United States Patent

[11] 3,628,726

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[21] Appl. No. 791,239
[22] Filed Jan. 15, 1969
[45] Patented Dec. 21, 1971

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[54] NOZZLE AND CONTROL APPARATUS
6 Claims, 5 Drawing Figs.

[52] U.S. Cl. 239/101, 239/102, 239/265.17, 239/425.5
[51] Int. Cl. B05b 1/08
[50] Field of Search 239/101, 102, 427.5, 265.17, 425.5, 601

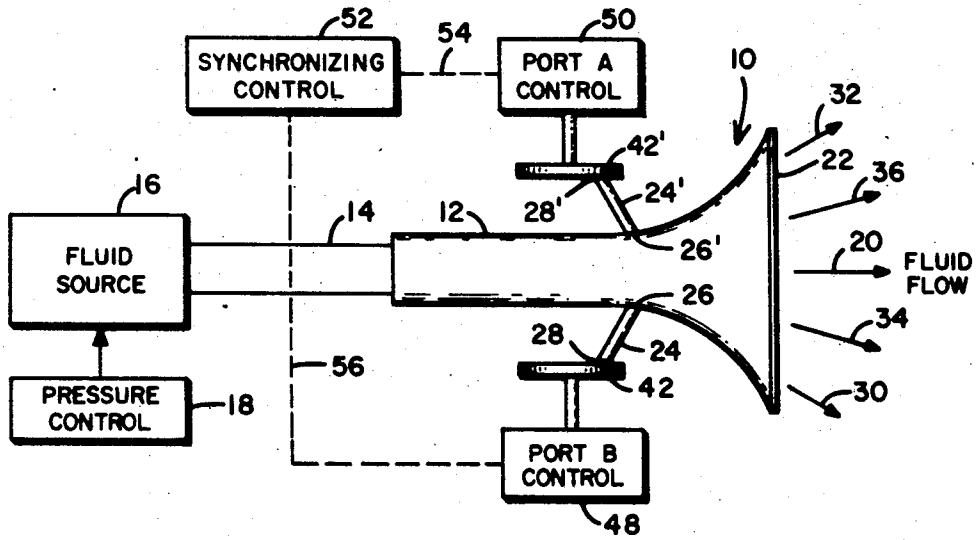
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ABSTRACT: An improved fluidic nozzle and fluid-flow control apparatus is described. Control apparatus for altering the path of fluid flow in the nozzle, including chambers capable of being selectively opened and closed for creating pressure imbalances are shown.



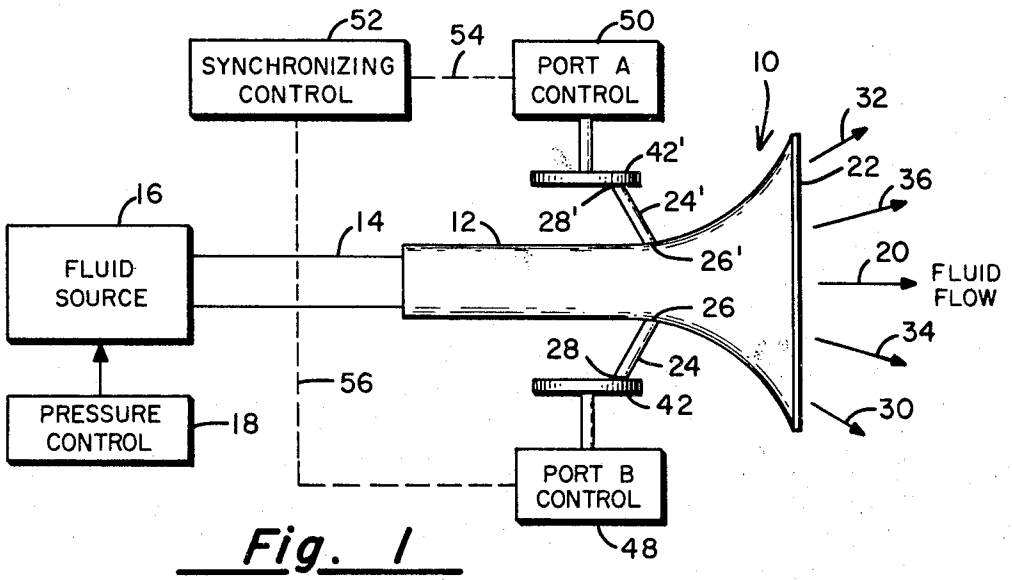


Fig. 1

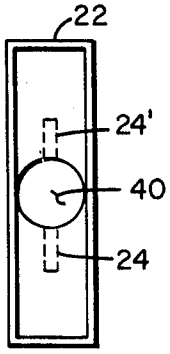


Fig. 2

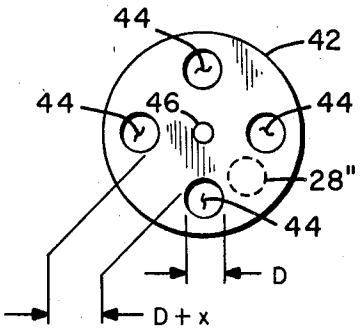


Fig. 3

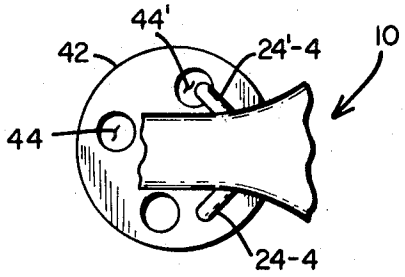


Fig. 4

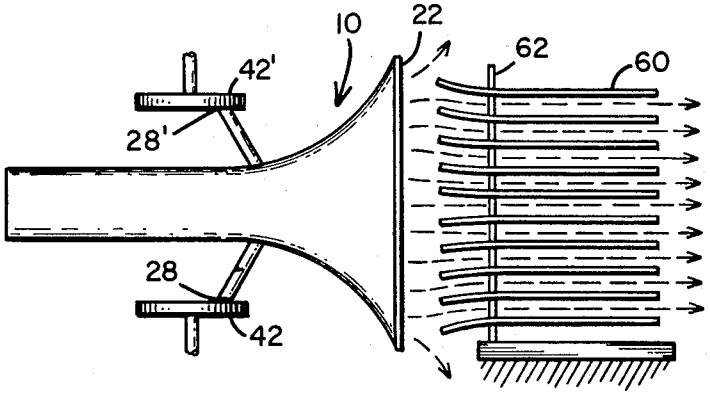


Fig. 5

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NOZZLE AND CONTROL APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to fluid nozzles; and, more specifically, relates to improved control apparatus for use with the so-called Prandtl nozzle.

2. Description of the Prior Art

The so-called Prandtl nozzle is known to the prior art. This nozzle generally has a neck portion for receiving a fluid flow, and expands in a bell-like fashion at the exhaust end. In the absence of applied control, the fluid will normally flow directly through the Prandtl nozzle from the neck portion straight or through the bell-like exhaust end. It is known, that by the injection of a fluid pressure along the neck portion approximately in the vicinity of the expanding bell-like exhaust portion, that the fluid will be forced away from the injected fluid pressure and will tend to adhere to the opposite portion of the nozzle. This adherence of the fluid to the wall of the nozzle, is referred to as the Coanda effect, or alternatively as wall-attachment effect. The fluid flow will therefore be deflected at the exhaust end away from the straight line flow, and will continue in this deflected manner even in the absence of the continued injection of the directing fluid impulses. In order to cause the flow to deflect in the opposite direction, a fluid impulse must be injected at the opposite side of the nozzle, thereby causing the fluid to be deflected toward and adhere to the opposite wall of the nozzle. In order to get the fluid flow directly through the nozzle, it was necessary to inject fluid signals to both sides of the Prandtl nozzle, thereby causing the flow of fluid to be detached from each of the walls. Alternatively, a fluid impulse could be injected along the wall to which the fluid flow was attached, but of an impulse level insufficient to force the fluid flow to the opposite wall. This prior art arrangement for switching the direction of fluid flow at the output of the Prandtl nozzle had the drawback of requiring separate sources of fluid pressure and control for causing the switching of the direction of fluid flow, and required the additional control elements for the switching and gating of the controlling fluid impulses. Further, it was necessary to provide controls for establishing the level, or force, and the duration of such controlling fluid impulses.

SUMMARY

In summary, then, this invention comprises an improved Prandtl nozzle that does not require the application of fluidic impulses for controlling the direction of flow of the fluid through the nozzle. The nozzle of this invention, is provided with a plurality of chambers that are open to the inner portion of the nozzle, and are open at port ends to a reference pressure, for instance the atmosphere. Means are provided for selectively closing off one or more of these chambers from access to the atmosphere. When a chamber is closed off from the atmosphere, the fluid flowing through the nozzle creates a pressure decrease in the chamber so closed off, and causes the fluid flow to be directed toward the wall whose chamber is so closed off. When a chamber thus closed off is subsequently opened to the atmosphere, and another of the chambers is closed off, the pressure imbalance will cause the fluid flow to be deflected to the wall whose chamber is then closed off.

A primary object of this invention, then, is to provide an improved Prandtl nozzle and control apparatus therefore. Another object of this invention is to provide a control apparatus for a Prandtl nozzle that does not require the application of externally supplied fluid impulses for controlling the direction of fluid flow. Still another object of this invention, is to provide a mechanical apparatus for opening and closing ports to control chambers in a Prandtl nozzle for controlling the direction of fluid flow therein. Still another object of this invention, is to provide a simply constructed Prandtl nozzle for use in document-handling equipment. These and other more specific and detailed objectives will become apparent from a consideration of the description of the preferred embodiment when viewed in light of the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic view of the improved Prandtl nozzle and controls therefore,

FIG. 2 is an end view showing the shape of the exhaust portion of the Prandtl nozzle;

FIG. 3 illustrates a face view of one type of mechanical control element that is used for opening and closing the control ports;

FIG. 4 illustrates a single control element of the type illustrated in FIG. 3 for controlling a plurality of ports; and

FIG. 5 is a diagrammatic representation of the improved Prandtl nozzle when used for separating documents in a document-handling apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 is a diagrammatic view of the Prandtl nozzle of this invention with its associated control apparatus. The nozzle **10** has a neck portion **12** coupled to a conduit **14** which in turn is coupled to fluid source **16**. Characteristically the fluid can be considered to be air. Fluid source **16** has associated therewith a pressure control **18** for establishing the fluid pressure to be established from the fluid source **16** in conduit **14**. It should be noted that for certain applications, the pressure control **18** can be of a varying type control such that the fluid pressure in conduit **14** results in a pulsating fluid flow into neck **12**. As the fluid flows through neck **12**, it tends to follow the path indicated by arrow **20** out of the exhaust portion **22** of nozzle **10**. Chambers **24**, **24'** are located at the sides of neck **12** in the area of the nozzle where the exhaust portion **22** expands outwardly.

The operation is such, that the chambers **24**, **24'** can control the direction of fluid flow out of exhaust portion **22**. The chambers **24**, **24'** have ends **26**, **26'** open to the inner portion of nozzle **10**. The outer ends **28**, **28'**, otherwise referred to as ports are subject to being open to the atmosphere. In order to control the direction of fluid flow, the ports are selectively opened and closed. In order to cause the air to flow in the downward direction indicated by arrow **30**, it is necessary only to close off port **28** from communication with the atmosphere. This causes a reduced pressure in chamber **24**, thereby tending to cause the airstream to adhere to the lower wall of exhaust portion **22**. During the closing of port **28**, to cause the fluid to proceed in the direction arrow **30**, it is necessary that port **28'** be open. In order to switch the direction of fluid flow from that indicated by arrow **30** to the direction indicated by arrow **32**, it is necessary only to open port **28** and close port **28'**. Again, closing port **28'** will result in the lowered pressure in chamber **24'**, thereby causing the wall-attachment effect of the fluid to the upper surface of exhaust portion **22**. It is of course clear, that in switching the fluid flow from the direction of arrow **30** to the direction of arrow **32** that the stream of air will traverse the path upwardly at the exhaust portion **22** of the nozzle, as indicated by arrows **34**, **20**, and **36**. It can be seen, therefore, that in order to cause the fluid flow to move upwardly and downwardly, it is necessary to only to alternatively open and close ports **28** and **28'**.

FIG. 2 illustrates an end view of the exhaust portion **22** of the nozzle. The opening **40** is in neck portion **12** and communicates with the conduit **14**.

The ports **28** and **28'**, are controlled by control elements **42** and **42'**, respectively. Turning attention briefly to FIG. **3**, there is shown an element **42** that can be used advantageously to control ports **28** and **28'**. There is shown a circular element **42** having apertures **44** therein. The dotted circular portion **28''**illustrates the location of the element **42** with respect to port **28**. As element **42** is caused to rotate about axis **46**, the apertures **44** proceed to periodically expose port **28** to the atmosphere. When element **42** is in the position shown in FIG. **3**, port **28** is blocked. The diameter D of apertures **44** is somewhat less than the spacing D+X between apertures **44** in order to permit time for the stream of fluid flow to be switched upwardly and downwardly. Control elements **42** and **42'** can be driven for instance by port B control element **48** and port A

control element 50 respectively. A synchronizing control 52 can be coupled, as indicated by dashed lines 54 and 56 to control elements 50 and 48 respectively. The synchronizing control 52 can be utilized to assure the alternate opening and closing of ports 28 and 28'. The controls 48 and 50 can be geared linkages, pulley linkages, fluidic motors, or any other well-known devices for causing a predetermined movement of control elements 42 and 42'.

It is of course clear that the rotary motion of control elements 42 and 42' can be replaced by reciprocating members that merely move back and forth across ports 28 and 28', or other movable device for opening and closing the ports.

FIG. 4 illustrates a partially broken away alternative arrangement for controlling the ports of a Prandtl nozzle as used in this invention. In FIG. 4 there is shown a single rotary element 42 having several apertures 44 therein. In this arrangement, a single rotatable element 42 is arranged to cooperate with a pair of chambers 24–4 and 24'–4. In this arrangement, it can be seen that chambers 24–4 is cooperating with the solid portion of element 42 while chamber 24'–4 is in cooperation with aperture 44' thereby being exposed to the atmosphere. In this configuration, a single drive can be utilized for driving element 42, thereby further simplifying the control structure. In this arrangement it is necessary only that chambers 24–4 and 24'–4 have their port portions directed to the side to permit cooperating with the single element 42.

The improved Prandtl nozzle and control apparatus of this invention finds use in document-handling equipment. FIG. 5 shows an arrangement wherein the exhaust portion 22 of nozzle 10 is directed at a stacked plurality of documents 60 which are retained in a predetermined relationship, such as by a pin 62. In this arrangement, it can be seen that fluid flow leaves the exhaust portion 22 and is switched upwardly and downwardly by the alternate opening and closing ports 28 and 28', there is a turbulence generated at the ends of documents 60, thereby causing the documents to separate for allowing the fluid to pass therebetween. Many document-handling devices provide for holding documents in a predetermined relationship by a plurality of pins 62 which are selectively withdrawn for permitting a selected one of the documents to be removed from the stack. This end-coding of documents is well known in the prior art as is the coded withdrawal of pins for permitting extraction of a selected document. The extraction may be done manually or by machine. It can be pointed out that while the documents are shown in the horizontal position in FIG. 5, that they can also be suspended vertically with the improved nozzle being directed downwardly at the upper ends of document 60. This provides the advantage that the fluid flow need not support the weight of the documents but can be used merely to separate the documents in a horizontal manner. Both systems find advantageous use. It will be recalled from the consideration of FIG. 1 that pressure control 18 can be used to cause fluid source 16 to provide a pulsating fluid flow to conduit 14 and thence to the nozzle 10. The combination of the pulsating fluid and the movement of the fluid upwardly and downwardly by the nozzle provides an advantageous arrangement for keeping documents 60 separated.

Having, therefore, in the foregoing description fully set forth the improvements and advantages of this invention, it is clear that the stated objectives have been achieved. It being understood that various modifications will become apparent to those skilled in the art upon viewing this discussion and the drawings, without departing from the spirit and scope of the invention, what is intended to be protected by Letters Patent is set forth in the appended claims.

We claim:

1. An improved nozzle comprising neck means for receiving fluid; exhaust means coupled to said neck means and having outwardly extending walls; chamber means positioned in said walls and in fluid communication with said fluid and an ambient fluid pressure; and control means for selectively blocking said fluid communication with said ambient fluid pressure in said chamber means for causing a fluid pressure imbalance for causing change of direction of flow of said fluid in said exhaust means.

2. A nozzle as in claim 1 wherein said chamber means includes a pair of chambers each associated with one of said outwardly extending walls, and said control means includes movable means for selectively blocking and unblocking said chambers, the blocking of one of said chambers causing the direction of fluid flow to be deflected toward the one of said walls associated with said one chamber.

3. A nozzle as in claim 2 wherein said movable means includes a rotary member having a plurality of apertures therethrough, said rotary member arranged for opening and blocking said pair of chambers.

4. A nozzle as in claim 2 wherein said movable means includes a pair of rotary members, a different one of said pair associated with each of said pair of chambers, each of said rotary members having a plurality of apertures therethrough said rotary members arranged for opening and blocking said associated one of said chambers.

5. A nozzle as in claim 4 and further including synchronizing means for synchronizing movement of said pair of rotary members.

6. A nozzle as in claim 2 and further including fluid pressure control means for causing pulsating fluid flow in said neck means.

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