137-13. OR 3,374,799 SR

March 26, 1968 B. LYMAN 3,374,799

FLUID FLOW CONTROL SYSTEM

Original Filed June 21, 1962

Fig. 1

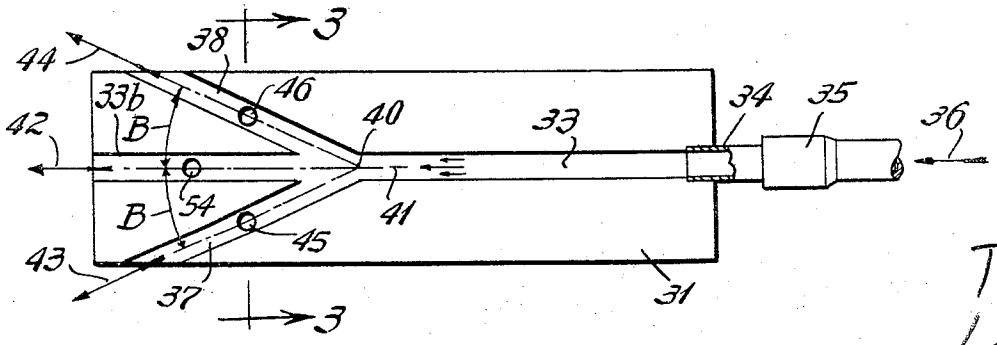


Fig. 2

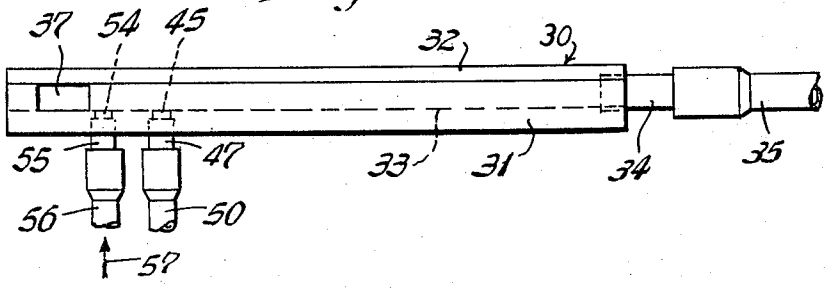
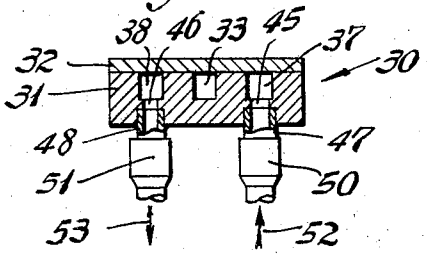


Fig. 3



Toro
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X2378
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FLUID FLOW CONTROL SYSTEM

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Original application June 21, 1962, Ser. No. 204,206, now Patent No. 3,194,253. Divided and this application Nov. 25, 1964, Ser. No. 413,943
2 Claims. (Cl. 137—81.5)

This application is a division of copending application Ser. No. 204,206, filed June 21, 1962, for Fluid Flow Control Device, now Patent No. 3,194,253.

This invention relates to a novel fluid flow control arrangement which has no moving parts and which may be utilized to establish and maintain variable flow paths for a fluid stream. More particularly, the invention relates to a novel fluid flow control system for dividing a fluid supply stream into two constituent streams, one of the constituent streams always flowing through a principal exhaust conduit and the other constituent stream selectively flowing through one of a plurality of branch exhaust conduits.

Various fluidic devices having no moving parts have recently been developed. For example, U.S. Patents 3,024,805 and 3,030,979 respectively illustrate different arrangements which may be used in controlling a fluid flow. In the operation of such known devices the fluid supply stream passes through a nozzle and is then selectively directed along one of a plurality of different possible flow paths by appropriate control means so that for any given operating condition the fluid supply stream remains substantially undivided and extends principally along one predetermined path through the system. The instant invention on the other hand contemplates dividing the fluid supply stream into at least two separate streams which are selectively directed along two of at least three possible flow paths. Here for a given supply stream and a given operating condition of the system two predetermined separate and simultaneous exhaust flow streams are always produced. The operating condition of the system may be shifted by the application of relatively small fluid control signals at points in the two individual exhaust streams that are located respectively downstream from the point where the division of the main supply stream occurs. This operational shifting may be obtained by using two distinct levels of signal power, a lower power signal being effective upon initiation of system operation while an effective higher power signal is required after the system is in operation.

The present type of system may be used where a small-signal low-power fluidic control is desired.

One object of the invention is to provide an improved fluid flow control system having no moving parts.

Another object of the invention is to provide an improved fluid flow control system wherein a main fluid supply stream is divided into two separate streams, one of the separate streams always flowing along a fixed path while the other separate stream selectively flows along different predetermined paths.

Another object of the invention is to provide a fluid flow control arrangement wherein a single fluid supply stream may be divided and directed along at least two of a plurality of separate individual flow paths, and wherein selective direction of a divided portion of said stream may be controlled from points downstream from the respective initial portions of said individual flow paths.

A further object of the invention is to provide a novel fluid flow control system wherein fluid control signals of different intensity levels are operable to shift the operating condition of the system depending respectively on whether

the system is or is not operating at the time of application of the control signals.

Another object of the invention is to provide a novel fluid control system wherein a control signal, having a power level below that normally required to shift the operating condition of the main fluid flow, is applied before initiation of said main fluid flow whereby the said control signal will be capable of causing the said main fluid flow to assume a desired condition.

Further objects and advantages of the invention will become apparent as the description proceeds.

In the drawings:

FIG. 1 is a plan view showing the grooved construction of a main lower plate member utilized in one embodiment of the instant invention;

FIG. 2 is a side elevational view showing the sandwich type unit construction used in said one embodiment of the invention;

FIG. 3 is a transverse sectional view taken along section line 3—3 of FIG. 1.

In the illustrative embodiment of the invention shown in FIGS. 1–3 a sandwich type construction is utilized wherein a main body unit **30** comprises a lower grooved plate **31** and an upper cover plate **32** that is secured in superimposed sealed relation with respect to lower plate **31**. The upper surface of grooved plate **31** is formed with an elongated and substantially straight cylindrically cross sectioned channel **33** one end of which communicates, by means of a suitable fitting **34** and flexible tubing **35**, with a suitable fluid flow source indicated by arrow **36**. Two straight symmetrically arranged divergent branch channels **37** and **38** are formed in plate **31** so as to communicate with the main channel **33**; the axes of channels **37** and **38** intersecting at a common point **40** along the intermediate portion of the main channel axis **41**. The angles B, FIG. 1, are substantially equal and may have a value of between 15 and 45 degrees. An exemplary value of 25 degrees has been found to be very satisfactory. There are no substantial restrictions in the cylindrical channels **33**, **37** and **38**, and each channel has a substantially uniform cross sectional shape and size throughout its effective length particularly in the region of the junction **40**.

In the operation of the trident fluid conduit arrangement thus far described a main fluid supply stream in being introduced into the main channel **33** from source **36** is columnated as it flows along the elongated portion of said main channel **33** located upstream from junction **40**. When arriving at junction **40** one part of the fluid stream will always exhaust through the downstream portion **33***b* of the main channel while the other part of said main stream will exhaust either through the branch channel **37** as indicated by arrow **43** or through the branch **38** as indicated by arrow **44**. Whichever mode of operation exists at any given time i.e., whether air is exhausting as at **42**, **43** or as at **42**, **44** the flow conditions will persist and will be stable until the flow system is changed by the application of control signals as will be described below.

A pair of fluid signal control channels **45** and **46** are formed in plate **31**; these control channels respectively communicating with said branch channels **37** and **38** at points downstream from the region of the junction **40**. The control channels **45** and **46** are respectively connected by means of suitable fittings **47** and **48** to suitable conduit means, such as flexible tubing **50** and **51**, through which fluid control signals may pass. With no control signals applied through control channels **45** and **46** the instant device will have, upon initiating the flow on the main stream, an initial preferred operational mode wherein a portion of the main fluid stream will always flow or exhaust through a predetermined one of said branch channels **37** and **38**. Let it be assumed that the initial preferred

operational mode is such that channel 33*b* and the branch channel 37 are conducting while branch channel 38 remains non-conducting. When it is desired to shift or change this operational mode of the system a control signal is initiated in the control channel 45 as indicated by arrow 52, the power level of this control signal being equal to or greater than a predetermined minimum. In response to the application of this control signal, which may be momentary in duration, the operational mode of the system will be shifted so that branch channel 38 is now conducting while 37 is non-conducting. Instead of initiating a positive control signal, i.e. one above atmospheric pressure, in the control channel 45 the same mode shifting action may be obtained here by initiating a corresponding negative or sub-atmospheric control signal in the control channel 46 as indicated by the arrow 53, FIG. 3. With the channels 33*b* and 38 now conducting and channel 37 non-conducting it is possible to shift back to the original operational mode by introducing either a positive control signal, having a fluid power level above said predetermined minimum level, into control channel 46 or a corresponding negative fluid control signal into the control channel 45 whereupon the device will assume its first mentioned operational mode wherein channels 37 and 33*b* are conducting. In either operational mode a slight sub-atmospheric pressure will normally exist in the non-conducting branch channel of the unit.

The system illustrated in FIGS. 1–3 may under certain conditions be controlled by the application of control signals that have less than the minimum power mentioned above. Normally when a positive control signal of predetermined reduced power, that is a signal below said predetermined minimum, is initiated in the appropriate control channel the operational mode of the system will not be shifted. If however such reduced power control signal is maintained and the flow of the main stream through the channel 33 is momentarily interrupted then upon the re-establishment of the main stream the maintained reduced signal will be sufficient to cause the shift in the operational mode. As will be apparent this type of control arrangement will be desirable where a control signal is to be maintained or stored until such time as it is to become effective upon the initiation of another command signal. The said interruption of the flow of the main fluid stream may be accomplished by cutting off the stream source or by blocking the downstream end of the main channel 33; however a third procedure may under some conditions be preferable. Here the lower grooved plate 31 of the body unit 30 is provided with a control channel 54 which communicates with channel portion 33*b* and which by means of a suitable fitting 55 communicates with a suitable conduit means, such as the flexible tubing 56, through which control signals may pass as indicated by arrow 57, FIG. 2. By introducing a positive signal into the control channel 54 the main fluid stream may be momentarily disturbed to the extent necessary to produce the above described reduced signal mode shifting action.

While one embodiment of the invention has been shown and described, it will be apparent to those skilled in the art that numerous variations and modifications may be made in the particular construction without departing from the underlying principles of the invention. It is therefore desired, by the following claims, to include within the scope of the invention all such variations and modifications whereby substantially the results of the invention may be obtained by the use of substantially the same or equivalent means.

The invention claimed is:

1. A method of selectively controlling the flow of a fluid along at least two predetermined flow paths; comprising the steps of

providing a fluid flow source;

establishing a continuous main fluid stream from said source;

establishing two symmetrically disposed divergent flow paths which communicate at a substantially common point with the main stream whereby at any given time at least a portion of said main stream is conducted along only one of said divergent flow paths, this fluid flow system normally remaining in a stable condition until caused by a predetermined fluid control signal having at least a predetermined minimum power to shift to another stable condition wherein at least a portion of the main stream is conducted along the other of said divergent paths;

applying a reduced fluid control signal having a power less than said predetermined minimum power to said [first and second] one of said divergent flow paths downstream of said common point;

interrupting the fluid flow along the main stream during the application of said reduced fluid control signal; and

re-establishing said main fluid stream during the application of said reduced fluid control signal so that at least a portion of the main fluid stream flows along only the said other of said divergent flow paths.

2. The method defined by claim 1 wherein said reduced control signal is applied before the initiation of the step of interrupting the said main fluid stream from said source.

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