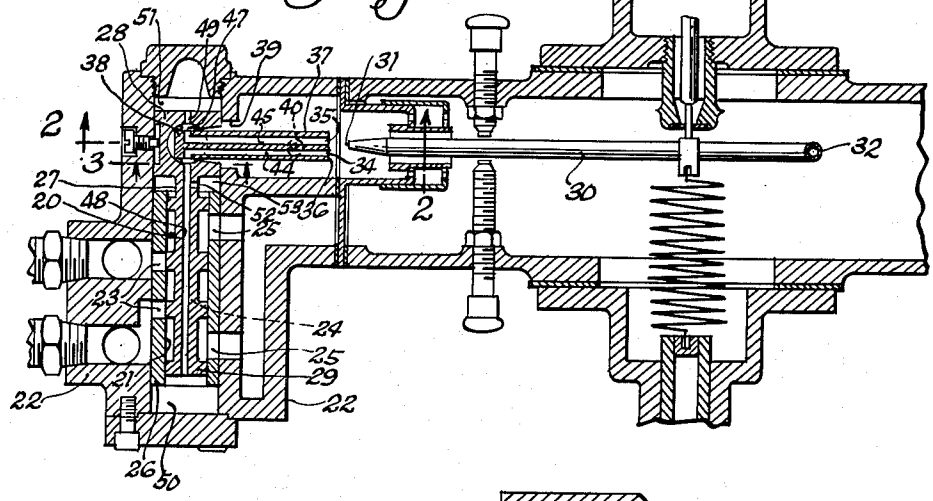
April 17, 1956 S. A. JACQUES 2,742,022

PROPORTIONAL FLUID DELIVERY RELAY JET PIPE REGULATOR

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Fig. 1



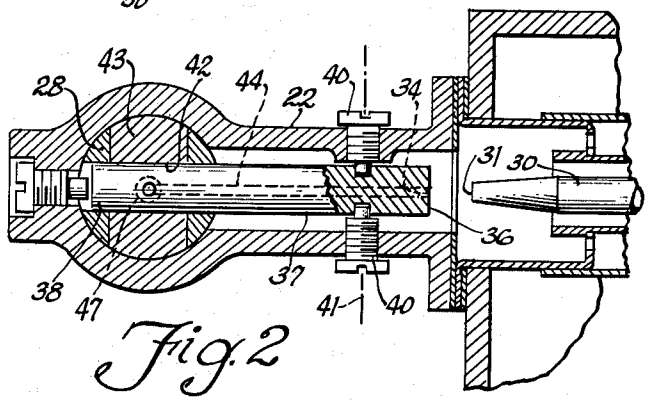


Fig. 2

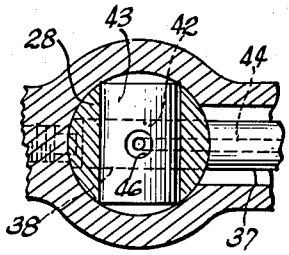


Fig. 3

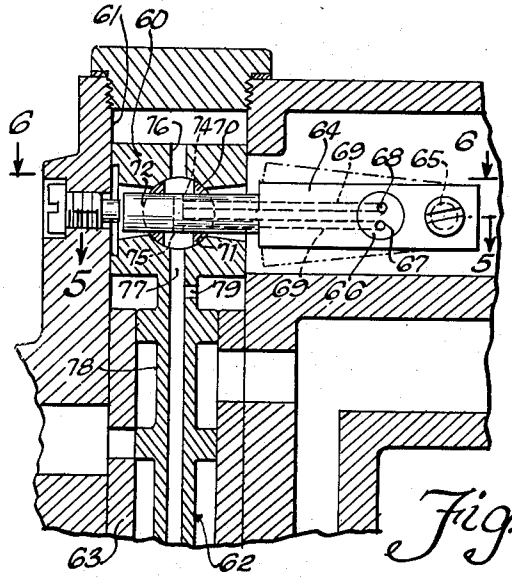


Fig. 4

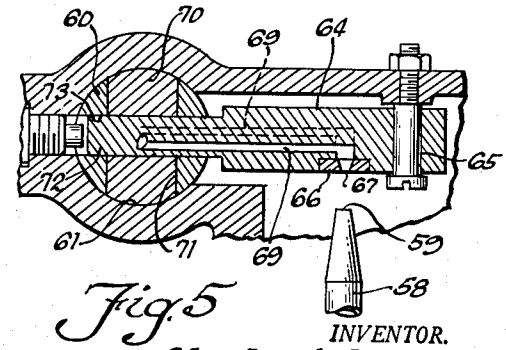


Fig. 5

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Fig. 8

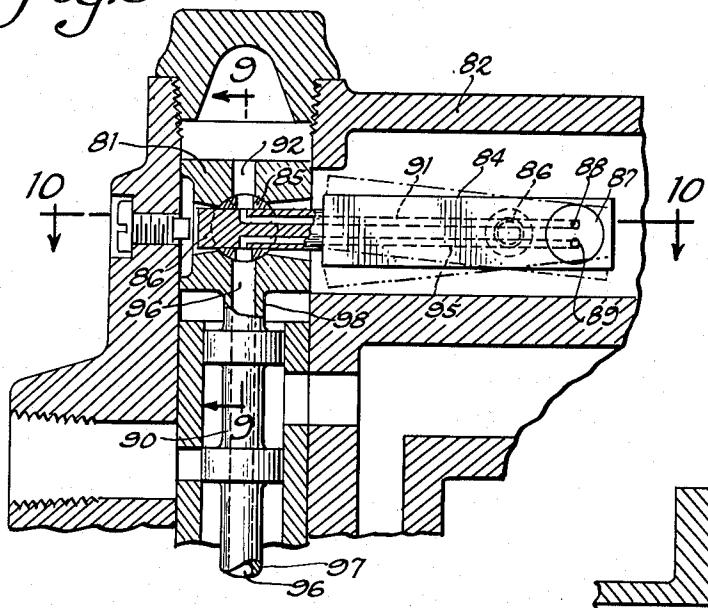
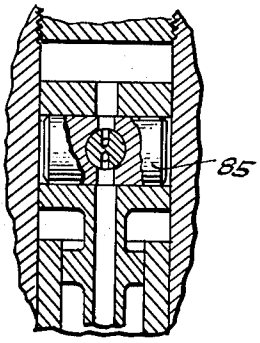


Fig. 9



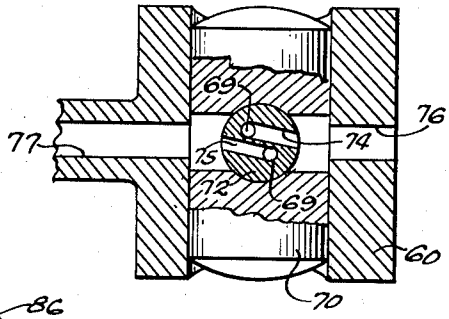
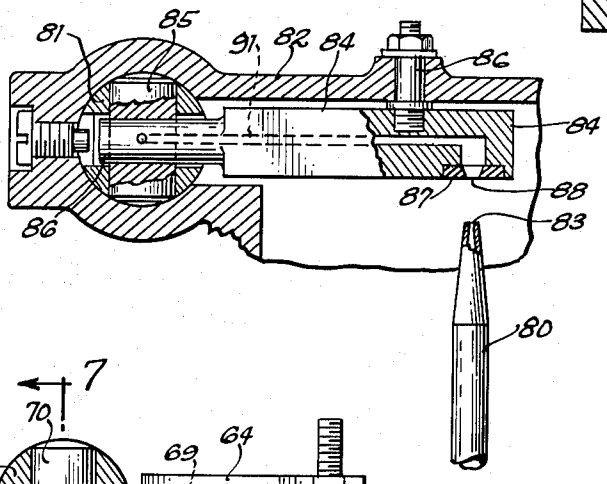


Fig. 7

Fig. 10



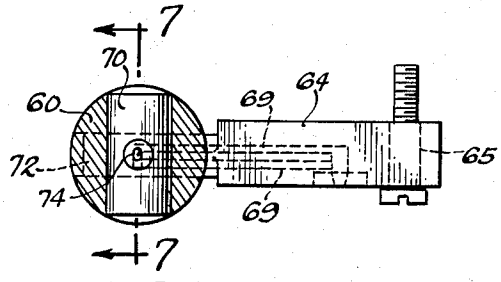


Fig. 6

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2,742,022

PROPORTIONAL FLUID DELIVERY RELAY JET PIPE REGULATOR

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Application April 24, 1952, Serial No. 284,031

3 Claims. (Cl. 121—41)

The present invention relates to hydraulic fluid relay regulators of the kind generally known as jet pipe regulators, and more particularly to regulators of this general type that include auxiliary pistons as amplifiers. Such auxilary pistons are piston members movable in cylinder bores and having mounted on them distributor receivers provided with a pair of receiver ports that are spaced apart in the directions of travel of the discharge orifice of the pivotally mounted jet type. The receiver ports face the discharge orifice of the jet pipe so that they receive fluid discharged from the latter. The receiver ports are connected by internal passages in the piston member in such relation that an unbalance of pressure in the receiver ports, caused by a variation from equal registration of the ports with the jet pipe orifice, will cause the piston to move in the direction of displacement of the jet pipe orifice from that equal registration. Thereby the auxiliary piston, the receiver and the receiver ports tend to move to follow swinging movements of the jet pipe discharge orifice.

A characteristic of jet pipe operation is that the swinging movement of the jet pipe orifice is rigidly restricted to a range of the order of one-eighth inch. In devices of the prior art wherein essentially the auxiliary piston and the jet pipe orifice are locked together, the restricted movement of the auxilary piston member in some instances has unduly restricted the field of utility of such devices.

The present invention is directed to provision of a structural arrangement of receiver and auxiliary piston elements whereby the latter may be given a range of travel much greater than the range of travel of a jet pipe orifice, and yet an arrangement that insures that the distance of travel of the auxiliary piston in response to a movement of the jet pipe will be for a distance having an exact proportional relationship to the distance of travel of the jet pipe orifice. This primary object is accomplished by pivoting the receiver member to the auxiliary piston member and, at a location spaced from the latter, also pivoting it for swinging about a fixed axis. By making the lever arms with which the swinging receiver member thereby becomes provided of unequal length, and more specifically, by locating the fixed pivot axis closer to the path of travel of the jet pipe orifice than to the axis about which it pivots relative to the piston member, the desired differential is established and provides the increased but proportional travel of the auxiliary piston.

Fig. 1 is a median section of an assembly including a main spool type flow sense and volume rate control valve, and an auxiliary piston and jet pipe regulator, arranged in accordance with the invention for positioning the main valve body in correspondence to the position of the jet pipe.

Fig. 2 is a section on line 2—2 of Fig. 1.

Fig. 3 is a section on line 3—3 of Fig. 1.

Fig. 4 is a median fragmentary section of a similar general arrangement but showing a modified form of jet pipe and auxiliary piston regulator, also in accordance with the invention.

Fig. 5 is a section on line 5—5 of Fig. 4.

Fig. 6 is a section on line 6—6 of Fig. 4.

Fig. 7 is a section on line 7—7 of Fig. 5.

Fig. 8 is a view similar to Fig. 4 showing a third jet pipe and auxiliary piston regulator arrangement made in accordance with the invention.

Fig. 9 is a section on line 9—9 of Fig. 8.

Fig. 10 is a section on line 10—10 of Fig. 8.

First referring to Figs. 1 to 3, a main valve spool body **20** is movable in a bore **21** provided by casing structure **22**, to control communication of the different ones of a pair of controlled ports **23** with supply and exhaust ports **24**, **25**. Advantageously the ports are provided in a liner **26**, and preferably controlled ports **23** are rectangular to provide variation in their areas uncovered by body **20** that is linearly proportional to distance of movement of the latter, so that volume flow rate through the controlled ports is accurately related to the distance of body **20** from its neutral or out of position blocking communication of both ports **23** with all of ports **24**, **25**. To position valve body **20** in correspondence to magnitude of an input signal, valve body **20** is rigidly connected by a stem **27** with a piston structure comprising a pair of piston bodies or members **28**, **29** that lie to opposite ends of the valve body. The piston structure **28**, **29** comprises the auxiliary piston of a jet pipe regulator that also includes a jet pipe **30** having in its end a discharge orifice **31**, and supported in radially projecting disposition by a spindle **32**. Spindle **32** is pivotally mounted for swinging the jet pipe about the fixed axis of the spindle, and with the axis of the jet pipe discharge orifice **31** moving in a median plane of the auxiliary piston structure. The latter structure is made to follow movements of jet pipe orifice **31** by means of pressures that are exerted on the structure in opposite directions and that are balanced or unbalanced in a sense to move the piston in the direction in which the jet pipe orifice is displaced from a condition of equal registration with a pair of receiver ports that are moved along the orifice path by travel of the auxilary structure. Pressures are developed in these receiver ports by the fluid jet delivered by the jet pipe, the magnitude of each such pressure varies with the degree of registration with the jet pipe orifice of the receiver port wherein that pressure is developed. The receiver ports are connected through the piston structure with cylinder parts at the respective structure ends in a sense to deliver the higher pressure to the one of such cylinder portions wherein it is effective to drive the piston structure in a direction to move the surface having the receiver ports in the direction of the port developing the higher pressure. When the axis of the orifice extends between the receiver ports they develop equal pressure and the fluid delivery by the jet pipe is not effective to move the piston.

In the arrangement of the present invention provision is made for movement of the auxiliary piston structure **28**, **29** and valve body **20** that is greater than, but accurately proportional to, movements of the jet pipe orifice **31**. Instead of providing the receiver ports in a member rigidly attached to and moving with the auxilary piston structure in accordance with prior practice and whereby the piston moves distances equal to movement distances of the orifice, in accordance with the invention the receiver ports **34**, **35** are provided in the outer end surface **36** of a receiving member **37**. Receiving member **37** has a delivery end **38** pivotally connected with auxiliary piston member **28**, from which the member projects through an opening **39** in casing structure **22**, and has pivot support, as by pins **40** in the casing structure, for swinging about a fixed axis **41** that is spaced from the jet pipe orifice path and piston member **28**,

and closer to the former, by distance having the ratio that distances of corresponding movements of the orifice and auxiliary piston structure are to have. Surface 36 faces the orifice path and receiver ports 34, 35 are spaced in the direction of its extent. The receiver ports are located, and axis 41 is positioned so that throughout the orifice path and the corresponding movement range of the ports, the latter will receive the fluid jet discharged by the orifice. To accommodate the changing angular relation between the axes of the piston structure and member 37 and the changing distance between the axis of their pivotal connection and fixed axis 41, the delivery end 38 of member 37 is slidable in a transverse bore 42 in a trunnion pin 43 that is mounted for rotative movement in piston body 28. Receiver ports 34, 35 respectively communicate, by internal passages 44, 45 with openings 46, 47 in pin 43, and through passages 48, 49 with the cylinder portions 50, 51 that respectively lie outside the opposite end surfaces of piston bodies 28, 29. Passage 48 extends completely through the valve body 20, along stem 27, and communicates by a port 52 with a space 53 that lies between the end of liner 26 and the adjacent end of member 28, which serves to balance the effective areas of the oppositely facing surfaces of the piston structure. Since location of the pivot axis 41 between the jet pipe orifice path and the auxiliary piston structures results in movement of the piston structure and receiving surface 36 in opposite directions, receiver ports 34, 35 respectively are connected to cylinder portions 50, 51 having the same positional relation as the receiver ports, to provide the movement-following relation between the receiver ports and jet pipe orifice referred to above.

In the form of the invention shown in Figs. 4 to 7; the jet pipe 58 is arranged with the axis of its orifice 59 moving in a plane spaced from a parallel plane in which the axis of the auxiliary piston member 60 also lies, the path of orifice 59 and the adjacent surface of piston member 60 being spaced a substantial distance apart. Piston member 60 again is shown as slidable in a bore 61 and as connected with a valve body 62 that is slidable in a line 63 in that bore. Piston member 60 is provided with a receiver member 64 that projects radially from member 60 across the path of the jet pipe orifice 59 and that is pivoted at its end that is remote from member 60, as by a pin 65, for movement, in the directions of extent of the orifice path and by swinging of member 64 about the fixed axis provided by pin 65, or a lateral receiving surface portion 66 that faces the orifice path. Receiving surface 66 is provided with a pair of receiver ports 67, 68 that are positioned to receive fluid from orifice 59 during corresponding movement of jet pipe 58 and member 60 and jet pipe orifice 59 to provide a desired amplification factor and in the movement of member 60 in response to movements of the jet pipe orifice. The delivery end of receiver member 64 is secured to piston member 60 for pivotal and sliding movement, as by a trunnion pin 70 rotatable in a transverse bore 71 in member 60, arranged on an axis that is perpendicular to that of receiver member 64, the delivery end portion 72 of the receiver ports 67, 68 respectively are connected with passages 69, leading to ports in opposite ends of the piston structure provided as in Fig. 1 by piston members including member 60, and a valve body. By reason of similar directions of travel of the receiver surface 66 and delivery end 72 of receiver member 64, occurring by reason of their location in the same direction from the fixed pivot axis, the receiver ports are cross connected to the spaces lying to the oppositely facing piston structure end surfaces, to drive the piston and receiver ports to follow the jet pipe orifice. This is accomplished by crossing transverse delivery passages 74, 75 in the delivery end portion 72 of member 64, passage 74 connecting the receiver port 67 and one passage 69 with a port 76 in the piston member 60 that faces in the same direction as the other receiver port 68 is spaced from port 67. Similarly passage 75 connects receiver port 68 and the other 69 passage with the passage 77 that is extended through valve stem 78 to the opposite piston member end and also having a port 79 adjacent to the second end surface of member 60.

In the arrangement shown in Figs. 8 to 10, and as in Figs. 4 and 5, jet pipe 80 and auxiliary piston member 81 are so mounted by casing structure 82 that the plane of swing of the jet pipe discharge orifice 83 is spaced laterally from the piston member in the direction of the median plane of the latter to which the orifice axis is perpendicular in the center position of the jet pipe. The receiver member 84 is pivotally and slidably connected with piston member 81 by a transverse trunnion pin 85, wherein the delivery end 86 of member 84 is radially slidable. The receiver member 84 in this form of the invention is pivotally mounted to casing structure 82 by a pin 86 that is located between member 81 and the plane of swing of the axis of orifice 83, and member 84 has a lateral surface portion 87 facing the orifice and provided with receiver ports 88, 89. To make the piston structure provided by member 81 and the valve body 90 follow the jet pipe orifice, ports 88, 89 are connected to cylinder spaces faced by piston structure surfaces having the same positional relation as the ports to which they are connected. To this end, port 88 is connected by a passage 91 and a suitable clearance opening in trunnion pin 85 with a passage 92 that leads through the adjacent end of piston member 81. Port 89 is connected by a passage 95 in member 84 and a clearance opening in trunnion pin 85, with a passage 96 that extends through stem 97 and that also has a lateral port 98 beyond the second end of member 81.

It will be apparent that many changes and modifications may be made in the arrangements herein disclosed, and it is to be understood that the scope of the invention is determined solely by the appended claims.

I claim:

1. A jet pipe regulator assembly that comprises a jet pipe having a discharge orifice, means pivotally mounting said jet pipe for swinging of said orifice with its axis swinging in a single plane, means for limiting swing of said jet pipe to confine the swing path of said orifice to preselected limits, a piston member movable axially in a cylinder structure a distance substantially greater than the length of said orifice swing path, structure mounting said jet pipe, cylinder structure and piston member for travel of the latter in the directions of extent of said orifice path and with said orifice path displaced from a lateral surface portion of said piston member that faces toward it, a distributor member having a delivery end pivotally connected with said piston member for traveling with it and a receiver portion extended from the piston toward and having a receiver surface facing and closely adjacent said orifice path, and means pivotally mounting said distributor member for swinging about a stationary axis located to provide lever arm portions of said member of relative lengths that permit said receiver surface to travel substantially between the ends of said orifice path and said delivery end to travel a greater distance with said piston member, said surface having a pair of receiver ports narrowly spaced in the directions of extent of said orifice path and centered on said plane wherein the orifice axis swings and said ports respectively being connected by internal passageways in said receiver and piston member with the different ones of a pair of delivery ports in the opposite ends of the latter.

2. A jet pipe regulator in accordance with claim 1, wherein said means pivotally mounting said receiver member is arranged to fix said stationary axis in a location between said delivery end and receiver surface of said receiver member, whereby said end and surface move in opposite directions during movement of said piston member, and the interconnected ones of the different receiver

and delivery ports are spaced in the same directions from the other receiver and receiver ports, whereby said delivery member surface and receiver ports follow movements of said jet pipe orifice.

3. A jet pipe regulator assembly according to claim 1, wherein said means pivotally mounting said receiver member is arranged to fix said stationary axis in a location to the opposite side of said orifice path from said piston member, whereby said piston member and receiver member surface move in the same direction during movement of the piston member, and the different receiver ports are connected by said passageways with the different delivery ports in crossed senses with respect to the different directions of movement of said piston member, whereby said receiver member surface and receiver ports follow movements of said orifice.

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