

[72] Inventor **Herbert P. Horacek**
 Scottsdale, Ariz.
 [21] Appl. No. **794,842**
 [22] Filed **Jan. 15, 1969**
 [45] Patented **May 25, 1971**
 [73] Assignee **The Garrett Corporation**
 Los Angeles, Calif.

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Primary Examiner—Samuel Scott

Attorneys—Herschel C. Omohundro and John N. Hazelwood

[54] **BISTABLE FLUIDIC AMPLIFIER**
 7 Claims, 2 Drawing Figs.

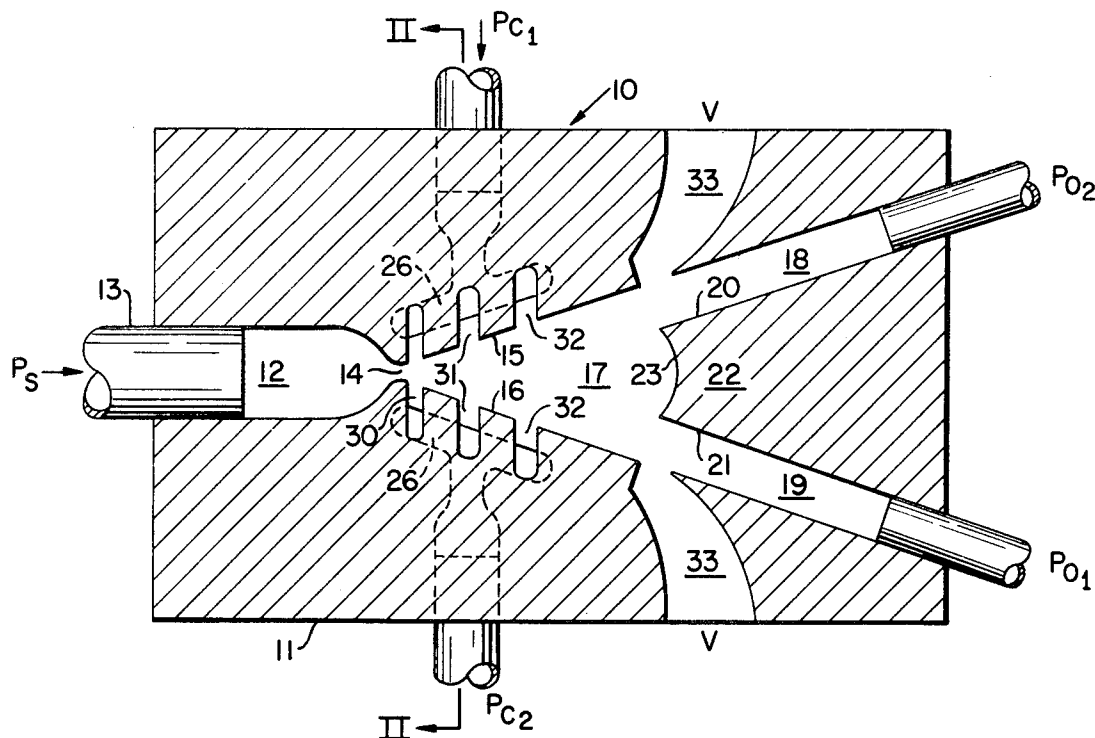
[52] U.S. Cl..... 137/81.5
 [51] Int. Cl..... F15c 1/04
 [50] Field of Search..... 137/81.5

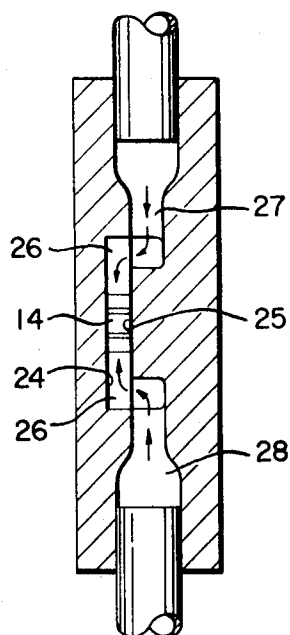
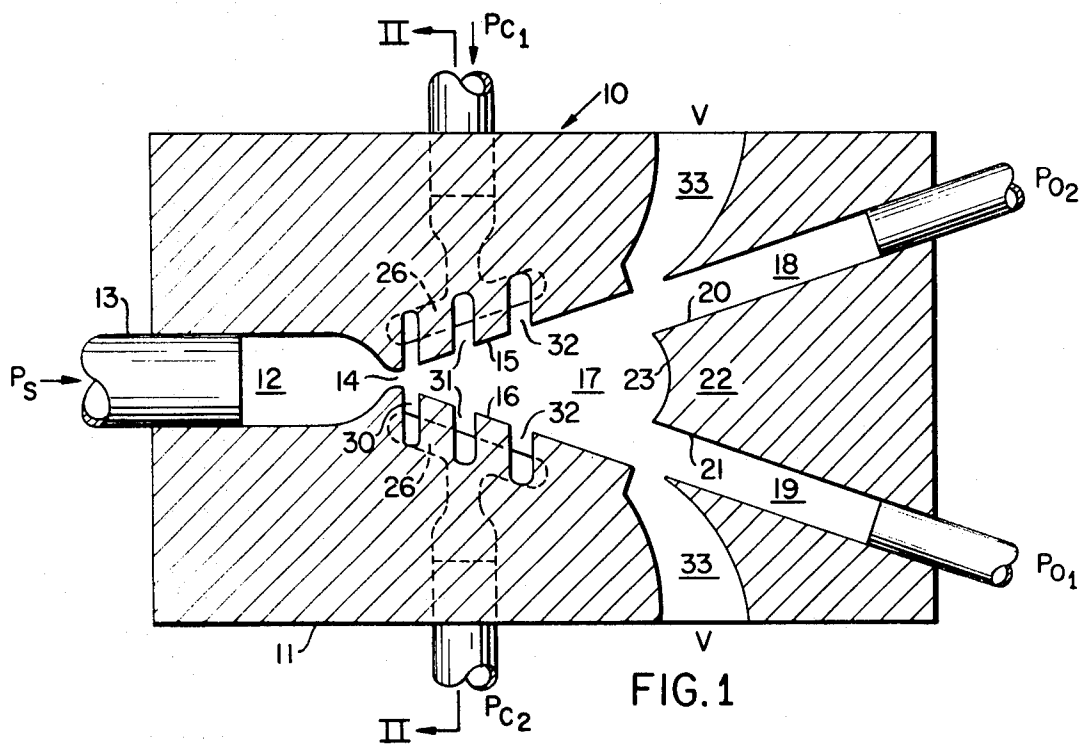
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ABSTRACT: This bistable fluidic amplifier has a converging-diverging, beam- or power-jet-forming inlet nozzle, the diverging sides being extended to form an interaction chamber with laterally spaced output ports opposite the inlet nozzle. A control pressure manifold is disposed at each side of the interaction chamber and a plurality of spaced sets of control pressure inlet nozzles lead from the manifold to the interaction chamber. The control pressure inlet nozzles are of different widths and serve to distribute the control flow into the interaction chamber to deflect the power jet beam over a wide range of supply pressures. As the supply pressure is varied, the flow issuing from the inlet nozzle into the interaction region varies between subsonic, sonic and supersonic flow.





INVENTOR.
HERBERT P. HORACEK

BY

Herschel C Omohundro
ATTORNEY

BISTABLE FLUIDIC AMPLIFIER

SUMMARY

This invention relates to the fluidic art. It is particularly concerned with fluidic amplifiers, and especially those of the bistable type wherein an inlet nozzle directs a fluid beam into an interaction chamber toward output ports and control jet streams are utilized to deflect the beam toward one or the other output port, the beam locking onto the adjacent sidewall of the interaction chamber by coanda effect to maintain flow to a selected output port until a change in control conditions occurs. It has been discovered that, in the use of fluidic amplifiers heretofore provided, the range of supply pressures which may be used for a particular amplifier is limited. If low supply pressures having subsonic conditions are used the amplifier is constructed in one way, and if high supply pressures having supersonic conditions are used an amplifier with a different construction must be employed.

It is an object of this invention to provide a fluidic amplifier with a construction which will make it adaptable for use with high or low supply pressures.

An object of the invention also is to provide a bistable fluidic amplifier suitable for use with a power jet supply pressure ratio which may vary as much as 10 to 1 or more. The bistable device disclosed herewith has operated successfully over a 17 to 1 supply pressure ratio.

Another object of the invention is to provide a bistable fluidic amplifier which will function with desired stability whether the supply pressure is low enough to form a power jet with subsonic flow or sufficiently high to cause a power jet with supersonic flow, the same pressure for the control jet streams being employed in either case.

A further object of the invention is to provide a bistable fluidic amplifier having a body forming an interaction chamber with a nozzle for directing a power jet beam toward spaced output ports and a manifold at either side of the chamber, a plurality of control ports or jet nozzles leading from the manifolds to the chamber at points spaced along the sidewalls thereof, fluid streams issuing from the control jet nozzles serving to deflect a power beam into predetermined output ports whether the beam is flowing at a subsonic or supersonic rate.

A still further object of the invention is to provide the amplifier mentioned in the preceding paragraph with control jet nozzles of varying area depending upon the position thereof relative to the exit end of the power-beam-forming nozzle, the control nozzles nearest the beam-forming nozzle being smaller than those more remote therefrom.

Another object of the invention is to provide a bistable fluidic amplifier having a converging-diverging, power-beam-forming nozzle, the diverging walls of which form the sides of an interaction chamber and a pair of spaced output ports, a plurality of control jet nozzles being spaced along the sides of the interaction chamber and communicating with manifolds which are connected to receive control pressure signals, the control jet nozzles being graduated in size from those nearest the power-beam-forming nozzle to those most remote therefrom, streams flowing from the former serving to deflect a power beam with subsonic flow and from the latter, or a combination of all, serving to deflect a power beam with supersonic flow, the amplifier increasing the range of supply pressures over which a system equipped therewith may be used.

Other objects and advantages of the invention will be apparent from the following description and the accompanying drawing in which one embodiment of the invention has been illustrated.

THE DRAWINGS

FIG. 1 is a horizontal sectional view taken through a bistable fluidic amplifier formed in accordance with the present invention; and

FIG. 2 is a transverse sectional view taken through the amplifier on the plane indicated by the line II-II of FIG. 1.

DESCRIPTION

Referring more particularly to the drawing, the amplifier is designated generally by the numeral 10. This amplifier includes a body 11, which may be formed in any suitable manner from plastic, metal or other materials. The body is shown in the drawing as of integral form but may be composed of laminations, as is well known in the fluidic art.

In the amplifier shown, an inlet port 12 is provided at one end, a suitable pipe or duct 13 being connected with the port to conduct fluid under pressure from a source to the amplifier. The port 12 leads to a converging-diverging, fluid-beam- or power-jet-forming nozzle 14, the diverging sides 15 and 16 of the nozzle being continued to form an interaction chamber 17. The sides 15 and 16, in the form of the invention shown, are further extended to coincide with the outer walls of a pair of output ports 18 and 19. Walls 20 and 21 of a divider 22 form the inner walls of the output ports 18 and 19. In the present instance, the divider has a concave end wall 23 which faces the nozzle 14 and is disposed at the opposite end of the interaction chamber 17. This chamber, together with the inlet and output ports, is completed by top and bottom walls 24 and 25.

In accordance with the invention, the body is provided at each side of the interaction chamber with a manifold 26, these manifolds, in the form of the invention shown, being disposed below the surface of the bottom wall 25 and communicating with control inlet pressure ports 27 and 28 entering the body from opposite sides. It should be obvious that the manifolds could also be located on the same level as the interaction chamber. The method employed depends on the construction of the elements, i.e., laminated vs integral.

A plurality of sets of control jet nozzles lead from the manifolds 26 to the interaction chamber, the sets of control jet nozzles being spaced longitudinally of the interaction chamber. The first set 30 of control jet nozzles is disposed closely adjacent the exit end of the beam-forming nozzle 14. The second set 31 of control jet nozzles is spaced a predetermined distance downstream from the nozzle 14. In the present instance this spacing is approximately equal to three times the width of the nozzle 14. The third set 32 of control jet nozzles is spaced still further downstream from the nozzle 14. While three sets of control jets have been illustrated, it is obvious that the number of control jets may be varied from a minimum of two to any desired maximum, and the spacing may also be varied.

It will be noted from FIG. 1 that, in the present instance, the width of the control nozzles increases in accordance with the spacing thereof from the nozzle 14; in other words, the narrowest control jets are disposed closest to the nozzle. However, this invention includes cases where the width of the control jets is equal, or the width is gradually decreased, or any combination of widths which may be required to provide control of the power jet.

Suitable vent ports 33 lead from the interaction chamber at the points of connection of the output ports therewith.

In the operation of the amplifier, fluid under pressure from the source is supplied to the inlet 12. This fluid will flow through the nozzle 14 to form a power jet or beam which is directed generally toward the output ports 18 and 19. When a control signal pressure is supplied to one or the other of the manifolds 26, control streams will issue from the jets 30, 31 and 32 at the corresponding side of the interaction chamber. These control jets will impinge upon and deflect the power beam toward the opposite side of the interaction chamber from which it will flow through the respective output port.

In bistable amplifiers, the beam will attach itself to the sidewall of the interaction chamber toward which it is deflected and will remain attached even though the application of the control jet is discontinued. The introduction of control pressure to the manifold on the opposite side of the interaction chamber, that is, the side to which the beam has been attached, will cause the beam to deflect away from such wall and become attached to the other sidewall, the beam then flowing from the adjacent output port.

The present amplifier has been designed for use with a wide range of supply pressures, for example, from a 10 to 1, or greater, ratio. When the lower pressure ratio supply is employed, the beam issuing from the nozzle 14 will flow at a subsonic rate. In such event, a control stream issuing from a control jet nozzle nearest the beam-forming nozzle 14 will be sufficient to deflect the beam in the interaction chamber. When higher pressures which are sufficient to create a beam flowing at a supersonic rate are used, shock conditions are created that move further downstream in the diverging section, and controlling streams issuing from control nozzles spaced a greater distance from the beam-forming nozzle will serve to deflect the power beam in the interaction chamber. It is possible that control streams issuing jointly from a plurality of nozzles cooperate to deflect the power beam. With the construction shown, a control jet nozzle will be disposed relatively close to the point where the static pressure of the beam is the lowest, irrespective of whether the beam is flowing at subsonic or supersonic rates. The device will function over a wide range of supply pressures without requiring variations in the control pressure supplied to the control ports.

I claim:

1. A bistable fluidic amplifier, comprising:

- a. body means forming an interaction chamber with a beam-forming inlet nozzle at one side and spaced output ports at the opposite side, said means forming sidewalls leading from the sides of said inlet nozzle to the outer sides of said output ports;
- b. means forming a control pressure inlet port in said body means at each side thereof;
- c. a control pressure manifold provided in said body means at each side of said interaction chamber, each of said con-

trol pressure inlet ports communicating with an adjacent manifold; and

- d. a plurality of sets of control pressure nozzles leading from said manifolds to said interaction chamber, the control pressure nozzles of each set being spaced along said sidewalls at different distances from said beam-forming nozzle than the control pressure nozzles of the other sets and oriented in a manner to cause control fluid jets issuing therefrom to strike the beam flowing from the inlet nozzle at different distances from such nozzle.

2. The bistable fluidic amplifier of claim 1 in which the beam-forming inlet nozzle has converging-diverging sidewalls, the interaction chamber being bounded on the sides by the diverging sidewalls.

3. The bistable fluidic amplifier of claim 1 which the control pressure nozzles are of different widths.

4. The bistable fluidic amplifier of claim 1 in which one set of control pressure nozzles is disposed closely adjacent the exit end of said beam-forming inlet nozzle.

5. The bistable fluidic amplifier of claim 1 in which the control pressure nozzles nearest the beam-forming nozzle are narrower in width than the control pressure nozzles more remote therefrom.

6. The bistable fluidic amplifier of claim 1 in which at least two sets of control pressure nozzles are provided.

7. The bistable fluidic amplifier of claim 6 in which the first set of control pressure nozzles is disposed closely adjacent the exit end of the beam-forming inlet nozzle and the next set is disposed downstream a distance equal to a predetermined number of widths of the beam-forming nozzle.

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