United States Patent [19]

Mocarski

[11] **3,829,027**

[45] **Aug. 13, 1974**

[54] **VARIABLE VACUUM PRODUCING NOZZLE**

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[22] Filed: **Feb. 28, 1973**

[21] Appl. No.: **336,723**

[52] **U.S. Cl.**..... **239/410,** 239/DIG. 7, 239/417.3

[51] **Int. Cl.**..... **B05b 7/12**

[58] **Field of Search**..... 239/DIG. 7, 425.5, 424, 239/410, 412, 411, 417.3

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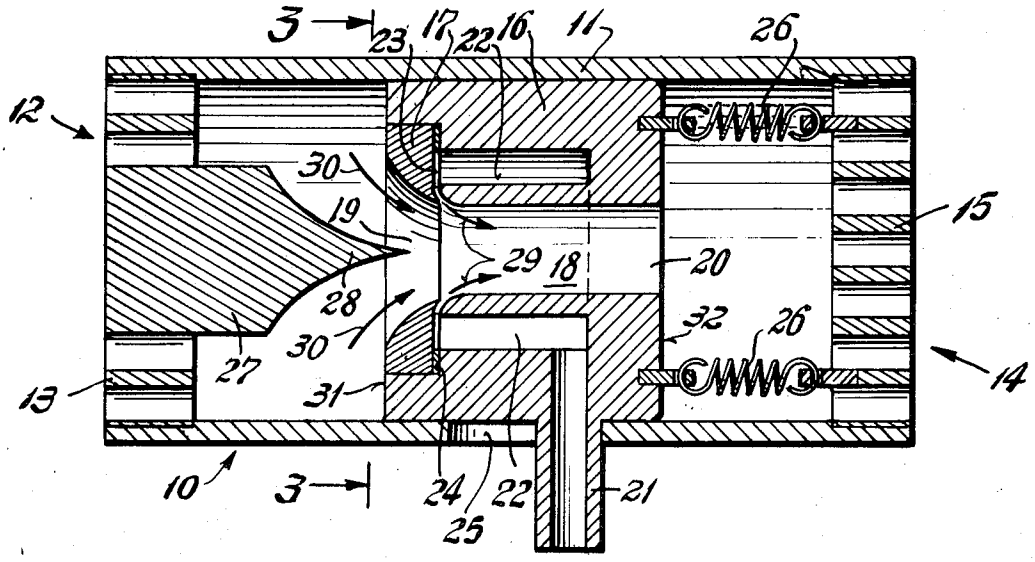
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[57] **ABSTRACT**

A nozzle having a through passageway with an intermediate slot connected to a source of pressurized fluid with the flow of pressurized fluid inducing flow of ambient fluid into the entrance and through the passageway and in which the area of the entrance to the passageway through which the ambient fluid may flow is decreased to increase the extent of the vacuum produced by the nozzle to thereby provide a lower absolute pressure at the entrance.

12 Claims, 3 Drawing Figures



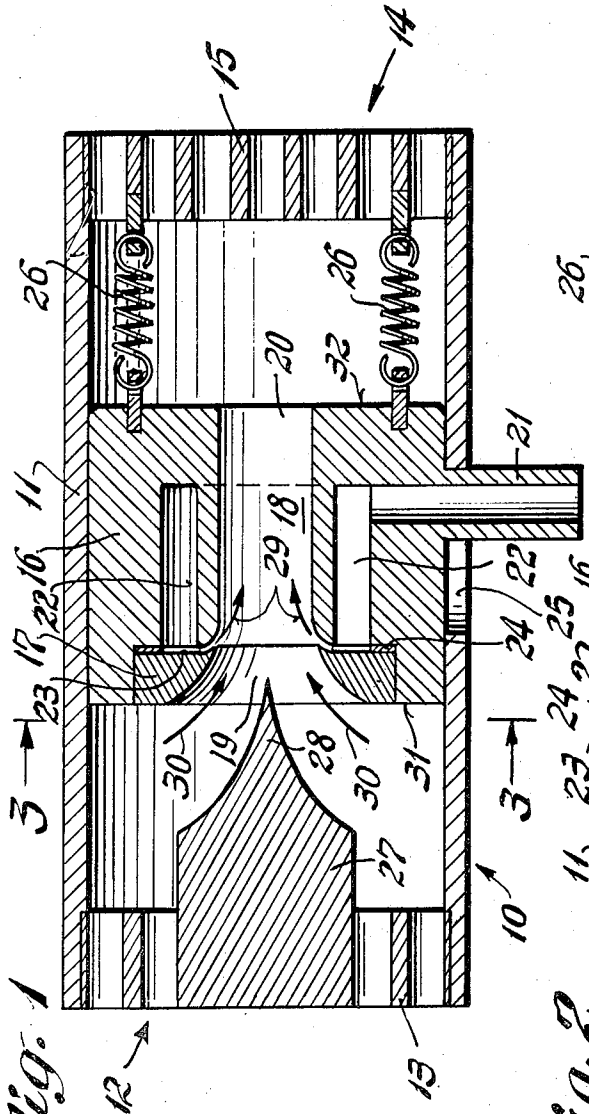


Fig. 1

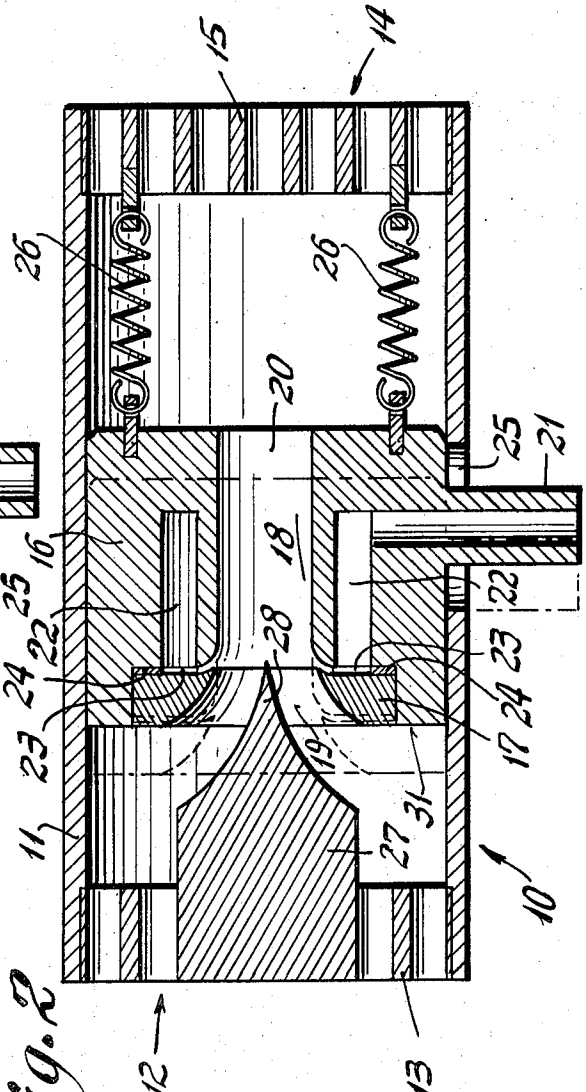


Fig. 2

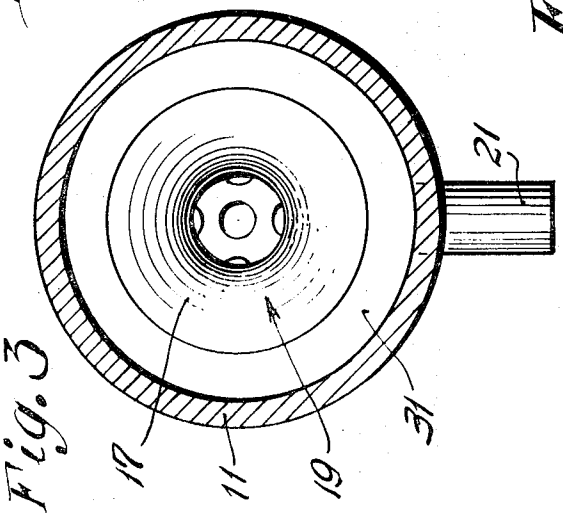


Fig. 3

VARIABLE VACUUM PRODUCING NOZZLE

The nozzle of the present invention has a special utility when connected to a container in which it is desired to produce a vacuum. Such nozzles are formed to have a passageway having an entrance and an exit with an intermediate slot. The passageway is shaped so that when a fluid under pressure flows through the slot, it, by the Coanda effect, induces the flow of ambient fluid at the entrance through the passageway. The discharge from the passageway exit is thus the combined pressurized and ambient fluids.

While such nozzles have been found to be extremely useful in many applications they have heretofore been incapable of producing ambient fluid flow if there is a vacuum of perhaps **5** psi less than atmospheric or so at the entrance. This thus became the maximum section which such nozzles could produce.

It is accordingly an object of the present invention to provide, a nozzle, which while using the Coanda effect of fluid flow through a slot is capable of producing a greater value of vacuum than heretofore attainable.

Another object of the present invention is to provide a nozzle that is capable of adjusting the area through which the ambient fluid flows into the entrance of the passageway to thereby increase the differential pressure that may exist between the entrance and exit before the nozzle fails to function.

Another object of the present invention is to provide a nozzle that while capable of providing a high vacuum, is also capable of automatically varying the area to the entrance inversely with the extent of the vacuum with the flow of ambient fluid induced varying with the size of the area.

A further object of the present invention is to achieve the above objects with a nozsle that is simple in construction, reliable in use and relatively economical to manufacture.

In carrying out the present invention, the nozzle is herein shown as being formed to have a through passageway with an entrance, an exit and an intermediate slot. It further includes a tube also having an entry and a discharge with the discharge preferably being open to the atmosphere while the entry is connected to a container from which the ambient fluid is desired to be removed. Pressurized fluid is flowed through the slot to induce the flow of the ambient fluid through the entry, the passageway and the discharge.

The entry of the tube, while essentially open, has positioned therein a plug that is in alignment with the passageway and which has a somewhat tapered nose positioned adjacent to the entrance. For small values of vacuum, the nose is spaced from the entrance and does not limit the size or area of the entrance through which the ambient fluid flows so that there is thus basically unrestricted flow from the entry to the passageway. When it is desired to increase the extent of the vacuum, the plug is relatively moved nearer to the entrance so that at the maximum vacuum, the nose is essentially in the passageway approximately at the slot. The tapered portion substantially reduces the area through which ambient fluid may flow and also reduces the area through which the pressurized fluid may reversly flow and hence obstructs reverse flow thereof. With such a construction, the extent of the vacuum may be almost tripled, with the nozzle inducing flow of ambient fluid substantially to a vacuum of 15 inches of mercury.

The relative position of the plug may be fixed into a position which sets the maximum vacuum desired. However, the present invention also provides for varying the position of the plug in accordance with the extent of the vacuum at the entrance. For the lesser extent of vacuum, there will be a higher ratio of induced ambient fluid flow for pressurized fluid while for the higher values of vacuum the ratio of ambient fluid is decreased. This is achieved by varying the area to the entrance automatically by mounting the plug and the nozzle for relative movement and utilizing the difference of pressure between the entrance and the exit for adjusting the relative position of the plug and entrance. In this manner, the nozzle will adjust itself to the extent of the vacuum at the entrance and tend to be operating most efficiently for inducing ambient fluid flow.

Other features and advantages will hereinafter appear.

In the drawing

FIG. **1** is a diametric section of the variable vacuum nozzle of the present invention.

FIG. **2** is a view similar to FIG. **1** showing a different position of the nose and entrance for a higher value of vacuum at the entrance than in FIG. **1.**

FIG. **3** is a section taken on the line **3**—**3** of FIG. **1.**

Referring to the drawing the nozzle of the present invention is generally indicated by the reference numeral **10,** and includes a tube **11** that has an entry **12** in which a perforated plate **13** is secured and a discharge **14** in which another perforated plate **15** is positioned. The entry **12** is connected to a container or conduit from which it is desired to induce the flow of ambient fluid therefrom while the discharge **14** is preferably open to the atmosphere when, for example, air is an induced fluid. In any event it is connected to a non-pressurized conduit. The size of the openings in the plates **13** and **15** are such as to enable essentially unrestricted flow of ambient fluid into the tube and to have it discharged therefrom.

Located intermediate the entry and discharge of the tube **11** is an annular member **16** having the cross-sectional shape shown and having a cap **17** secured thereon. The member and cap define a passageway **18** having an entrance **19** and an exit **20.** In addition, a conduit **21** communicates with an annular chamber **22** which in turn communicates with a slot **23** formed between the adjacent surfaces of the member and cap. A washer **24** may be interposed between the adjacent surfaces of the parts **16** and **17** to facilitate the dimensioning of the width of the slot **23** and also, if desired, may have metering segments to regulate the extent of the fluid flow through the slot **23.** The member **16** is mounted in the tube **11** for movement along the axis of the tube with the tube **11** being formed with an opening **25** through which the conduit **21** extends. The conduit prevents relative rotation of the member, but yet, enables movement along the axis thereof for the extent of the opening **25.**

The member **16** normally is caused to assume the position in which it is shown in FIG. **1** by tension springs **26** that are secured between the member **16** and the discharge plate **15.** The springs **26** exert a force tending to pull the member towards the discharge plate and away from the entry.

Secured on the entry plate **13** is a plug **27** that has the diametric cross-section shown and is mounted to be in

axial alignment with the passageway **18.** It includes a nose portion **28** which is of decreasing diameter as it extends towards the entrance **19** of the nozzle and is preferably pointed as shown.

In the operation of the nozzle to produce a suction at the entry **12** of the tube which may have a higher value than heretofore possible with such Coanda effect nozzles, a fluid under pressure is introduced into the conduit **21** to flow through the chamber **22** and out the slot **23** as indicated by arrow **29.** It then passes through the exit **20** and the discharge plate **15.** This flow by reason of the Coanda effect, induces the flow of ambient fluid, indicated by arrows **30,** into the entrance **19** and through the passageway **18** where it combines with the pressurized fluid so that the exit **20** has the combined fluids flowing therethrough. The flow of ambient fluid creates a vacuum between the entrance **19** and the entry **12** and this vacuum is exerted on a surface **31** of the member **16.** The member further has another surface **32** adjacent the discharge and thus has the discharge pressure exerted thereon so the discharge pressure is higher, generally atmospheric, so that a pressure difference exists on the two surfaces **31** and **32.** This difference exerts a force to move the member **16** leftward toward the plug against the tension of the springs **26.** The amount of movement depends on the extent of pressure difference which is normally totally dependent on the extent of vacuum on the surface **31,** the relative areas between the surfaces **31** and **32** and the spring rate of the springs **26.** Accordingly, as the vacuum at the entry **12** increases, the force moving the nozzle leftwardly increases to increasingly stretch the springs **26** and move the member leftwardly to a stable position where the forces are in equilibrium. Thus, as shown in the solid line position of the parts in FIG. **2** the member may, at times, be halfway between the extremes of its range of movement. The most open position of the member is shown in solid lines in FIG. **1,** while the most restricted position is indicated by dotted lines in FIG. **2.**

In the most open position, the area through which ambient fluid may flow between the plug and the entrance is essentially unrestricted and the ratio of the volume of ambient fluid induced to flow as compared with the volume of pressurized fluid utilized, is at its highest, perhaps **7** to **1.** This occurs at the lower values of vacuum at the entry. At its most restricted position, where the highest value of vacuum is present at the entry, the area through which ambient fluid may flow between the nose and the entrance is substantially reduced so that the ratio of the volume of ambient fluid to pressurized fluid is quite small, perhaps 1.2 to 1.

It will be understood that while the position of the nose **28** decreases the area through which the ambient fluid may flow the restriction in area also tends to increase the value of vacuum which would cause pressurized fluid flowing through the slot **23** from reversing its direction to flow out of the entrance. Without the plug, the maximum vacuum which such a nozzle could produce and sustain on the order of **5** inches of mercury which is basically set, as above noted, by the pressurized fluid tending to flow at least partially through the entrance instead of all out the exit. However, with the plug the value of vacuum which can cause a directional change of the compressed fluid has been increased to perhaps 15 inches of mercury. Thus, while the plug reduces the area through which the ambient fluid may flow, it also, in so doing, increases the resistance to flow of the compressed fluid through the entrance. It will be noted by the dotted lines in FIG. **2** that the front of the plug extends into the passageway at the maximum restricted position just slightly beyond the slot.

While there has been disclosed a variable vacuum nozzle, the nozzle may be fixed at a selected value of vacuum by simply securing the member in the tube where such a value is created with, for example, a set screw.

While the above description specifically relates to the producing of a high vacuum, it will be understood that if desired, the plug may be used to increase the exit pressure that occurs before pressurized fluid reversal. Thus the plug enables a greater differential pressure to exist between the entrance and exit. Also if the entrance is not connected to a container, but instead is open, the plug may be merely held by struts.

The shape of the slot forming members and the plug has not been found to be essentially critical, though extensive deviation for the shape shown may decrease the ability to create the large differential pressure. In any event it is preferred, for maximum differential pressure to have the plug have a portion that extends into the passageway beyond the slot.

It will accordingly be appreciated that there has been disclosed a nozzle which uses the Coanda effect to produce a vacuum. The extent of the vacuum may be substantially increased beyond that heretofore attainable by restricting the area through which the ambient fluid flows. The restriction is such that is enables laminer flow of the ambient fluid by blocking the interior of the nozzle entrance with at least a portion of the blocking including the center of the passageway where the slot enables introduction of the pressured fluid. The blocking also increases the resistance of the nozzle to a reversal of flow of pressurized fluid.

Variations and modifications may be made within the scope of the claims and portions of the improvements may be used without others.

I claim:

1. A nozzle for producing a flow through a conduit comprising a member having a through passageway formed with an entrance, an exit and an intermediate slot, means connecting the slot to a source of pressurized fluid and means connecting the entrance to the conduit whereby flow of pressurized fluid through the slot and out the exit induces flow of ambient fluid into the entrance, through the passageway and out the exit and means for restricting the flow of ambient fluid to the entrance to thereby increase the extent of the differential pressure existing between the entrance and the exit, in which the restricting means is mounted for relative movement and means for varying the restricting means inversely with the extent of the differential pressure between the entrance and exit and in which the restricting means includes a stationary plug, means mounting the passageway member for movement towards and away from the plug and means for utilizing the difference in pressure between the entrance and exit for providing a force tending to move the member.

2. A nozzle for producing a flow of ambient fluid through a conduit comprising a member having a through passageway formed with an entrance, an exit and an intermediate slot, means connecting the slot to a source of pressurized fluid and means connecting the

entrance to the conduit whereby flow of pressurized fluid through the slot and out the exit induces flow of ambient fluid into the entrance, through the passageway and out the exit and adjustable means for restricting the flow of ambient fluid into the entrance in accordance with the extent of the differential pressure existing between the entrance and the exit.

3. The invention as defined in claim **2** in which the restricting means includes a pair of surfaces located adjacent the entrance between which ambient fluid flows and in which one of the surfaces is movable with respect to the other to thereby vary the size therebetween through which the ambient fluid flows.

4. The invention as defined in claim **3** in which one of the surfaces is formed at the entrance and converges toward the exit, in which the restricting means includes a plug having the other surface and in which the other surface converges towards the entrance.

5. The invention as defined in claim **4** in which the another converging surface terminates with a front portion that is postionable within the passageway and in which there remains an area between the entrance converging surface and the plug converging surface for flow of ambient fluid.

6. The invention as defined in claim **2** in which the adjustable means varies the restriction inversely with the extent of the difference in pressure between the entrance and exit.

7. A nozzle for producing fluid flow comprising a member formed to have a through passageway with an entrance and an exit, inlet means for directing a flow of pressurized fluid into the passageway and intake means connecting the entrance with a source of secondary fluid whereby flow of pressurized fluid through the passageway and out the exit induces flow of secondary fluid through the intake means into the entrance, through the passageway and out the exit and adjustable means for varying the size of the intake means in accordance with the difference in pressure existing at the exit and of the secondary fluid at the intake means.

8. The invention as defined in claim **7** in which the adjustable means includes a movable portion responsive to the difference in pressure and in which the movable portion reduces the size of the intake means as the pressure difference increases.

9. The invention as defined in claim **8** in which the adjustable means includes means for urging the movable portion to increase the size of the intake means against the action of the pressure difference tending to reduce the size.

10. The invention as defined in claim **7** in which the adjustable means includes a stationary portion and a movable portion with the latter being mounted for movement toward and away from the stationary portion and in which the intake means is formed between a surface on the movable portion and an adjacent surface on the stationary portion.

11. The invention as defined in claim **10** in which the movable portion includes a first surface exposed to the pressure at the exit and a second surface exposed to the pressure at the intake means.

12. The invention as defined in claim **10** in which the adjustable means includes spring means tending to exert a force to move the movable portion away from the stationary portion and in which there are means for setting the extent of the movement to set the maximum size of the intake means.

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