the fluid is being introduced through the port 32 and that ports 33 communicate with passages extending to points of use of the fluid under pressure. If valves 37 are set to offer the same degree of resistance to fluid flow through the passages 30, the same rate of fluid flow will take place through the outlet 33. Due to resistance to flow offered by the valves 37 pressure drops will prevail between the inner and outer ends of the chambers 23 and the higher pressures in the inner ends of such chambers will cause the pistons to move outwardly thereof until the collars 46 at the outer end portions of the rod 45 are engaged by the pistons. Since the same resistance is offered by the valves 37, similar pressures will prevail in the corresponding ends of the piston chambers and the piston assembly will be centrally positioned relative to grooves 25 to offer a minimum throttling effect to the fluid flowing from ports 32 to ports 33. Should resistance to flow occur in one or the other of the branches connected with the ports 33 a pressure differential will develop between the outer end of the piston chambers causing the piston assembly to move toward the outer chamber end containing fluid at the lower pressure. This motion causes the piston in such chamber to exert a throttling action on the fluid flowing from the chamber into the groove 25 communicating therewith until the flow into both ports 33 is equalized. When the condition causing the resistance to flow in the particular branch is remedied, the pressure in the chamber connected therewith will fall and the piston assembly will return toward its original setting. It should be obvious that if the valves 37 are adjusted to provide unequal resistances to flow through passages 30 the piston assembly will op-

erate to automatically maintain the selected pressure ratio. This operation results because the pressure differentials created by the resistance members **37** are applied to the piston assembly and will cause it to move to a position wherein the piston will exert the proper throttling action. If extraneous resistance develops in one of the outlet lines the piston assembly will be moved to create a counteracting resistance in the other line as above described.

The operation of the device is similar when fluid flow therethrough is reversed, except the throttling action takes place between the inner grooves **28** and the inner ends of the piston chambers **23**. By providing the lost motion connection between the pistons and the rod **45** a certain degree of relative movement will take place on the part of the pistons when such reverse flow is initiated. The pistons will then be disposed in engagement with the inner collars **46** and the piston assembly will then move as a unit, a counter-throttling action being secured in the passages. When reverse flow is utilized, the resistance elements **37** will create pressure drops in the same manner as when fluid was introduced through the port **32**. However, the higher pressures will then prevail in the outer ends of the chambers **23**. If a condition should occur in which fluid flow through either of the ports **33** should vary from the initial flow, a different pressure relation between the outer ends of the piston chambers will develop and the piston assembly will be caused to move toward the chamber end containing the lower pressure. The inned end of the piston in the chamber containing the higher pressure will then throttle fluid flow from the inner chamber end to the groove **28** thus maintaining the ratio of fluid admitted from the ports **33** to the ports **32**. When the condition is remedied, the piston assembly will return to its initial position due to the resumption of the selected pressure relation between the corresponding ends of the piston chambers.

The ends of the connecting rod **45** are disposed in the sockets **44A** in the end walls so that the effective areas of the piston ends will be equal.

While the form of embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claim which follows:

I claim:

A flow divider comprising casing means having an inlet port, a pair of outlet ports and a pair of chambers, each chamber being connected at one end with said inlet and at the opposite end with an outlet; a piston slidably received in each of said chambers, the end portions of said pistons cooperating with said casing to throttle communication between the ends of said chambers and the ports connected therewith; means establishing a lost motion connection between said pistons, said means providing for movement of said pistons in unison and limited relative movement therebetween, and a restricted fluid passage connecting the portions of each of said chambers at opposite ends of the piston therein, said pistons being responsive to the difference in fluid pressures at the outer end of each piston to throttle communication between either end of each chamber and the port connected therewith.

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