Aug. 26, 1958 B. L. CALLENDER 2,849,013

MULTIPLE JET PIPE RELAY REGULATOR

Filed July 27, 1956 2 Sheets-Sheet 1

FIG. 1

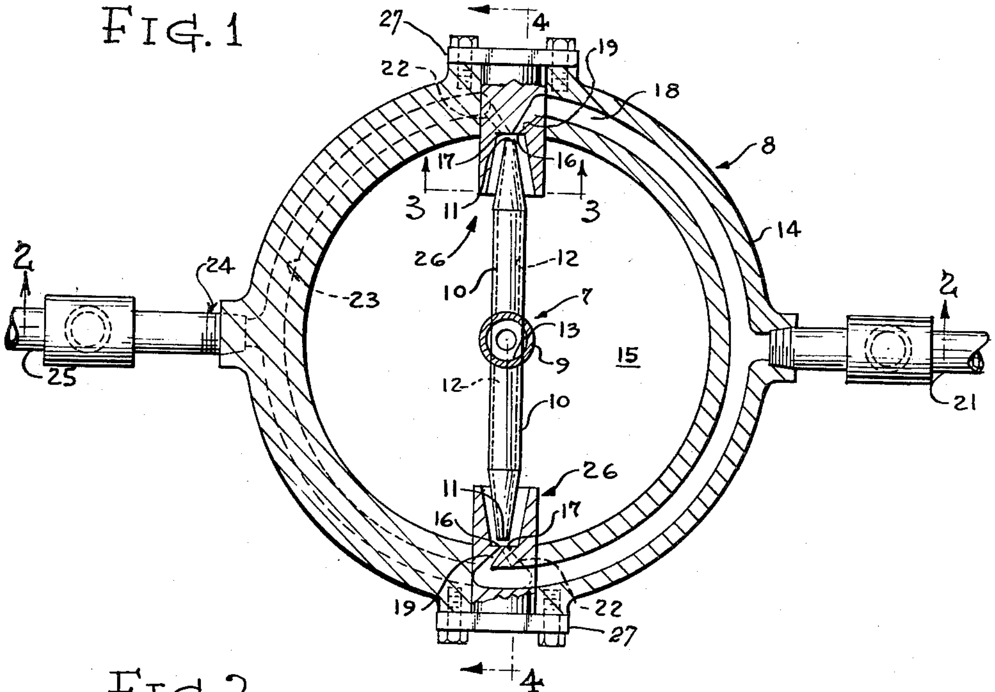


FIG. 2

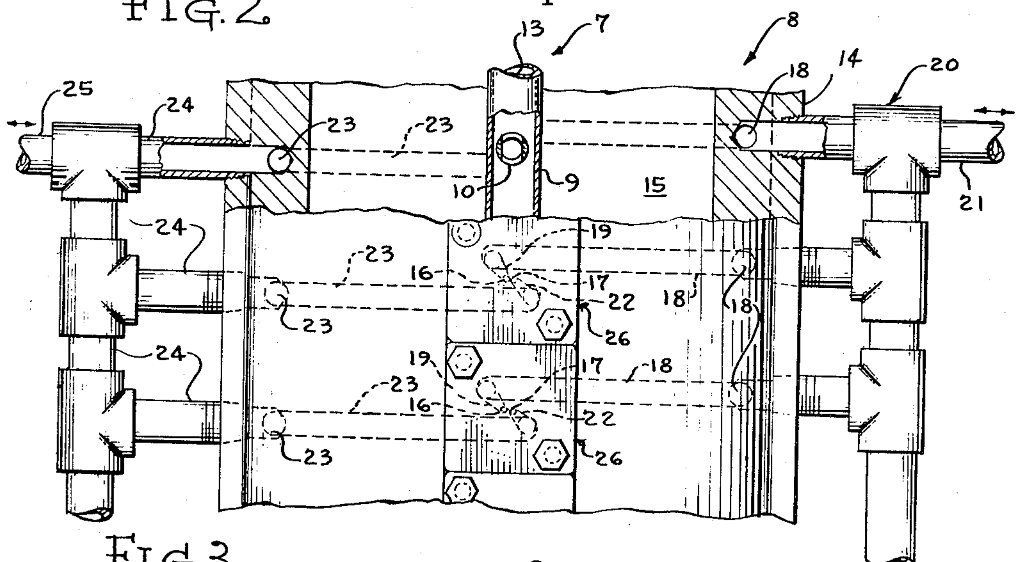
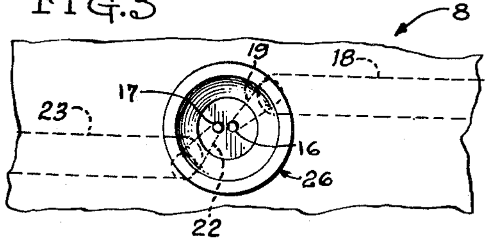


FIG. 3



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MULTIPLE JET PIPE RELAY REGULATOR

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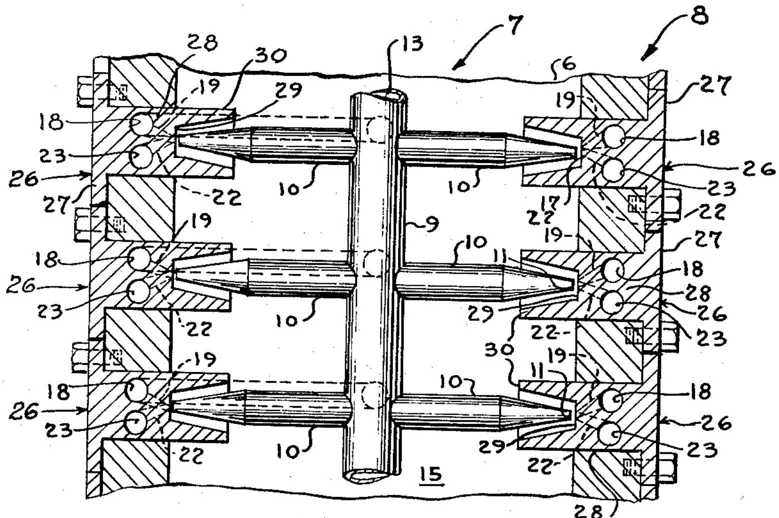

FIG. 4

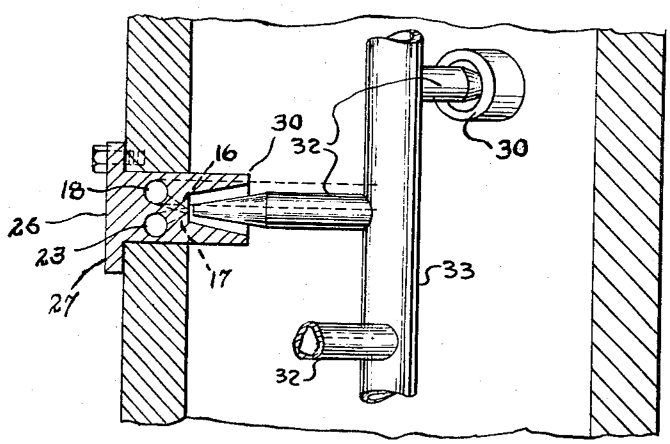

FIG. 5

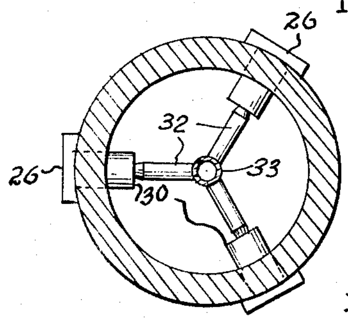

FIG. 6

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MULTIPLE JET PIPE RELAY REGULATOR

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Application July 27, 1956, Serial No. 600,497

6 Claims. (Cl. 137—83)

The present invention relates to multiple jet pipe relay regulators of the general type well known as "jet pipe regulators," an early form of which is disclosed by United States Patent to Wunsch, No. 1,550,410. As heretofore used commercially, such a regulator comprises a jet pipe radially projecting from a spindle that is supported for rotative movement about its axis for variation of degree of registration of an axial fluid discharge opening in its end with a facing receiver port, or variation of relative degrees of registration of the orifice with a pair of receiver ports that are narrowly spaced in the directions of swing of the orifice. Fluid under pressure is discharged as a jet from the jet pipe orifice, to which it is supplied through internal passages in the spindle and jet pipe, and the kinetic energy of the jet as it impinges on the port or ports develops therein a pressure or pressures the magnitudes of which is a function of degree of orifice-port registration. Such pressure, or difference between pressures of a pair of receiver ports, is the output of the regulator.

For a number of reasons having to do with linearity of response of variation of effective output pressure to degree of jet pipe swinging movement, sensitivity to very minute jet pipe deflections, accurate repeatability of response, and so on, there is an apparent practical limit to jet discharge orifice diameter of the order of eight or ten millimeters, which, as will be readily understood, very seriously limits the volume rate of delivery capacity of such regulators. Somewhat similarly, there are apparent practical limits to magnitudes of pressure and volume flow rate at which the jet fluid can be supplied, arising from the throttling effect of the receiver ports, the diameters of which are limited in correspondence to discharge orifice diameters. Heretofore in installations requiring fluid delivery capacities beyond the practical maximum of jet pipe regulators, it has been customary to employ pilot arrangements wherein the jet pipe operates in relay fashion a control valve that is positioned to regulate a large capacity supply to the power unit of the relay, in a so-called "booster" arrangement.

The primary object of the present invention is provision of a novel relay regulator of jet pipe type, having capacity that is high as compared to conventional prior art regulators of the type in question, but that avoids undesirable consequences, such as those indicated, of increase of jet diameter and/or pressure and rate of jet delivery beyond practical limits.

Another object is the provision of a practical multiple jet pipe relay regulator.

Still another object is provision of a practical and convenient multiple jet pipe relay regulator assembly.

In the accompanying drawings:

Fig. 1 is a transverse section of a jet pipe regulator arranged according to the invention.

Fig. 2 is a side elevation partially broken on line 2—2 of Fig. 1.

Fig. 3 is a fragmentary elevation on the plane line 3—3 of Fig. 1.

Fig. 4 is a section on line 4—4 of Fig. 1.

Fig. 5 is a section similar to Fig. 4 showing a modified regulator arrangement.

Fig. 6 is a horizontal section showing the plan arrangement of the device of Fig. 5.

Describing the drawings in detail, the invention resides in arranging an ejector structure, designated generally **7** in Figs. 1 to 4, to deliver a plurality of fluid jets each of which may be limited as to discharge pressure, rate of flow and diameter, as practically necessitated as described, and a receiver structure, generally designated **8** in Figs. 1 to 4 provided with a plurality of receivers each disposed for cooperation with one of the jets for output pressure development as described. The two structures **7**, **8** are arranged for relative movement in preselected opposite directions and the individual jet-ejecting and receiver units are positionally arranged for cooperation to correspondingly vary the output pressures that they respectively develop in consequence of relative movement of the structures.

In the arrangements shown the ejector, as is conventional in jet pipe regulators, is the movable structure. In Figs. 1, 2 and 4 the ejector **7** structure comprises a spindle **9** that is suspended in conventional jet pipe arrangement, as by rotary bearings at its ends, for rotation about its longitudinal axis. A plurality of jet pipes **10** project radially from spindle **9**. Each jet pipe **10** has a discharge orifice in its distal end **11**, and an internal passage **12** (Fig. 1) that connects its discharge orifice with a passage **13** in the interior of spindle **9**, through which, and again in conventional jet pipe fashion, the pressurized power fluid is supplied for forcible jet discharge by the jet pipe orifices.

Receiver structure **8** advantageously comprises a casing wall **14** that encloses a cylindrical regulator chamber **15** that is disposed coaxial with spindle **9**, and with receiver ports opening into chamber **15** in locations for respective cooperation with the different jet pipes **10**. As is more common in jet pipe regulators the port arrangement shown comprises paired receiver ports for cooperation with each jet pipe, the effective output pressure of the regulator being the differential between the pressures developed by the different ports of such pairs. For cooperation with each jet pipe **10** a pair of ports **16**, **17** is provided. The more counter clockwise ports **17** of each pair correspond to each other with respect to sense in which pressures that the jets develop in them vary in response to direction of rotative movement of spindle **9** and swing of jet pipes **10**, as do the more clockwise ports **16** of each pair. In the arrangement of Figs. 1, 3 and 4, the jets pipes **10** are arranged in oppositely projecting, coaxial pairs, with the pairs spaced along spindle **9** and in stacked registration. The corresponding ports **16** that are disposed for cooperation with the different jet pipes **10** are interconected by passage means, shown as a system of passageways **18** extended circumferentially about approximately one-half of the receiver structure and in its wall **14** and to which ports are connected by inclined ways **19**, one such passage **18** being provided for each pair of jet pipes, and the different passages **18** being externally interconnected by piping **20** and all connected to a service line **21**. Similarly, all of corresponding ports **17** are interconnected by inclined ways **22**, internal partially circumferential passages **23** and external piping **24**, and all are connected to a second service line **25**.

Preferbaly each pair of ports **16**, **17** is provided in an individual distributor member **26**, which permits individual adjustments for proper positioning of the ports relative to the different jet pipes **10**, as may be necessary due to tolerances in the jet pipes and their positions as mounted on spindle **9**. Each such distributor member is shown as a unitary body having an external mounting flange **27** for face to face contact with the exterior surface of casing wall **14**, and a body **28** extended through wall **14** and having a surface **29** that faces the interior of chamber **15** and through which a pair of ports **16**, **17** open, and, for use in an oil powdered regulator, a flange **30** that surrounds the ports and that acts as an oil catcher, a semi-enclosure that maintains a body of spent oil about the jet pipe orifice and receiver ports to prevent entrainment of air by the jet and its injection into the ports and delivery system.

It will be understood from the foregoing that rotative movement of the ejector structure **7**, in response to imposition upon it of a signal force or stroke, will swing all jet pipes in a single direction, resulting in a corresponding change in degrees of registration of all jet pipe discharge orifices with the different ports **16**, **17** of each distributor member **26**, and that the rates of flow through service lines **21**, **25** is determined by the number of jet pipe-distributor member couples **10**, **26**, as well as by the magnitude of difference between pressures developed between ports **16**, **17** of each member **26**.

In the modified arrangement of Fig. 5, plural jet pipes **32** are spaced along spindle 33, with the axes of the jet pipes symmetrically spaced about the spindle axis. The distributor members are identical to those shown in Figs. 1 to 4 and have the same reference numerals applied to them.

It is preferable that the multiple jet pipes suspended by a single spindle be symmetrically distributed, so that reactive forces generated by the axial discharges from the respective jet pipes will be balanced, instead of exerting on the spindle forces that are unbalanced and that would tend to deflect it from its proper position or to cause development of friction forces at its suspension bearings. Such symmetrical jet pipe distribution is accomplished in the Fig. 1 form by axial alignment of oppositely directed pairs of jet pipes, and in the Fig. 6 arrangement by angularly spacing the jet pipes equally about the spindle axis.

It will be appreciated that numerous arrangements of multiple jet pipe and receiver or distributor couples other than those shown can be made while obtaining the benefit of large fluid delivery capacity and retaining the previously recognized advantages of jet pipe relay regulators, such as extremely high sensitivity, good linearity and large amplification. Accordingly, it is to be understood that the limits of the invention herein disclosed are to be ascertained from the appended claims rather than from the foregoing exemplary specific arrangements.

I claim:

1. A hydraulic relay regulator comprising an ejector structure and a receiver structure and support means interconnecting said structures for movement of one relative to the other in preselected directions and in a preselected path, said ejector structure having plural fluid discharge apertures and internal passage means for delivering fluid to them for discharge as multiple jets, and said receiver structure having plural distributor members each of which has at least one receive port, said distributor members corresponding in number to said discharge apertures, each of said distributor members being disposed for cooperation with a different one of said apertures, and said apertures and ports being relatively disposed for corresponding variation in degrees of registration of the various said ports with the respective cooperative said apertures as a consequence of movement of said one structure relative to the other, said receiver structure having internal passage means communicating with said ports for delivery of fluid that they receive from said apertures and said regulator including structure provided with a common delivery passage and

branch passageways interconnecting said delivery passage with said receiver structure passage means.

2. A hydraulic relay regulator according to claim 1, wherein said receiver ports are arranged in pairs the different ones of which are disposed for cooperation with the different ones of said apertures, and the different ports of each said pair being narrowly spaced in the directions of relative movement between said structures, said receiver structure internal passage means comprise a pair of passages the different ones of which communicate with all of the ones of said ports that correspond in respect to their directions of spacing from the ports with which respectively they are paired, and the latter said structure being provided with a pair of delivery passages respectively connected with the different ones of said ports that so correspond.

3. A hydraulic relay regulator comprising an ejector structure including a spindle mounted for rotative movement about its longitudinal axis and a plurality of jet pipes projecting substantially radial from said spindle, said jet pipes having discharge apertures in their distal ends and they and said spindle having internal passages for supply of fluid under pressure to said apertures for jet discharge therefrom, and a receiver structure having different portions that respectively face said apertures and each of which is provided with at least one receiver port, said ports being positioned for respective cooperation with the different said apertures and for corresponding variation of degree of registration of each said orifice with the port in the facing said surface in consequence of rotation of said receiver structure about said axis, said receiver structure having passage means for delivering fluid received by said ports from said orifices, and said regulator including structure provided with a common delivery passage and branch passageways interconnecting said common delivery passage with each of said passage means that is connected with a said port.

4. A hydraulic relay regulator according to claim 3, wherein said jet pipes, apertures and receiver ports are spaced axially of said spindle.

5. A hydraulic relay regulator according to claim 3, wherein said jet pipes comprise plural pairs of coaxially disposed jet pipes, the pipes of each pair projecting oppositely from said spindle and the respective said pairs being spaced along said spindle in the directions of said axis.

6. A hydraulic relay regulator according to claim 3, wherein said receiver structure comprises a casing enclosing a cylindrical chamber that is disposed coaxial with said spindle and plural distributor members corresponding in number to said jet pipes, said members being supported by said casing and each having a surface exposed in said chamber and facing a different one of said discharge apertures, said ports comprising pairs of ports each said pair of ports opening through a different one of said surfaces and the ports of each pair being spaced circumferentially of said chamber, said passage means comprising a pair of internal passages extended about said chamber in the wall structure of said casing and the different said passages respectively communicating with the ports of each said pair that correspond with respect to direction of their spacing from the other ports of each pair.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,849,013 August 26, 1958

Bernard L. Callender

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, lines 16 and 17, for ""jet pipe regulators,"' read -- "jet pipe regulators", --; column 2, line 51, for "jets" read -- jet --; line 55, for "interconected" read -- interconnected --; line 67, for "Preferbaly" read -- Preferably --; column 3, line 60, for "receive" read -- receiver --.

Signed and sealed this 11th day of November 1958.

(SEAL)

Attest:

KARL H. AXLINE

Attesting Officer

ROBERT C. WATSON

Commissioner of Patents