

[72] Inventors **John W. Mark**
Sunnyvale;
Howard H. Barney, Palo Alto, Calif.
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Primary Examiner—Samuel Scott
Attorney—Roland A. Anderson

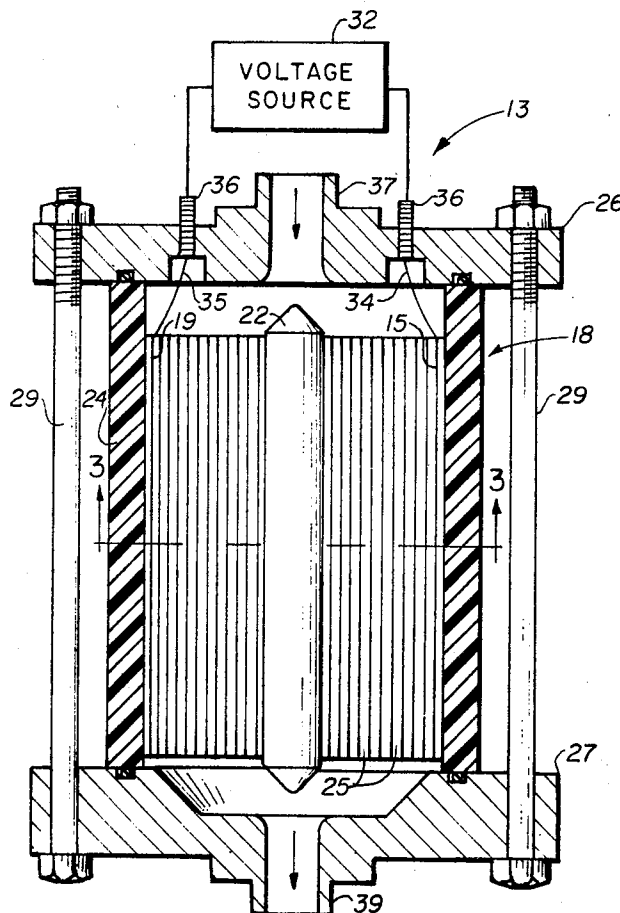
[54] **ELECTRO-FLUID VALVE HAVING STRIP**
ELECTRODES

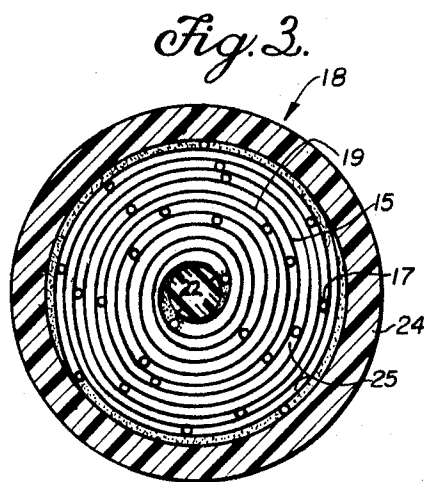
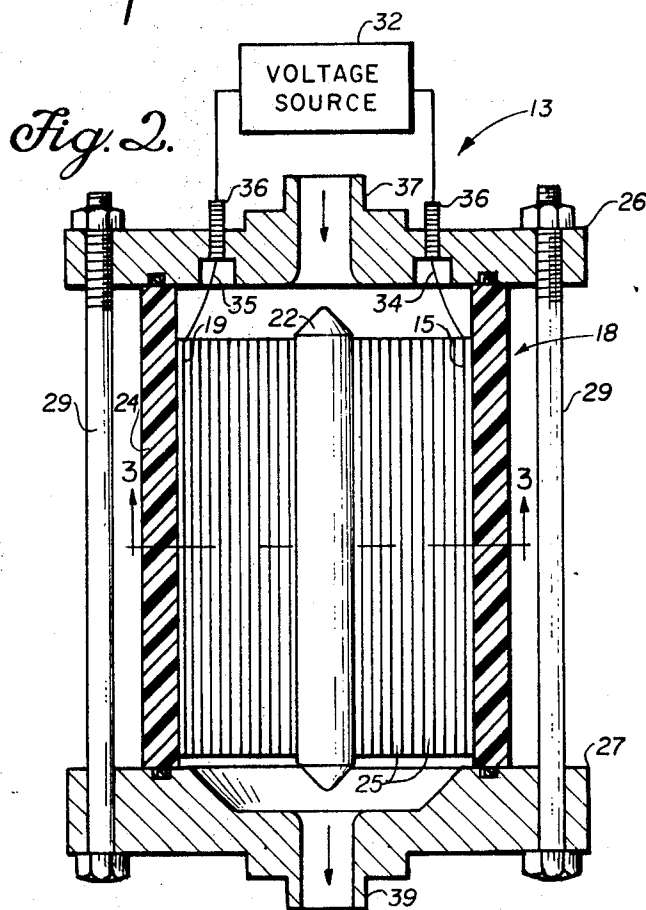
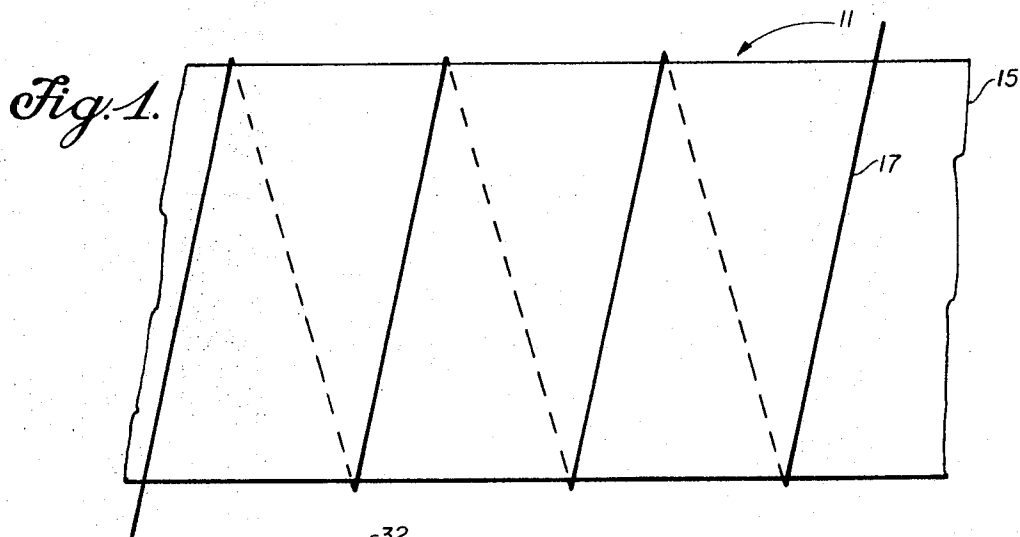
6 Claims, 3 Drawing Figs.

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[51] Int. Cl.....	F15c 1/04
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ABSTRACT: A valve comprised of string insulation wrapped at a wide path pitch around the width of a long thin flat strip of stainless steel and rolled with a second unwrapped strip of stainless steel to form a cylinder. An electrical gap is maintained by the spring between the strips of each layer of the cylinder. The string and the strips also form a multitude of narrow axial channels for passage of an electric-field-sensitive fluid from one end of the cylinder to the other under control of a voltage applied across the gap.





INVENTOR.
JOHN W. MARK
HOWARD H. BARNEY

BY

Robert G. Groves
ATTORNEY

ELECTRO-FLUID VALVE HAVING STRIP ELECTRODES

BACKGROUND OF THE INVENTION

The invention relates to valves used for controlling the flow of electric-field-sensitive fluids, and more particularly the invention relates to a valve comprised of strip electrodes defining a plurality of channels.

An electric-field-sensitive fluid is described by Willis M. Winslow in his U.S. Pats. No. 2,417,850, issued Mar. 25, 1947; No. 2,661,596, issued Dec. 8, 1953; and No. 3,047,507, issued July 31, 1962. The electric-field-sensitive fluids disclosed in the Winslow patents are termed "electrofluids" in the patents. An electrofluid is one which is normally thin but becomes very viscous, for practical purposes it becomes a solid, when an electric field is applied transversely across its path of flow. The resulting viscosity of the fluid is so great as to effectively stop its flow as long as the field is present. Removal of the electric field restores the oil to its normally thin state to permit resumption of continuous flow. An electrofluid is particularly useful in a hydraulic system which must be manipulated at a relatively high frequency, for example, a system in which it is desirable to start and stop fluid flows in periods in the range of less than 1 millisecond. To effectively achieve such results the gaps between the electrodes should be short and the applied fields high; and to provide for large useful volumes of fluid flow, the electrode area should be large. In prior electric field valves, a short, high-volume gap has been provided by nesting cylindrical shells concentrically with annular spaces therebetween. Adjacent shells are electrically insulated and alternate shells are connected together electrically. A control voltage selectively applied across adjacent shells is used to control the rate of fluid flow between the annular spaces. A typical spacing between the cylindrical shells is 0.030 inches and a typical voltage across the shell gaps is 3,000 volts. It is desirable that construction of such a valve be simple and inexpensive yet accurate and reliable. In view of the necessary high voltages used in such a valve, it is also desirable that electrical connections be minimized.

SUMMARY OF THE INVENTION

In brief, the present invention is an electrofluid valve that may be simply and economically fabricated by wrapping together two electrically conductive strips that are separated with electrical insulating means between the strips for maintaining a short, high-volume electrical gap over the entire length of the strips. The insulating means between the strips are oriented to define a plurality of channels in the axial direction of the wrapped strips for passage of an electrofluid. A high voltage may be applied across the gap for controlling the flow of the electrofluid while the large volume of the gap permits a large flow of the electrofluid in the absence of a control voltage.

It is an object of the invention to provide an electrofluid valve that may be simply and economically fabricated.

Another object is to provide a continuous short gap between two adjacent electrically conductive strips that are wrapped together into a single integral unit.

Another object is to provide a continuous, short, high-volume electrical gap in an electrofluid valve.

Another object is to provide an electrofluid valve that is fabricated by wrapping a string of electrical insulation around the width of an electrically conductive strip and then rolling the strip with a second electrical conductive strip to form an integral cylinder.

Other objects and advantageous features of the invention will be apparent in a description of a specific embodiment thereof, given by way of example only, to enable one skilled in the art to readily practice the invention, and described hereinafter with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a diagram of an electrically conductive strip wrapped with insulating string as one element of an electrofluid valve according to the invention.

FIG. 2 is a cross-sectional diagram of an electrofluid valve utilizing the element shown in FIG. 1 combined with other elements.

FIG. 3 is a cross-sectional view of the electrofluid valve of FIG. 3 taken along lines 3-3.

DESCRIPTION OF AN EMBODIMENT

Referring to the drawing there is shown in FIG. 1 an element 11 which is one element of an electrofluid valve 13 shown in cross section in FIG. 2. The element 11 is comprised of a long thin strip of electrically conductive material such as stainless steel which is wrapped at a wide pitch with thin lengths or strings of insulation material 17 such as fiberglass string or braid. The valve 13 is fabricated by laying a second strip 19 of electrically conductive material that is similar in dimensions to the strip 15 next to the element 11 and then rolling the strips 15 and 19 into a cylindrical form with an electrically nonconductive element 22 lying along the axis of the cylinder. The strips are then secured by wrapping them with electrical insulating material 24 to form a cylinder 18 (FIGS. 2 and 3).

For convenience of construction and to achieve a high level of strength while maintaining good electrical insulation, the braid 17 may be impregnated with an adhesive such as an epoxy resin; the material 24 may be fiberglass cloth also impregnated with epoxy resin; and the rod 22 may be a reinforced rod of epoxy resin. With such an arrangement, the wrapped cylinder 18 may be cured to achieve a single integral unit. The string 17 electrically isolates the strip 15 from the strip 19 and maintains an electrical gap 25 over the entire length of the strips. Because of the wide pitch of the string wrapping, the gap 25 is divided into a multitude of channels by the string, which channels are substantially parallel to the axis of the cylinder. In production line fabrication it may be found desirable to start with very wide strips 15 and 19 and construct a very long cylinder which is then cut into shorter lengths the ends of which may then be machined to any desired configuration. By using very wide strips 15 and 19 the channels formed by the string 17 may be made as nearly parallel to the axis of the cylinder as desired.

To complete the valve 13 the cylinder 18 is sealed between a pair of flanges 26 and 27 by means of bolts 29. In such an arrangement the flanges 26 and 27 and wrapping 24 comprise the housing of the valve. Conveniently the wrapping 24 may be made as thick as needed to withstand the anticipated operating pressure. Alternatively, the cylinder may be mounted in a steel pipe and secured between or made integral with the end flanges.

In operation a high-voltage source 32 is connected across the strips 15 and 19 by means of electrical lead-in wires 34 and 35 respectively through suitable high-voltage insulators 36. Preferably, for maximum flexibility of operation, the source 32 should be capable of being adjusted from zero to full voltage. The strips 15 and 19 constitute first and second electrodes respectively for control of an electrofluid circulated through the valve from an inlet 37 to an outlet 39. The electrofluid flows through the multitude of channels of the gap 25 thereby exposing a very large volume of electrofluid to large areas of the strip electrodes 15 and 19 across the very short gap 25. By varying the voltage that is supplied across the strip electrodes, the rate of flow of electrofluid may be varied from a normal flow rate to complete stoppage of the flow.

It will be noted that the valve 13 may be fabricated from standard materials, that the steps of fabrication are very simple and inexpensive, that the gap may be made very short, that the effective area of the electrodes and the volume of the gap may be made very large, that the construction is reliable and accurate, and that a minimum number of parts are used.

While an embodiment of the invention has been shown and described, further embodiments or combinations of those described herein will be apparent to those skilled in the art without departing from the spirit of the invention.

We claim:

1. A valve for controlling the flow of an electrofluid, comprising:

a first electrically conductive strip;

a second electrically conductive strip rolled together with said first strip in a plurality of turns to form a cylinder;

and electrical insulation means separating said rolled strips across a short gap, said strips and said insulation means defining a plurality of channels for flow of said electrofluid, said insulation being a continuous length of string wrapped at a wide pitch around the width of said first strip.

2. The valve of claim 1, wherein said electrically insulation means is a fiberglass braid string impregnated with an epoxy resin and said braid is wrapped at a wide pitch around the width of said first strip, and further including a fiberglass cloth impregnated with an epoxy resin and wrapped around said cylinder.

3. The valve of claim 1, further including:

a rod of electrical insulation material secured to one end of each of said strips, said strips being rolled together around said rod; and

a wrapping of electrical insulation material around said rolled strips to hold said strips, string and rod together as an integral unit.

4. The valve of claim 3, wherein said rod is a reinforced rod of epoxy resin and said wrapping is fiberglass cloth impregnated with epoxy resin.

5. The valve of claim 3, wherein

said wrapping forms a cylindrical wall around said strips; said wall extending beyond the ends of said strips; and

further including:

first and second flanges, said wall being secured between said flanges with the ends of said wall in sealing engagement with said flanges, said flanges each being provided with a central passage for flow of an electrofluid through said valve.

6. The valve of claim 5, wherein said rod is centrally located within said cylindrical wall and the ends of said rod are conically shaped and aligned with said central passages in said flanges to smoothly and symmetrically direct the flow of an electrofluid through said valve.

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