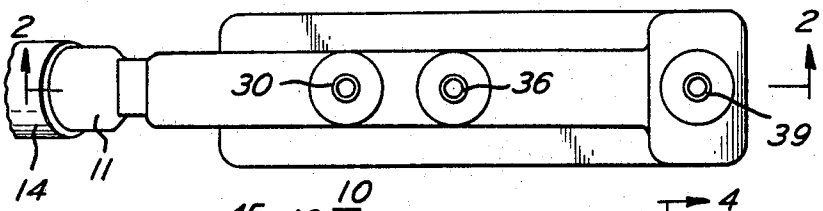
Nov. 18, 1969 D. B. KIRK 3,478,765

PILOT VALVE

Filed April 18, 1967

FIG. 1



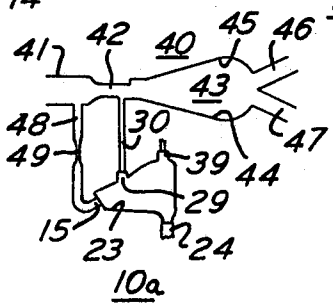
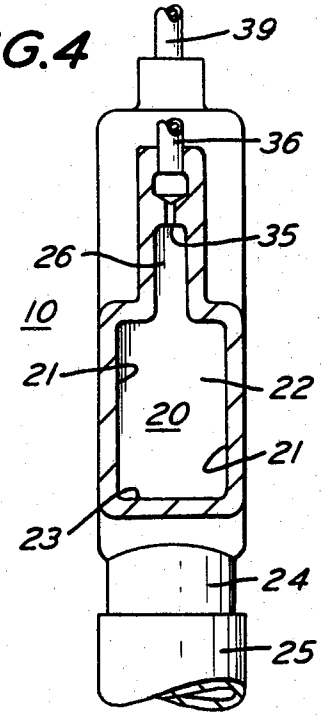


FIG. 6

FIG. 2

FIG. 4



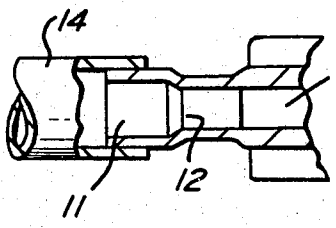


FIG. 3

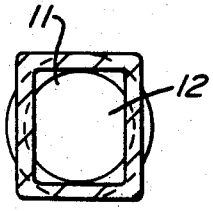


FIG. 5

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PILOT VALVE

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U.S. Cl. 137—81.5 9 Claims

ABSTRACT OF THE DISCLOSURE

A liquid flow sensitive pilot valve having no moving parts exposed to the liquid and in which one wall or a plurality of walls in sequence are provided for liquid lock-on dependent on the flow, the walls having control signal ports affected by the flow along the wall in which the port is located.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to liquid flow sensitive pilot valve in which a jet of fluid from a nozzle has its path determined by the rate of flow.

Description of the prior art

Various types of pilot valves have heretofore been proposed most of which have had moving parts with accompanying problems of maintenance, necessity for adjustment, and limited useful life.

It has also been proposed to employ transmitted and received fluid jets with the pick up influence or modified by an external object. These were not however, dependent on variations of the rate of flow of the fluid.

SUMMARY

It is the principal object of the present invention to provide a liquid flow sensitive pilot valve having no moving parts in which a jet of liquid delivered into a chamber takes a path determined by the rate of flow of the liquid of the jet, and in which in one condition of flow the liquid passes to one path and for a different rate of flow of the liquid, the liquid locks onto a surface which has a central signal port.

It is a further object of the present invention to provide a pilot valve of the character aforesaid in which the valve can be embodied in a multiple stage unit.

It is a further object of the present invention to provide a pilot valve of the character aforesaid which is simple in construction and may be cast or molded.

It is a further object of the present invention to provide a pilot valve responsive to rate of flow therethrough, and in which the liquid from a nozzle while subject to gravity may be locked onto an interior surface which has a control signal port.

BRIEF DESCRIPTION OF THE DRAWING

The nature and characteristic features of the invention will be more readily understood from the following description taken in connection with the accompanying drawings forming part thereof, in which:

FIGURE 1 is a top plan view of a preferred embodiment of a pilot valve in accordance with the invention;

FIG. 2 is a longitudinal central sectional view, enlarged, taken approximately on the line 2—2 of FIG. 1;

FIG. 3 is a sectional view, taken approximately on the line 3—3 of FIG. 2;

FIG. 4 is a sectional view, taken approximately on the line 4—4 of FIG. 2;

FIG. 5 is a setcional view, taken approximately on the line 5—5 of FIG. 2; and

FIG. 6 is a diagrammatic view showing one mode of use of a simplified form of pilot valve in accordance with the invention.

Like numerals refer to like parts throughout the several views.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now more particularly to the drawings, the pilot valve in accordance with the invention preferably includes a housing **10**, which may be made in any desired manner such as by molding or casting, of metal, synthetic plastic or any desired material. The material is preferably resistant to and free from corrosion by the liquid being handled.

The housing **10** has a liquid inlet connection **11** which is preferably provided with an interior transitional section **12**. The section **12** has an interior shape which advances from circular at the inlet to rectangular at its outlet. A conventional tubular conduit **14** can be connected to the inlet connection **11** for the introduction of the liquid whose flow variation is effective within the pilot valve. Immediately beyond the transitional section **12**, a nozzle section **15** is provided, preferably rectangular in transverse cross section. The longitudinal axis of the nozzle section **15** in the particular embodiment is at an angle of 60° with respect to the vertical. The nozzle section **15** preferably has an upper sharp terminal edge **16** and a lower sharp terminal edge **17** on an interior face **18**.

The housing **10** includes a chamber **20** with which the nozzle section **15** is in communication. The chamber **20** has opposite vertical side walls **21**, a vertical end wall **22** connecting the side walls **21**, an inclined bottom wall **23** extending downwardly from the face **18** and connecting the side walls **22**, and a liquid discharge connection **24** at the lower terminus of the bottom wall **23**.

A fluid connection **25** is provided for delivery of the fluid from the discharge connection **24**.

The chamber **20** is bounded at the top thereof by a wall portions which provides an upwardly inclined channel **26**.

The channel **26**, extending from the face **18** and accordingly in upwardly offset relation to the upper edge **16** of the nozzle section **15**, has an inclined surface **27** which can be flat and which provides a surface for liquid lock-on. The surface **27** has a sharp edge terminal **28** and upstream of the edge **28** a port **29** is provided to which a signal take off connection **30** is connected.

In set back relation to the inclined surface **27**, a second surface **32** is provided for liquid lock on. The surface **32** inclined as at **33** and substantially parallel to the longitudinal axis of the nozzle section **15** has its terminal portion **34** curved and brought substantially horizontal.

The surface **32**, a sufficient distance therealong beyond the edge **28** for liquid lock on to occur has a port **35** to which a signal take-off connection **36** is connected.

The chamber **20** including the upper end of the channel **26** are in communication with a vent opening **38**, for venting, and to which a fluid connection **39** is connected which extends to any desired pressure reference.

Referring now to FIG. 6, a simplified form of pilot valve **10***a* is illustrated, connected to a diverting valve **40**. The diverting valve **40** has a supply connection **41** for fluid connected thereto for delivery through a nozzle **42** into a fluid interaction chamber **43**. The chamber **43** is non-symmetrical and has a favored lower wall **44** which is blended into the axis of the nozzle **42** with only a small set back at the exit end of the nozzle **42**. The upper wall **45** has a larger set back from the nozzle **42** and diverges

from the nozzle **42**. The walls **44** and **45** respectively control the delivery into the discharge passageways **46** and **47**.

The supply connection **41** has a fluid connection **48** extending therefrom through a restriction **49** to the inlet connection **11** of the pilot **10***a*. The take off opening **29** is connected to the nozzle **42** close to its exit end.

The mode of operation will now be pointed out.

Assume that liquid is supplied through the inlet connection **11**, the transitional section **12** and the nozzle section **15** into the channel **26** of the chamber **20**.

At a very low rate of flow the liquid, as a jet from the nozzle section **15** will not reach the surface **27** or if it does reach the surface does not contact that surface sufficiently to lock on. The fluid path of the jet is influenced by the accelerating field such as that of gravity acting on the jet in a direction away from the surface **27**. The set back on the surface **27** at the interior face **18** aids in preventing undesired lock on. The liquid from the nozzle section **15** will accordingly fall toward bottom wall **23**, move downwardly therealong, and then out through the discharge connection **24**. The ports **29** and **35** are subect to the pressure prevailing in the chamber **20** since nothing has brought about any change at those ports.

At a higher level of liquid flow through the nozzle section **15**, and subject as before to the accelerating field, the jet will contact the surface **27** and lock onto that surface by the Coanda effect. At the edge terminal **28** the liquid will commence to fall in the chamber **20** for discharge through the discharge connection **24**.

The continuous flow of liquid along the surface **27** will prevent air from being exhausted through the port **29** and pipe **30** thereby providing change of condition which is useful for signaling purposes available in the take off connection **30**.

At a still higher rate of liquid flow through the nozzle section **15**, and subject as before to the accelerating field, the jet will contact the surface **32** and lock onto that surface by the Coanda effect and then turn downwardly in the chamber **20**, and discharge through the liquid discharge connection **24**.

The continuous flow of liquid along the surface **32** will prevent air from being exhaust through the port **35** and pipe **36** thereby providing a change of condition which is useful for signaling purposes.

Upon decrease of flow through the nozzle section **15** the reverse of the operations just described would occur.

The terminal edge **17** and the set back of the wall **23** with respect to the nozzle is such as to prevent any lock-on of liquid on the wall **23** which would prevent its movement in the channel **26**.

The pilot valve described above is particularly suitable for use with the diverting valve described and claimed in the application of C. B. Moore and Robert B. Adams, filed Mar. 27, 1967, Ser. No. 626,027, but is not limited to such use.

Referring now to FIG. 6, when the take off opening **29** is open to the atmosphere, air coming through the opening **29** will detach the main stream delivered by the nozzle **42** from the lower wall **44**. When, however, only liquid can be drawn up through the take-off opening **29**, this will not be sufficient to supply to entrainment of the main jet from the nozzle **42**. The pressure below the main jet will fall and since the biasing tends to favor flow along the lower wall **44** the jet will follow the lower wall **44**, under these conditions.

The pilot valve of the present invention has a wide variety of uses where a signal is desired dependent upon rate of flow of a liquid and particularly where it is preferred not to have any moving parts exposed to the liquid.

I claim:

1. A liquid flow responsive device comprising:
a source of liquid,

a nozzle to which said source is connected,
a surface in converging relation to the axis of the nozzle and in such converging relation extending downstream of the nozzle to a location spaced from said axis less than one half the width of the nozzle,
said surface further being arranged generally transverse to the direction of force of an accelerating field whereby the liquid from said nozzle will lock-on to said surface at a flow rate in excess of that necessary to overcome the effect of said accelerating field tending to urge flow therefrom,
said surface having a signal take off opening positioned such that the opening will be in the path of fluid flow when lock-on occurs.

2. A liquid flow responsive device as defined in claim **1** in which:
a housing is provided with an interior chamber into which said nozzle is directed,
said surface is along an upper wall of said housing, and
said chamber is bounded by facing side walls.

3. A liquid flow responsive device as defined in claim **2** in which:
said nozzle is of predetermined width, and
said side walls are spaced the same width as that of the nozzle.

4. A liquid flow responsive device as defined in claim **2** in which
said chamber is vented to a gaseous atmosphere, and
said take off opening is subject to said atmosphere at low liquid velocities and is sealed from said atmosphere at higher liquid velocities.

5. A liquid flow responsive device as defined in claim **4** in which:
said nozzle is rectangular in cross section, and
the upstream end of said surface is joined to the nozzle in fluid tight relation.

6. A liquid flow responsive device as defined in claim **5** in which:
said surface beyond said take off opening has a set back portion with a surface portion therebeyond inclined in a direction toward the flow axis of the nozzle, and
said surface portion has a second signal take off opening therein.

7. A liquid flow responsive device as defined in claim **4** in which:
a liquid diverting valve is provided having a control port, and
said signal take off opening is connected to said control port.

8. A liquid flow responsive device as defined in claim **2** in which:
a liquid diverting valve is provided having a control port, and
said signal take off opening is connected to said control port.

9. A liquid flow responsive device as defined in claim **1** in which:
a liquid diverting valve is provided having a control port, and
said signal take off opening is connected to said control port.

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