United States Patent

[11] **3,575,188**

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[54] **PROPORTIONAL FLUIDIC AMPLIFIER**
1 Claim, 4 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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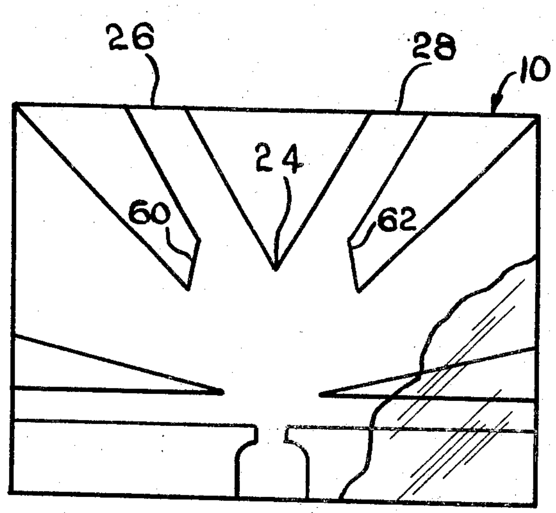
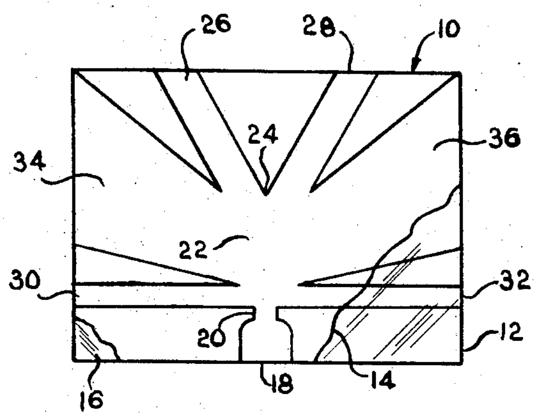
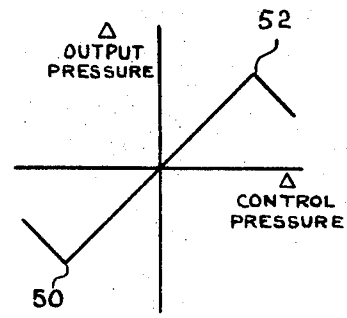
ABSTRACT: A proportional amplifier having tapering channel means to prevent overdrive and subsequent fluid loss thereby providing a fluidic element whose output pressure curve demonstrates a hard saturation characteristic.





PRIOR ART

FIGURE 1



PRIOR ART

FIGURE 2

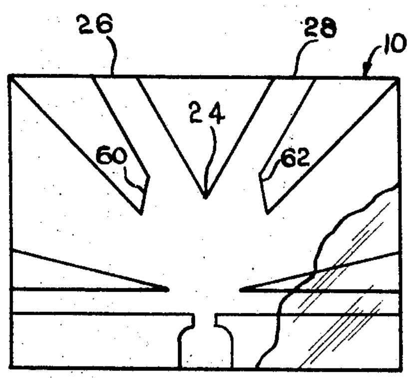


FIGURE 3

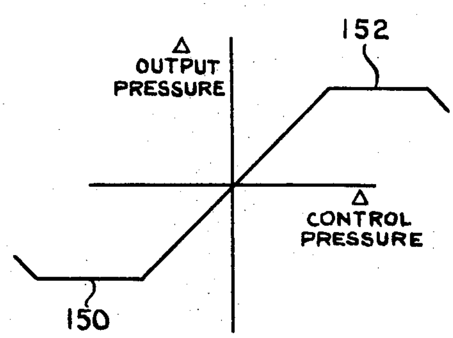


FIGURE 4

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PROPORTIONAL FLUIDIC AMPLIFIER

SUMMARY OF THE INVENTION

The present invention relates to pure fluid amplifiers in general and to those pure fluid amplifiers known as stream interaction proportional amplifiers in particular. The stream interaction proportional amplifiers are well-known in the art and are characterized by their ability to control high-energy fluid flows with relatively lower energy fluid flows so as to controllably produce a high-gain pressure output or output pressure ratio. These devices depend upon the direct relationship between input and output for their functional utility. To achieve this direct relationship, steps are taken during the manufacturing process to reduce or completely eliminate the possiblity of the wall attachment effect occuring to disrupt the control/output relationship. These steps usually involve removal of the sidewalls of the fluid interaction chamber in the vicinity of the power fluid stream and the addition of vents to this area to prevent wall attachment in those zones where it is not possible to remove the walls of the fluid interaction chamber. This results in the unfortunate fact that excessive control pressures are able to partially or completely divert the power stream into these vents. This, of course, results in loss of amplification and of output power as well as loss of power stream fluid. It is, therefore, an object of the present invention to provide a proportional fluidic amplifier having means to prevent the operational losses which result from excessive control pressure differentials. In order to provide simple, reliable means to prevent the losses associated with overdrive of fluidic proportional amplifiers, it is a further object of this invention to provide such means as do not rely upon feedback of a portion of the output flow to counter possible fluid control overdrive. The advantages of avoiding the feedback means controlling overdrive lie in simplified fabrication and the avoidance of output pressure losses which result from feedback of a portion of output fluid signal.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 shows the prior art proportional fluidic amplifier.

FIG. 2 shows the response curve for the prior art amplifier.

FIG. 3 shows a fluidic proportional amplifier made according to the present invention.

FIG. 4 shows the response curve for the proportional amplifier made according to the present invention.

DETAILED DESCRIPTION OF THE DRAWING

Referring now to FIG. 1, a prior art proportional amplifier 10 is shown. The amplifier, as shown, is formed by forming the various passages in a piece of plastic 12 and placing the channel-containing member 12 between two pieces of clear plastic 14 and 16. Of course, many other methods of fabrication are known employing the same or similar materials as well as employing dissimilar materials and the invention herein described and hereinafter claimed is of advantage in all fluidic proportional amplifiers of whatever manner and material of construction. In operation, a source of pressurized fluid, not shown, is communicated by known means to the fluid supply port 18. As the fluid is pressurized, a stream will be issued through nozzle 20 so as to cross the interaction region 22 and impinge upon the splitter means 24. The splitter means 24 divides the fluid stream into two approximately equal streams which then exit via outlet passages 26 and 28.

Control passage means 30 and 32 are shown as being at right angles to the stream issued by nozzle 22, but this is merely illustrative and other configurations are possible. The control passage means 30 and 32 are connected to means, not shown, for generating a control fluid signal. These means may be, for instance, additional fluidic elements or any other source of control fluid. When the pressures are the same in each of control passage means 30 and 32, the power fluid stream will be uneffected and the splitter means 24 will divide the fluid stream. The ratio of the division will then depend on whether the splitter is symmetrical or asymmetrical. In the event that a slight imbalance exists in the relative pressures in control passage means 30 and 32, the power fluid stream will be deflected toward the control passage having the lower relative pressure. This will result in the splitter means 24 dividing the power fluid stream into two unequal streams which will exit via the outlet passage means 26 and 28. The stream receiving the highest proportion of the fluid from the fluid source will, of course, be on the same side of fluidic element as the control passage having the lower relative pressure. As is obvious, the proportion of the fluids received by the outlet passage means 26 and 28 depends on the relative pressures in the control passage means 30 and 32 so that as the differential pressure rises, the amount of power stream deflection increases and proportion of fluid received by the outlet passage on the low-pressure control passage side approaches the totality of the fluid pressure stream.

Vent means 34 and 36 are operative to prevent wall attachment from occurring which would, of course, result in the power stream remaining in a deflected condition in the absence of control passage pressure imbalance of magnitude sufficient to overcome wall attachment effect.

FIG. 2 shows, by way of example, a graph of the output passage pressure differential plotted for various control passage pressure differentials. The control passage pressure differential is calculated by subtracting the pressure in the right control passage 30 from the pressure in the left control passage 32. The output passage pressure differential is calculated in the reverse manner, that is, pressure in the left output passage 26 is subtracted from the pressure in the right output passage 28. This reversal represents the actual reversal experienced by the fluidic element since higher pressure in the left control passage 32 produces high output pressure in right output passage 28. As can be observed, the output pressure differential increases rapidly for relatively slight changes in the control passage pressure differential. This, of course, is characteristic of this class of elements. Maximum points 50 and 52 represent those points at which all fluid issued by the power nozzle 20 is being directed to either the left or the right output passage.

However, due to the necessity of maintaining laminar flow and undisturbed ingress of the fluid to the output passages 30 and 32, the prior art teaches that the output passages must maintain a substantially straight passage wall on the portion of the output passages opposite the splitters or flow-dividing means in the vicinity of fluid impact. This results in a situation which prevents the proportional fluidic amplifier from operating effectively in a condition of hard saturation. The straight passage wall terminates in a sharp edge as the outlet passage enters the region of the vent. This sharp edge unintentional serves as a splitter whenever a hard saturation condition exists and causes power stream fluid to enter the vents rather than the intended outlet passage. This is represented by the not quite so steep slope which occurs almost immediately after the output pressure differential has achieved its maxima 50 and 52.

Referring now to FIG. 3, a proportional fluidic amplifier is shown substantially similar to that shown in FIG. 1. For the sake of clarity, numeral identification remains the same where possible. It will be observed that the present invention differs from the prior art only in the inlet region of the output passages. Instead of terminating in a sharp edge, the wall portion of the output passages 26 and 28 opposite the splitter means 24 flairs outwardly from the splitter means 24 forming intercept wall means 60 and 62 each of which forms an oblique angle with the centerline of the output passage. With reference to FIG. 4, I have found that the response curve for the amplifier, according to my invention, contains substantial zones of sustained high-pressure output 150 and 152 over a considerable region of increased control pressure differential where the prior art device almost immediately began to lose output pressure if the control passage pressure differential increased beyond the optimum value. This can be explained by the fact that as the power fluid stream attempts to deflect beyond the centerline of the outlet passage, the stream begins to impinge upon the intercept wall which tends to redirect the stream back toward the centerline of the outlet passage. This then gives the proportional amplifier, according to my invention, a hard saturation characteristic which permits satisfactory operation over a wider range of pressure differentials and also permits sustained satisfactory operation at or near its maximum output pressure differential without resort to control means external to the element.

I claim:

1. A proportional fluidic amplifier comprising:

a fluid interaction region;

means for issuing a power fluid stream into said interaction region;

output passage means in communication with said interaction region for receiving said power fluid stream;

control passage means communicating with said interaction region for controllably establishing and applying a pressure differential to said power fluid stream;

splitter means in cooperation with said output passage means to segregate power fluid stream flow through said output passage means;

control fluid means in fluid-conducting relation with said control passage means to provide the pressure differential for controlling power fluid stream flow through said output passage means; and

intercept means comprising the inlet of said output passage means operative to permit hard saturation of the amplifier;

said intercept means comprising straight wall portions of said output passage means;

said output passage means wall portions flairing outwardly away from said splitter means;

said wall portions operative when said power fluid stream of a portion thereof impinges thereupon to redirect said power fluid stream or portions thereof toward the centerline of said output passage means.