Dec. 2, 1969 R. W. HATCH, JR 3,481,353

FLUID DIODE

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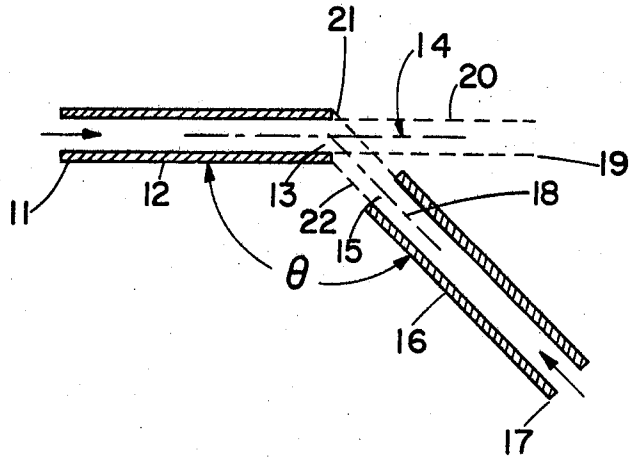


FIG. 1

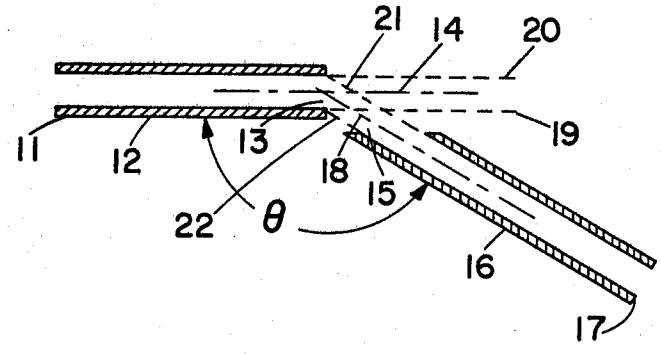


FIG. 2

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FLUID DIODE

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ABSTRACT OF THE DISCLOSURE

Two tubes preferably projecting laminar flow are disposed with an obtuse angle between their center lines and in a manner so that the projected flow from a first tube does not intercept the terminating orifice of the second tube, while the projected flow from the second tube does closely intercept the terminating orifice of the first tube; with this arrangement a fluid rectification phenomena is observed, in which a fluid supplied through the first tube has no affect upon the second tube, while a fluid supplied through second tube will produce a responsive pressure effect in the first tube.

This invention relates to fluid logic, and more particularly to a fluid diode element which may be used generally in fluid logic applications.

In the fluidic field, specific devices have been developed to perform functions analogous to those performed by electrical circuits. Among fluidic developments include various forms of amplifiers, switches, fluidic restrictions and resistances, fluidic capacitances, and resonant circuits. A diode element has been in use which is the vortex diode. In the vortex diode one direction of stream is tangentially with a chamber while the other stream is centrally in the chamber normal to the vortex. Reverse flow in which the fluid input is provided to the chamber center meets with a higher fluidic resistance than with the fluid supplied tangentially to the chamber. The vortex diode is somewhat bulky, and does not have too high a forward-reverse ratio.

Inasmuch as it is desirable to be able to incorporate all the fluidic analogs of electrical circuits into fluidic circuits, it would be convenient to have available a fluidic diode which is very simple in construction, inexpensive to manufacture, while exhibiting the characteristics of a good forward-reverse ratio so as to be readily employed as an element in a fluidic circuit.

The present invention provides a fluidic diode element having a high signal transfer in the forward direction, with an extremely low signal transfer in the backward direction. The fluidic device of the present invention is quite simple, consisting of a pair of tubes arranged in a fashion so that the projected stream of one tube interferes in no appreciable way with the termination of a second tube, while the projected stream from the second tube is directed at the orifice termination of the first tube so that the first tube responds to the fluid projected by the second tube. This arrangement is extremely simple, and performs the function of a fluidic diode element very acceptably with much less complication than fluid diode elements of the prior art.

These and other advantages of the invention will be in part apparent from the following sepcification and in part from the accompanying figures in which:

FIGURE 1 is a cross-sectional schematic diagram illustrating the mutual positions of the pair of tubes comprising the fluidic diode elements.

FIGURE 2 is a cross-sectional schematic of the fluidic diode of the invention illustrating beveled tube terminations to more effectively facilitate the functions of the diode element.

Referring to FIGURE 1, tube **12** is shown with termination **13** thereof closely proximate termination **15** of tube **16**. Tubes **12** and **16** are disposed with an obtuse angle theta between center line **14** of tube **12** and center line **18** of tube **16**. In addition, the projected diameter **19–20** of tube **12** is clear of termination **15**, or any part, of tube **16**; the projected diameter **21–22** of tube **16** is disposed to achieve as complete an interception of termination **13** of tube **12** as may be practical. This mutual disposition of tubes **12** and **16** may be effected by a convenient provision of an angle theta therebetween preferably in the range of 120°–160°, an angle theta of 150° being found convenient and suitable.

It is convenient in the practice of this invention to provide for sufficient lengths of tubes **12** and **16**, up to their respective terminations **13** and **15** thereof to provide for laminar projections from each tube when a source of supply is furnished. That is, the length of tube **12** from termination **13** thereof to a point **11** back in tube **12** should be sufficient in terms of the Reynolds number of the fluid contemplated for the application to provide for laminar flow; similarly, a distance between termination **15** and point **17** of tube **16** should be provided to insure laminar flow projection from tube **16** at times a source of supply is furnished back from point **17** thereof.

With this configuration, a provision of fluidic pressure in a direction from point **11** to termination **13** of tube **12** will result in a laminar projection of a fluid stream closely in a line with the projection diameter **19–20** of tube **12**. As is illustrated in FIGURE 1, the projected diameter **19–20** does not interfere with termination **15** of tube **16**. In practice, tube **16**, and particularly any part of termination **15** thereof, should be off-set sufficiently from projected diameter **19–20** to insure a minimum interaction at times tube **12** is projecting a laminar stream. The condition of projected laminar flow from tube **12** may be termed the reverse direction condition of the fluidic diode, in that no appreciable effect will be transferred to tube **16** in this reverse condition.

In the forward condition of the fluidic diode, a source of supply is furnished to tube **16** from point **17**, thereby projecting a laminar flow from termination **15** along projected diameter **21–22** of tube **16**. The projected flow from tube strikes the cross-sectional area of termination **13** of tube **12** at an angle which is sufficient to cause a responsive pressure build-up in tube **12**. This pressure build-up may be sensed by appropriate fluidic apparatus connected back of point **11** of tube **12**. For a strong response in tube **12**, the termination **13** of tube **12** should be disposed as completely as possible within the projected flow from tube **16**. In this disposition, projected center line **18** of tube **16** will intercept center line **14** of tube **12** approximately where center line **14** crosses through the plane of termination **13**.

Referring to FIGURE 2, termination **13** of tube **12** is shown with a bevel so that the plane of termination **13** more nearly is a right angle to projected center line **18** of tube **16**. In addition, termination **15** of tube **16** is shown beveled so that the complete termination **15** of tube **16** may more closely approach projected diameter **19–20** of tube **12**, without appreciably increasing any interaction in the reverse direction of fluidic element operation. By so beveling terminations **13** and **15** are described, the open area which must be allowed for between terminations **13** and **15** is considerably reduced, thereby improving the performance of the fluidic diode in the forward direction, transferring a higher pressure response to tube **12** thereof. The provision of beveling will not appreciably detract from the isolation function

of the fluidic diode element in the reverse condition thereof.

What is claimed is:

1. A fluidic diode element having a first tube adapted to project a laminar fluidic flow and a second tube adapted to project a laminar fluidic flow arranged with an obtuse angle of approximately 150° between their respective projected center lines and in a manner so that projected flow from said first tube does not intercept the termination of said second tube while projected flow from said second tube intercepts the termination of said first tube, with the respective termination of said first and second tubes being bevelled to allow a reduction in the spacing between said respective terminations while preserving non-interaction in the reverse condition of flow wherein a stream is projected from said first tube and enhancing forward interaction wherein a flow is projected from said second tube with an improvement in the pressure response in said first tube: whereby flow projected from said first tube results in no appreciable response in said second tube and flow projected from said second tube results in a pressure-responsive effect in said first tube.

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