Feb. 10, 1953 R. H. GODDARD 2,627,876

VENTURI CONTROL FOR LIQUID FLOW

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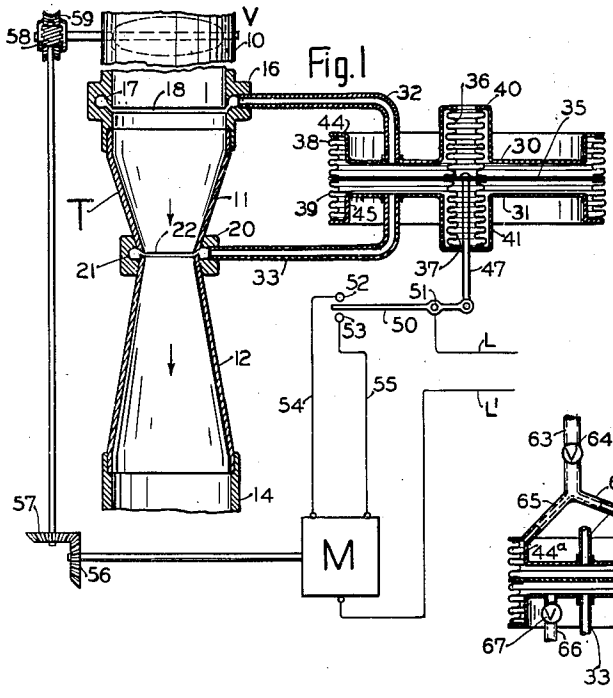


Fig. 1

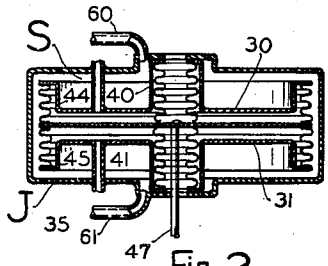


Fig. 2

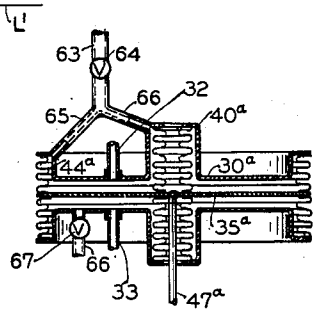


Fig. 3

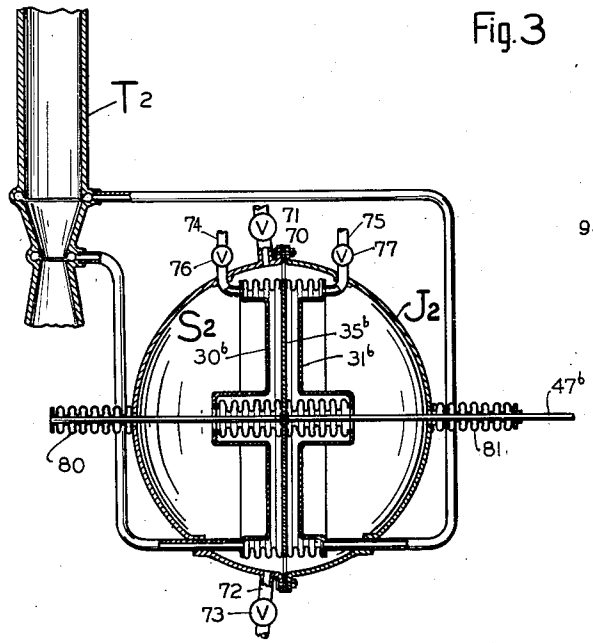


Fig. 4

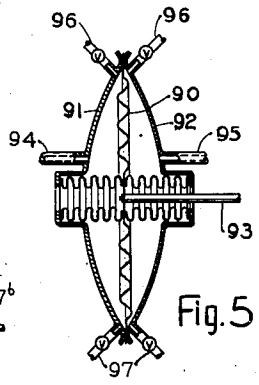


Fig. 5

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VENTURI CONTROL FOR LIQUID FLOW

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Application June 6, 1950, Serial No. 166,511

3 Claims. (Cl. 137—780)

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This invention relates to the control of liquid flow in feed pipes and other similar conduits. The invention is particularly useful in regulating the flow of a liquid combustion element to a combustion chamber of the general type used in rockets and rocket craft.

It is the general object of the invention to provide apparatus effective to control the flow of a liquid in predetermined relation to the difference in pressure found at different points in a Venturi tube through which the liquid is caused to flow.

This difference in pressure increases with any increase in the rate of flow of the liquid, and it is a further object of the invention to provide improved means to vary the flow in inverse relation to the changes in pressure. Means is also provided for producing the control indication with a minimum displacement of liquid in the control apparatus.

The invention further relates to arrangements and combinations of parts which will be hereinafter described and more particularly pointed out in the appended claims.

Preferred forms of the invention are shown in the drawings, in which:

Fig. 1 is a sectional side elevation of a Venturi tube and a preferred form of the control apparatus associated therewith;

Fig. 2 is a sectional side elevation of a jacketed construction;

Fig. 3 is a sectional side elevation showing a modified venting arrangement;

Fig. 4 is a sectional side elevation of a modified control apparatus; and

Fig. 5 is a sectional side elevation of a further modification.

Referring particularly to Fig. 1, a Venturi tube T is shown which comprises an inlet section 10, a contracting Venturi section 11, an expending Venturi section 12, and an outlet section 14.

An annular casing 16 connects the sections 10 and 11 and is provided with an annular recess 17 which communicates with an annular slot 18 between the adjacent ends of the Venturi sections 10 and 11. The slot 18 is inclined in the direction of flow, as clearly indicated in Fig. 1.

A second annular casing 20 connects the Venturi sections 11 and 12 and is provided with an annular recess 21 communicating with an annular slot 22 between the adjacent ends of the Venturi sections 11 and 12. The slot 22 is also inclined in the direction of flow.

The control apparatus shown in Fig. 1 comprises upper and lower casing members 30 and

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31, mounted in fixed spaced relation and connected by pipes 32 and 33 to the annular recesses 17 and 21 respectively. A disc 35 is mounted between the casing members 20 and 31 and is supported by inner bellows members 36 and 37 and outer bellows members 38 and 39.

The upper inner bellows member 36 connects the middle portion of the disc 35 to an upward extension 40 of the upper casing member 30, and the lower inner bellows member 37 similarly connects the disc 35 in a downward extension 41 of the lower casing member 31. The upper outer bellows member 38 connects the outer edge of the disc 35 to a peripheral upward extension 44 of the upper casing member 30, and the lower outer bellows member 39 similarly connects the edge of the disc 35 to a peripheral downward extension 45 of the lower casing member 31.

The middle portion of the disc 35 is connected to actuate a rod 47, which rod controls the flow of liquid through the Venturi tube T.

Any suitable control connections may be provided between the rod 47 and the tube T. Illustrative connections as shown in Fig. 1 comprise an indicating lever 50 pivoted at 51 and having its short arm operatively connected to the rod 47. The lever 50 is suitably insulated from the rod 47 and is connected to a line wire L.

The long arm of the lever 50 is adapted to engage one or the other of two contacts 52 and 53, connected by wires 54 and 55 to reverse windings in a motor M, to which a second line wire L' is also connected. The motor M is adapted to operate a valve V in the Venturi inlet section 10 through bevel gears 56 and 57, a worm 58 and a worm gear 59.

With these connections, it will be evident that upward displacement of the diaphragm 35 will cause the arm 50 to engage the lower terminal 53 and cause the motor M to rotate in one direction, whereas downward displacement of the disc 35 will cause the arm 50 to engage the terminal 52 and rotate the motor M in the other direction. The valve V will thus be shifted in accordance with the displacement of the disc 35, due to changes in relative pressures in the Venturi tube between the slots 18 and 22. An increase in pressure difference indicates an increase in rate of flow and acts to move the disc 35 upward and to initiate a movement of the valve V in a closing direction.

If the liquid to be controlled is a very cold liquid, such as liquid oxygen, it is desirable that the bellows-operated control apparatus be enclosed in a suitable jacket J (Fig. 2) which is

lined or coated with a suitable insulating material to prevent escape of heat and vaporization of the cold liquid.

It is also desirable that the space S within the jacket be filled with the same or some equivalent cold liquid, so as to further reduce the tendency to form vapor within the control apparatus. This cold liquid may be supplied through a pipe 60 (Fig. 2) and discharged through a pipe 61. Otherwise the construction is as shown in Fig. 1.

Before starting the control apparatus in operation, it is desirable to thoroughly exhaust all air or gas from between the casing members 30 and 31 and the disc 35. This may be accomplished manually by moving the rod 47 upward and downward to pump out the air or gas through the pipes 32 and 33 (Fig. 1), but in the construction shown in Fig. 3, this pumping operation is rendered unnecessary, at least in part, by the provision of a vent pipe 63 having a valve 64 and connected by branch pipes 65 and 66 to the upper ends of the upward extensions 40*a* and 44*a* of the upper casing member 30*a*. The space below the disc 35*a* may be similarly vented through a pipe 66 having a valve 67.

The construction shown in Fig. 4 is desirable where very high pressures are to be encountered in the Venturi tube T2. The control apparatus is substantially as shown in Fig. 1, except that the disc 35*b* is mounted in a vertical instead of a horizontal plane, and except that the casing members 30*b* and 31*b* are enclosed within a spherical jacket J2, which is preferably made of steel or other material adapted to resist substantial pressure.

Any suitable liquid under pressure may be supplied to the jacket space S2 through a supply pipe 70 and valve 71, and may be drawn off through a discharge pipe 72 and valve 73. Vent pipes 74 and 75 may be connected into the upper parts of the casing members 30*b* and 31*b* and may be provided with suitable valves 76 and 77.

In order to balance pressures on the actuating rod 47*b*, the rod is extended through both sides of the jacket casing J2 and may be sealed therein by elongated bellows members 80 and 81. These bellows members permit substantially free axial movement of the rod 47*b* and the pressures in said bellows members balance each other.

Any desired pressure may be maintained in the space S2 to selectively offset any pressures encountered in the tube T2 or within the casing members 30*b* and 31*b*.

A simplified and extremely rigid construction is shown in Fig. 5, in which a corrugated disc 90 is mounted between segmental concave casing members 91 and 92 and is provided with an actuating rod 93. Pressures from spaced points in a Venturi tube are applied through pipes 94 and 95, which correspond to the pipes 32 and 33 in Fig. 1.

Vent pipes 96 with associated valves are provided at the top of the casing members 91 and 92, and drainage pipes 97, also with associated valves, are connected into the lower portions of the casing members 91 and 92.

This form of the invention is economical to manufacture and is well adapted to handle substantial pressures in the associated Venturi tube.

In all forms of the invention, it will be seen that provision is made to regulate and control the flow of a liquid through a Venturi tube in accordance with the rate of flow through the tube, and to vary the supply of liquid to the tube in such manner as to maintain substantially uniform flow.

Having thus described the invention and the advantages thereof, it will be understood that the invention is not to be limited to the details herein disclosed, otherwise than as set forth in the claims, but what is claimed is:

1. Apparatus displaceable by differential liquid pressures and comprising a diaphragm disc, upper and lower casing members providing a closed compartment at each side of said disc, said casing members each having a substantially raised edge portion and an outwardly extending middle portion substantially spaced from said edge portion, separate bellows members sealed to said disc and to the raised edge portion of each casing member, separate bellows members sealed to said disc and to the outer end of the middle portion of each casing member, means to supply liquids under differential pressures to said closed compartments, which liquids are effective to bodily displace said diaphragm disc, and a control member fixed to said disc and movable therewith.

2. Displaceable apparatus as set forth in claim 1 in which said apparatus is entirely enclosed in an outer jacket, and in which means is provided to supply a fluid under pressure to said jacket to partially offset the internal pressures in said compartments.

3. Displaceable apparatus as set forth in claim 1 in which provision is made to connect the outwardly extending edge and middle portions of one casing member to each other and to the atmosphere, whereby to vent the compartment enclosed by said member and to facilitate filling of said compartment.

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Executrix of the Last Will and Testament of Robert H. Goddard, Deceased.

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