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FLUID STREAM DEFLECTING MEANS

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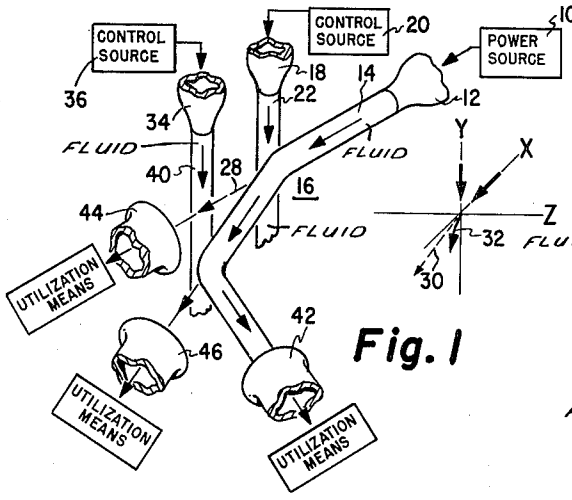


Fig. 1

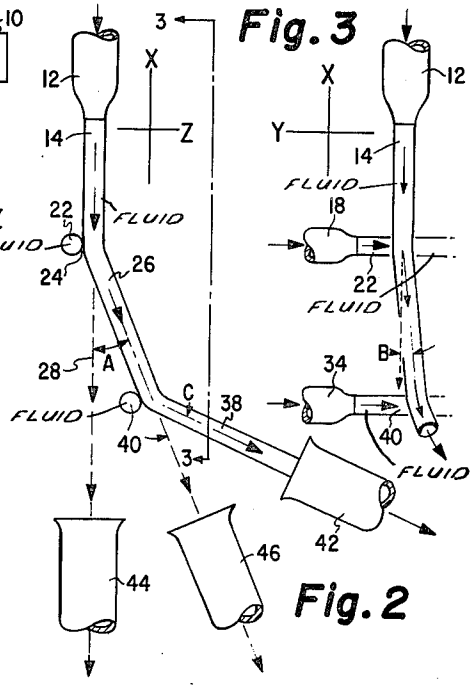


Fig. 3

Fig. 2

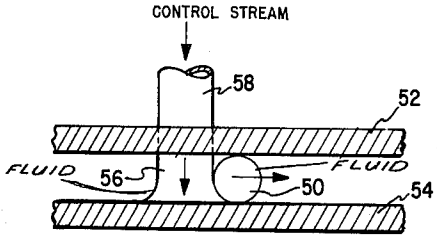


Fig. 5

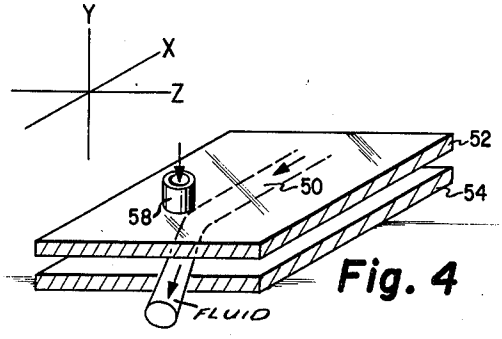


Fig. 4

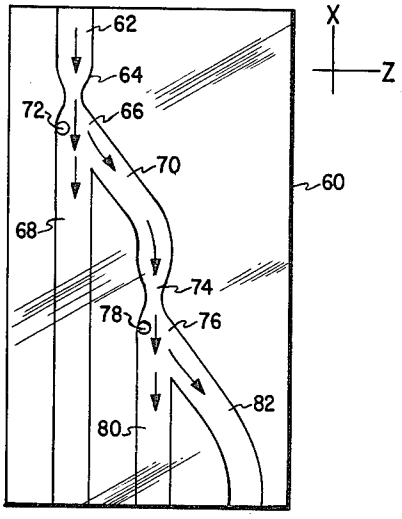


Fig. 6

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FLUID STREAM DEFLECTING MEANS

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This invention relates to a novel principle of fluid stream switching which finds particular use in a logic device.

In pure fluid amplifiers and switching circuits known to the prior art, a control fluid jet stream is made to intercept, generally at a right angle, a fluid power jet stream whose flow axis lies in the same plane as that of the control stream. The exchange of momentum between the control fluid particles and the power fluid particles causes the power jet to be deflected only in the direction of control stream flow. Thus, in the prior art amplifier there is a collision between most, if not all, of the particles in the power and control streams. The present invention, on the other hand, is based on the principle that a first fluid stream can be deflected without losing its integrity by mere peripheral contact between it and a second fluid stream whose direction of flow is transverse to the direction of first stream flow. In other words, a power stream and a control stream need not actually collide with one another, but instead can flow past each other so that they touch only at their outermost peripheries. The contacting of said control stream with the power stream increases the pressure on the contact side of the latter and causes it to shift primarily, if not exclusively, towards a direction which is at a right angle with the path of control stream flow.

One object of the present invention is to therefore shift a fluid power stream by means of a fluid control stream where contact is made between the two only at their peripheries.

A further object of the invention is to provide means to shift a first fluid stream, flowing in a first path, by a second fluid stream flowing in a second path, adjacent to and transverse with, but not intersecting, said first path such that said streams make peripheral contact with each other whereby said first stream is shifted through an angle in a direction perpendicular to said second path.

Another object of the present invention is to provide a device having logical properties which employs the principle of switching by peripheral contact between two fluid streams.

These and other objects of the present invention will become apparent during the course of the following description to be read in view of the drawings, in which:

FIGURE 1 is a diagrammatic view in perspective showing the shifting of a free power stream by peripheral contacting control streams to provide a logical output function;

FIGURE 2 is a plan view of FIGURE 1;

FIGURE 3 is a side elevation view of FIGURE 1;

FIGURES 4 and 5 diagrammatically show the switching of a power stream which is confined between parallel surfaces; and

FIGURE 6 is the view of a multiple switching and logic device employing a confined power stream which is switched by peripheral contacting control streams.

Referring first to FIGURES 1, 2 and 3, the basic principal of the invention will be described in connection with the description of structure having a logical function in which it finds particular use. A source **10** provides power stream fluid to a nozzle **12** which thereupon issues a fluid power jet **14** into free unbounded interaction region **16** in an initial undeflected direction X. Downstream from nozzle **12** is a first control stream nozzle **18** which is selectively supplied with control stream fluid from a control source **20**. Nozzle **18** issues a control jet **22** in a direction Y which is substantially transverse to path X, preferably at a right angle therewith. Normally, the power jet **14** has substantially greater energy content than does control stream **22**. Nozzles **12** and **18** are so arranged with respect to one another that the paths taken by power jet **14** and control jet **22** do not lie in the same plane. Hence, they do not intersect one another as is the case in prior art fluid amplifiers. However, the path taken by control stream **22** is adjacent to the path of power stream **14** such that contact is made between their peripheries in a manner best shown by the plan view of FIGURE 2. Beyond this point **24**, where the control and power jets just touch one another, the power stream **14** is shifted or deflected to thereafter flow in a new path indicated by portion **26**. In other words, power stream **14** moves through some angle A in the Z direction which in turn is perpendicular to direction Y of the control stream just prior to contact point **24**. Direction Z is also at a right angle to direction X. On the other hand, if control stream **22** is not present, then power stream **14** continues in its original path in direction X as shown by dotted arrow **28**.

The reason for the power stream shift in direction Z is believed accounted for by the following theory which in turn is not to be construed as limitative. As shown by the coordinate axes in FIGURE 1, the peripheral fluid particles in power stream **14** have relatively large momentum in direction X. Some few of these particles make contact with some few peripheral particles of control jet **22** having relatively low momentum in direction Y. The power fluid particles thus contacted shift their path through an angle towards direction Y and normally would have a resultant momentum in a new direction still lying within an X–Y plane, such as is shown by the dotted arrow **30** representing the vector addition of the X and Y momentums. For these particles to continue in such a direction **30**, though, would necessitate that they be separated from the particles in the main body of the power stream which continue to flow only in the original X direction due to the fact that there is no change of momentum given them by the control stream. However, it is difficult for these contacted power stream particles to break away from the body because of the cohesive force between fluid particles. Consequently, these contacted power particles begin to describe a somewhat helical trajectory upon leaving the point of contact **24**. This helical trajectory, the initial part of which is illustrated by arrow **32** in FIGURE 1, causes the contacted power particles to move toward the Z direction and in so doing, to apply pressure to the main power stream body so as to deflect same through some angle A. It will further be noted that since said contacted power particles also have been given some small momentum in the Y direction, the power stream may also change course through an angle B slightly towards the Y direction. This slight deviation through angle B is best shown in FIGURE 3 which is an elevation view of the perspective FIGURE 1 drawing. Contacted peripheral particles of the control stream may also cause deflection of same after leaving point **24**. However, such control stream shifting has not been shown in the drawings since the feature of interest is primarily that of power stream shifting. Furthermore, even if the control stream energy approaches the power stream energy in magnitude, there will still be a substantial component of power stream shift in Z direction. It also may be feasible to utilize the same control stream for shifting a plurality of power streams where the latter are disposed one above the other such that the control stream successively contacts each at a different point along the control stream flow path.

From the above it will be appreciated that the provision of a single, selectively actuated control stream **22** provides a choice of path **28** or path **26** of the power stream. Thus, if both power source **10** and control source **20** are actuated or pulsed at the same time, an intrinsic two input AND function is performed with power fluid being detected in path **26**. If either one or both streams are absent, then no fluid particles are detected in path **26**. By providing a second control nozzle **34** which is also selectively supplied with control stream fluid **40** from source **36**, any power fluid in path **26** can be selectively deflected through an angle C to still another path **38**. This configuration provides a second AND function. Additional control jet nozzles may be positioned further downstream so as to selectively deflect the power stream through more angles along its flow path. Thus, a multiple input device (one input being the power source **10**) can be constructed which uses a number of successively dependent AND gates all of which are serially additive to produce an overall AND function such that power fluid is detected in the final deflection path only if all control streams and the power stream are simultaneously present. A somewhat different mode of operation may be obtained by continuously operating power stream source **10** and selectively pulsing only the control stream sources. It should further be appreciated that it may not be necessary for all control streams to contact the same side of the power stream, nor is it necessary for the control streams to be parallel with each other.

The power fluid can be collected by providing receiving funnel-like members which conduct said fluid to utilization means. For example, two control streams **22** and **40** simultaneously flow to shift the power stream into path **38** where it is received by member **42**. Intermediate receiving members **44** and **46** may also be provided to collect power fluid appearing in respective ones of the other paths **28** or **26**. The provision of such additional receiving members also permits determination of the number of successively located control streams which are energized, since power fluid in any output channel depends upon a particular number of energized control streams upstream therefrom. For example, fluid in member **46** depends on control stream **22** being present, while fluid in member **42** depends upon both control streams **22** and **40** being present.

FIGURES 1, 2 and 3 show the switching of a power stream which flows through an interaction region **16** which effectively is not bounded by confining walls. However, the basic concept of switching by peripheral contact can be extended. FIGURES 4 and 5 illustrate how a power jet **50**, assumed moving initially in direction X, can be confined between the surfaces of parallel plates **52** and **54**, yet still be free to shift through an angle towards the Z direction upon peripheral contact with a control stream **56** flowing in the Y direction. Plates **52** and **54**, especially the latter, thus prevent any shift of power fluid in the Y direction without inhibiting a change of direction in the Z direction. One advantage of this arrangement is that power fluid flow always remains in the same plane, thus simplifying the location of receiving ports. It should be particularly noted in connection with FIGURE 5 that a control stream **56** is introduced to the region between the plates via a nozzle **58** without provision of an exhaust port in plate **54**. The control stream **56** can strike the lower plate **54** and simply be dissipated without any adverse affects on the power stream stability or integrity.

A consideration of FIGURES 4 and 5 leads to a bounded embodiment of multiple input logic structure such as is shown in FIGURE 6. In this figure, the plan view of a laminar multichannel device is shown whereby a fluid power stream originally introduced in an X direction may be selectively shifted towards the Z direction by virtue of control streams applied in the Y direction (which is normal to the plane of the paper). A body **60** of some fluid impervious material, such as transparent plastic, has cut or otherwise formed therein a plurality of fluid channels all lying in the same plane and having parallel top and bottom surfaces similar to the parallel configuration of plates **52** and **54** in FIGURE 4. A power stream input channel **62** narrows to a nozzle section **64** just prior to entry into a chamber **66**. From the chamber **66** branch two output channels **68** and **70** into either one of which the power stream flows after leaving chamber **66**. In the preferred embodiment, output channel **68** is almost directly in line with nozzle **64** so that the power stream normally flows thereto in the absence of a control stream input. A control nozzle **72** enters body **60** normal to the plane of the paper at a point whereby a control stream therefrom makes peripheral contact with the power stream. This switches the power stream into output channel **70**. Channel **70** in turn narrows to a nozzle **74** which terminates at a chamber **76** also provided with a control input **78**. Two output channels **80** and **82** branch from chamber **76**, with channel **80** being taken by the power fluid in the absence of a control stream input from **78**. On the other hand, if a control jet enters chamber **76** through orifice **78**, the power jet is deflected into output channel **82**. Additional chambers and control orifices may be provided downstream. The structure shown in FIGURE 6 therefore provides the logical functions previously explained in connection with FIGURES 1, 2 and 3. By stacking several laminar devices and providing both inlet and outlet openings for a control stream in the top and bottom chamber walls, a single control stream can be made to sequentially contact each of the several power streams.

It is also clear that for either the bounded or free region version of the invention, multiple control stream inputs may be provided at various locations for perofrming logical functions other than those described above. For example, more than one control stream nozzle may be spaced along the length of power stream path **28** in FIGURE 1 so that the energization of any one control stream therefrom will cause shifting of the power stream away from said path. Hence, while certain embodiments of the invention have been shown and described, it is obvious that many modifications thereto may be made by persons skilled in the art without departing from the novel principles recited in the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Fluid stream deflecting means comprising:

(a) an interaction region;

(b) first means for establishing a first fluid stream flow through said interaction region in a first path; and

(c) second means for establishing a second fluid stream flow through said interaction region in a second path adjacent to and transverse, but not intersecting, with said first path such that said streams make peripheral contact with each other whereby said first stream is shifted from said first path through an angle to a third path, with said shift having at least a substantial component of motion in a direction perpendicular to said second path.

2. The invention according to claim **1** wherein said second path is substantially perpendicular with said first path.

3. The invention according to claim **1** wherein at least said second means can selectively establish said second fluid stream.

4. The invention according to claim **3** wherein further means is situated in at least one of said first or third paths downstream from the point of contact to thereby detect any fluid flowing therein.

5. The invention according to claim **4** wherein said second path is substantially perpendicular with said first path.

6. Fluid stream deflecting means comprising:

(a) an interaction region permitting different possible flow paths for a power fluid stream therein;

(b) first means for establishing a power fluid stream flowing through said interaction region; and

(c) a plurality of second means for establishing a plurality of control fluid streams flowing through said interaction region in a plurality of diffeernt control paths which are physically located apart from one another, where each control stream path is adjacent to and transverse, but not intersecting, with a possible power stream path such that a control stream and said power stream make peripheral contact with each other whereby said power stream is shifted from said possible power stream path through an angle to another possible power stream path, with said shift having at least a substantial component of motion in a direction perpendicular to said control stream path.

7. The invention according to claim 6 wherein each said control stream path is substantially perpendicular with a possible power stream flow path.

8. Fluid stream deflecting means comprising:

(a) an interaction region;

(b) first means for establishing a power fluid stream flow through said interaction region in a first path;

(c) second means for establishing a first control fluid stream flow through said interaction region in a second path adjacent to and transverse, but not intersecting, with said first path such that said power and first control streams make peripheral contact with each other whereby said power stream is shifted from said first path through an angle to a third path, with said shift having at least a substantial component of motion in a direction perpendicular to said second path; and

(d) third means for establishing a second control fluid stream flow through said interaction region in a fourth path adjacent to and transverse, but not intersecting, with said third path such that said power and second control streams make peripheral contact with each other whereby said power stream is shifted from said third path through an angle to a fifth path, with said shift having at least a substantial component of motion in a direction perpendicular to said fourth path.

9. The invention according to claim 8 wherein said second path is substantially perpendicular with said first path, and said fourth path is substantially perpendicular with said third path.

10. The invention according to claim 8 wherein said second and fourth flow paths are substantially parallel with each other.

11. The invention according to claim 8 wherein further means is situated in at least said fifth path to thereby detect any fluid flowing therein.

12. Fluid stream deflecting means comprising:

(a) an interaction region;

(b) a surface adjacent said interaction region;

(c) first means for establishing a first fluid stream flow through said interaction region in a first path parallel to and touching said surface; and

(d) second means for establishing a second fluid stream flow through said interaction region toward said surface in a second path adjacent to, but not intersecting with, said first path such that said streams make peripheral contact with each other whereby said first fluid stream is shifted from said first path through an angle to a third path which in turn is still parallel to and touches said surface.

13. The invention according to claim 12 wherein said second path is substantially perpendicular to said surface.

14. The invention according to claim 12 which further includes third means for establishing a third fluid stream through said interaction region towards said surface in a fourth path adjacent to, but not intersecting with, said third path such that said first and third fluid streams make peripheral contact with each other whereby said first stream is shifted from said third path through an angle to a fifth path which in turn is still parallel to and touches said surface.

15. The invention according to claim 14 wherein both said second and fourth flow paths are substantially perpendicular to said surface.

16. Fluid stream deflecting means comprising:

(a) a pair of parallel surfaces spaced apart from each other to thereby form an interaction region therebetween;

(b) first means for establishing a first fluid stream flow through said interaction region in a first path parallel to and touching each said surface; and

(c) second means for establishing a second fluid stream flow through said interaction region in a second path transverse to said surfaces and adjacent to, but not intersecting with, said first flow path such that said streams make peripheral contact with each other whereby said first fluid stream is shifted from said first path through an angle to a third path which in turn is still parallel to and touches each said surface.

17. The invention according to claim 16 wherein said second path is substantially perpendicular to both said surfaces.

18. The invention according to claim 16 which further includes third means for establishing a third fluid stream flow through said interaction region in a fourth path transverse to said surfaces and adjacent to, but not intersecting with, said third flow path such that said first and third fluid streams make peripheral contact with each other whereby said first fluid stream is shifted from said third path through an angle to a fifth path which in turn is still parallel to and touches each said surface.

19. The invention according to claim 18 wherein both said second and fourth flow paths are substantially perpendicular with said surfaces.

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