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RELAY REGULATOR

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FIG. 1

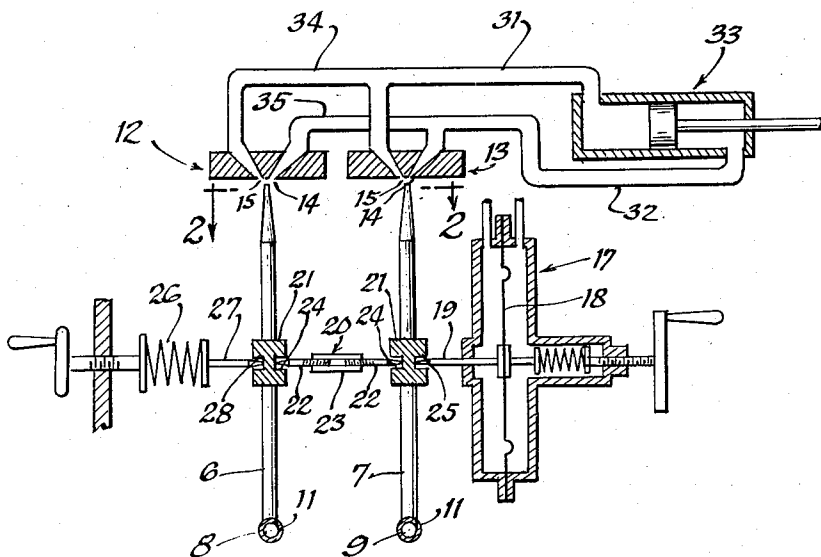
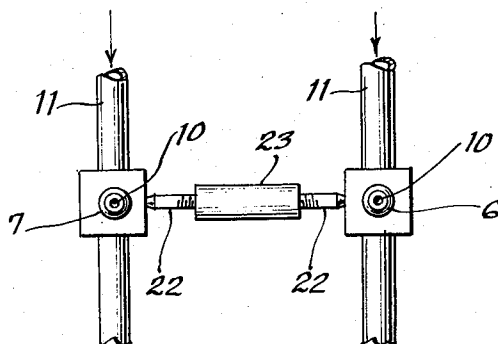


FIG. 2



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RELAY REGULATOR

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10 Claims. (Cl. 137—83)

The present invention relates to hydraulic relay regulators of the well known jet pipe type, wherein a jet pipe having an axial discharge orifice at its tip is suspended for swinging about a fixed pivot axis to move its discharge orifice along a fixed path and facing a receiver or distributor having therein a port, or more usually a pair of ports that are narrowly spaced in the directions of the orifice path, whereby pressure recovered in the port, or differential between pressures in the two ports is a function of degree of registration of the orifice with the port or relative degrees of its registration with the two ports, and therefore of the angular position of the jet pipe, the port pressures being developed by kinetic energy of a jet of fluid forcibly discharged from the jet pipe orifice and impinging on the port mouth, and constituting more or less of the jet as determined by the mentioned degree or degrees of registration, and consequently on the angular position of the jet pipe, which is determined by the magnitude of a control signal applied to it to control that angular position.

For various practical reasons the maximum size of discharge orifice areas of, and maximum pressure of fluid supply to, conventional jet pipes of the type described, are limited, thereby limiting the fluid delivery capacity and maximum volume rate of delivery to a utilization device, typically a piston and cylinder assembly. In many situations higher capacity of a relay regulator than that of the conventional jet pipe as so limited is necessary to conform to requirements of speed and power in a particular situation. Heretofore it has been customary in such situations to employ a two stage amplifier wherein a jet pipe positions an auxiliary piston in accordance with magnitude of a control signal, and the auxiliary piston positions a main control valve body connected in a high capacity fluid delivery system.

A primary object of the invention is provision of a novel assembly of multiple jet pipe regulators connected parallel whereby capacity of the assembly constitutes a multiple of the capacity of individual jet pipes.

Another object is provision of a novel transmission system for multiple jet pipes, of an assembly of the kind in question in a situation requiring highly accurate proportional response to signal magnitude, so arranged that the well known characteristics of jet pipe relay regulators, extreme sensitivity and repeatable accuracy of response to control signal variation, are provided by the overall assembly and reflected in its high capacity output.

In the accompany drawings:

Fig. 1 is a plan, partly in section of a jet pipe relay assembly wherein the regulator is arranged in accordance with the invention.

Fig. 2 is a fragmentary plan of an arrangement for signal transmission from one to another of the jet pipes of a multiple jet pipe assembly.

Referring to Fig. 1, each of a pair of jet pipes 6, 7 is suspended for swinging movement about a different one of a pair of fixed axes 8, 9, to which the different jet pipes are radial. As seen in Fig. 2 each jet pipe is pro-

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vided with an axial discharge orifice 10 in its tip, and is mounted on a hollow spindle 11 through which, and through an internal passage in the jet pipe, fluid under pressure is supplied for forcible discharge as a jet through orifice 10. Associated with the different jet pipes 6, 7, are receiver means 12, 13, each of which is provided with at least one receiver port 14 so positioned with respect to the path followed by the discharge orifice 10 of the associated jet pipe 6 or 7, that swinging of that jet pipe varies degree of registration of its orifice 10 with the receiver port 14. Thus each jet pipe 6 or 7 and the receiver 12 or 13 associated with it constitutes a jet pipe-receiver unit. Degree of registration of a jet pipe orifice 10 with the associated receiver port is determined by the angular position of the jet pipe and in turn determines magnitude of pressure developed in the port by kinetic energy of the portion of the fluid jet that impinges on the port mouth. In the illustrated arrangement, which is most usual in jet pipe installations the respective receivers 12, 13 are provided with second receiver ports 15 which are narrowly spaced from ports 14 in the directions of swing movement of orifices 10, so that magnitudes of pressures developed in the respective ports 14, 15, and differential between them is determined by relative degrees of registration of discharge orifices 10 with the different ports 14, 15, and varies with change in angular positions of the jet pipes.

In accordance with the invention the regulator assembly includes control means so arranged that in response to a change in a control signal applied to the assembly, a corresponding change will occur in the degree of registration of the jet pipe discharge orifice 10 of each unit with the receiver port of that unit, or in the relative degrees of its registration with the two ports of that unit if the receivers are of the illustrated two port distributor type. Correspondence of changes in degrees of registration of orifices 10 of the different units with single ports, as 14, or relative degrees of their registration with dual ports, as 14 and 15, of the receivers of the respective units, is a matter of distance of travel of the axes of the discharge orifices 10 relative to the axes of the receiver ports, and the travel distances of the axes of orifices 10 per unit of angular movements of the different jet pipes depends on the axial length of the jet pipe. Therefore the specific arrangement of the control means, for maintaining correspondence of registration of the orifices and ports of all receiver units, the length of the jet pipes of the different units, and the relative distances of angular movements of the different jet pipes that will produce corresponding changes in orifice and port registration in all units, all are interrelated factors. For simplicity of adjustment and construction it is preferable that the jet pipes of the different units be positively tied together for simultaneous corresponding movement.

In the preferred arrangement shown, to insure corresponding changes of degrees of registration of the different jet pipe discharge orifices with the receiver ports of the different units, all jet pipes are of the same length, have their axes disposed in a common plane, are so tied together as to maintain those axes parallel, and are so suspended that the fixed axes 8 and 9 about which they swing are parallel and lie in a common plane. Correspondingly the axes of the corresponding receiver ports, as 14, 14 and/or 15, 15 of the different units are spaced apart along the common plane of the jet pipe axes at distances equal to those spacing the fixed pivot axes 8, 9. In the two port arrangement the ports 14, 15 of each receiver are equally spaced.

A conventional jet pipe positioning signal translator includes a diaphragm assembly 17 including a diaphragm 18 that is disposed for movement in the direction of swing of the adjacent jet pipe 7 and a push pin 19 being

interposed between that jet pipe and the diaphragm for positioning the former in correspondence to the position of the later. In accordance with the invention a constant length, but adjustable transmission rod 20 is interposed between a pair of pad blocks 21 that respectively are mounted on the two jet pipes 6, 7. Rod 20 may comprise a pair of pin elements 22 having adjacent ends threaded into a connector member 23 so that total length of the rod assembly can be adjusted, and having their remote ends disposed in pockets 24 in blocks 21. Advantageously the end of diaphragm pin 19 is received in a pocket 25 of the adjacent pad 21, so that the axes of pins 19 and 22 are maintained in alignment. A return spring 26 is disposed to the opposite side of the regulator assembly from diaphragm assembly 17, and its transmission pin 27 advantageously is received in a pocket 28 of the adjacent jet pipe mounted pad.

Corresponding ports as 14—14, or 15—15 of receivers 12, 13 are connected together for transmission of pressure and delivery of fluid from those ports to a common service line, as 31 or 32, or a pair of such lines 31, 32 in the case that the receivers are of two port type. Lines 31, 32 are shown as connected to the opposite cylinder ends of a power unit 33 in conventional fashion. Such connection of corresponding ports is shown by conduit structure in the form of manifold piping 34, 35.

Employment of a regulator assembly of the character and arrangement herein disclosed provides retention of all desirable characteristics of jet pipe regulators, such as high sensitivity, response to force or stroke signals of small magnitudes, high power amplification and excellent repeatability, with the additional provision for greatly expanded capacity in volume rate of fluid delivery. It will readily be understood that many changes in and modifications of the specific exemplary form of the invention herein disclosed can be made while employing the invention and obtaining the benefit of its advantages. Consequently it is to be understood that the scope of the invention is to be ascertained solely from the appended claims.

I claim:

1. A hydraulic relay regulator comprising plural jet pipes, each having an axial discharge orifice in its tip, means suspending the different said jet pipes for swinging movement about different fixed axes to which said pipes are disposed substantially radial, for movement of their said orifices in fixed paths as said pipes are swung, control means responsive to magnitude of an applied control signal for simultaneously swinging the different said jet pipes in response to variation of said signal magnitude to move their respective orifices through distances having preselected ratios to each other and to degrees of signal magnitude variations and in directions corresponding to senses of such variations, receiver means provided with corresponding receiver ports that respectively are located in facing relation to the paths of the different said jet pipe orifices and in positions for corresponding degrees of registration with the different said orifices while said jet pipes are in corresponding positions and for corresponding changes in registration degrees as the jet pipes are swung in response to signal magnitude changes, and fluid conductive means interconnecting said corresponding receiver ports for conducting fluid received by them to a service line.

2. A hydraulic relay regulator according to claim 1, wherein said receiver means are provided with a pair of receiver ports facing each of said jet pipe orifice paths, the ports of the different pairs being spaced in the directions of the path that they face and at distances bearing to each other the same proportional relations as the ratios of distances of corresponding movements of the different jet pipes the orifices of which travel in those said paths, and wherein said conduit means interconnect the ones of the ports of the different said pairs that correspond with respect to directions of corresponding move-

ments of the different said jet pipes in response to the same signal magnitude variation.

3. A hydraulic relay regulator comprising plural jet pipes, each having an axial discharge orifice at its tip, means suspending the different said jet pipes for swinging movement respectively about fixed, parallel and laterally spaced axes to which the said pipes are disposed substantially radial, for movement of the said orifices in fixed paths as said pipes are swung, control means responsive to magnitude of an applied control signal for simultaneously swinging the different said jet pipes in response to variation of said signal magnitude to move their respective orifices through distances having preselected ratios to each other and to degrees of signal magnitude variations and in directions corresponding to senses of such variations, receiver means provided with corresponding receiver ports that respectively are located in facing relation to the different said orifice paths and in positions for corresponding degrees of registration with the different said orifices while said jet pipes are in corresponding positions and for corresponding changes in registration degrees as the jet pipes are swung in response to signal magnitude changes, and fluid conductive means interconnecting said corresponding receiver ports for conducting fluid received by them to a service line.

4. A hydraulic relay regulator according to claim 3, wherein said control means maintain said jet pipes with the axes of their discharge orifices disposed substantially parallel.

5. A hydraulic relay regulator according to claim 4, wherein said control means include a constant length transmission element disposed between each two adjacent ones of said jet pipes.

6. A hydraulic relay regulator according to claim 3, wherein said suspension means maintain said jet pipes with their discharge orifices movable in a common plane disposed perpendicular to the said axes about which said jet pipes swing.

7. A hydraulic relay regulator according to claim 3, wherein the axes about which the jet pipes swing are disposed in a common plane, said jet pipes are of equal lengths, said suspension means maintain said jet pipes with the axes of their discharge orifices disposed in a common plane, and said control means include a constant length transmission member connected to each of adjacent ones of said jet pipes at equal distances from the different said axes about which they respectively swing.

8. A hydraulic relay regulator according to claim 3, wherein the axes about which the jet pipes swing are disposed in a common plane, said jet pipes are of equal lengths, said suspension means maintain said jet pipes with the axes of their discharge orifices disposed in a common plane, and said control means maintain said discharge orifice axes parallel and include a constant length transmission member connected between each of adjacent ones of said jet pipes at equal distances from the different said axes about which they respectively swing.

9. A hydraulic relay regulator according to claim 3, wherein said receiver means are provided with a pair of receiver ports facing each said orifice path, the ports of the different said pairs being spaced in the directions of the paths that they face and at distances bearing to each other the same proportional relations as the ratio of distances of corresponding movements of the different jet pipes the orifices of which travel in those said paths, and wherein said conduit means interconnect the ones of the ports of the different said pairs that correspond with respect to directions of corresponding movements of the different said jet pipes in response to the same signal magnitude variations.

10. A hydraulic relay regulator comprising a pair of jet pipes each having an axial discharge orifice at its tip centered on the longitudinal axis of that jet pipe,

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means suspending the different said jet pipes for swinging movement respectively about fixed, parallel and laterally spaced pivot axes disposed in a common plane and to which the respective jet pipes are disposed substantially radial, the said jet pipes being of equal lengths and having their longitudinal axes disposed for movement in a common plane oriented perpendicular to said pivot axes, a constant length transmission member extended, between and connected with said jet pipes for pivotal movement relative to them respectively about axes that are parallel to and each of which is spaced at the same distance from the one of said pivot axes about which the jet pipe swings, and that are spaced apart at a distance equal to that spacing said pivot axes whereby said jet pipes are maintained with their said axes parallel, receiver means provided with two pairs of ports, each facing the path of one of said orifices and the ports of

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each pair being spaced apart in the directions of the path that they face and at equal distances from a midpoint between them that is spaced from the midpoint of the other port pair at a distance substantially equal to the spacing between said pivot axes, and conduit means interconnecting the ones of said port pairs that correspond with respect to directions of their spacing from the different said midpoints.

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