United States Patent [19]

Tsuchiya

[11] **3,776,470**

[45] **Dec. 4, 1973**

[54] **VARIABLE NOZZLE**

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[73] Assignee: **General Mills, Inc.**, Minneapolis, Minn.

[22] Filed: **Sept. 30, 1971**

[21] Appl. No.: **185,000**

[52] **U.S. Cl.**..... **239/534**, 239/265.43, 239/546

[51] **Int. Cl.**..... **B05b 1/32**

[58] **Field of Search**..... 138/45, 46, 239/546, 239/533, 534, 265.43

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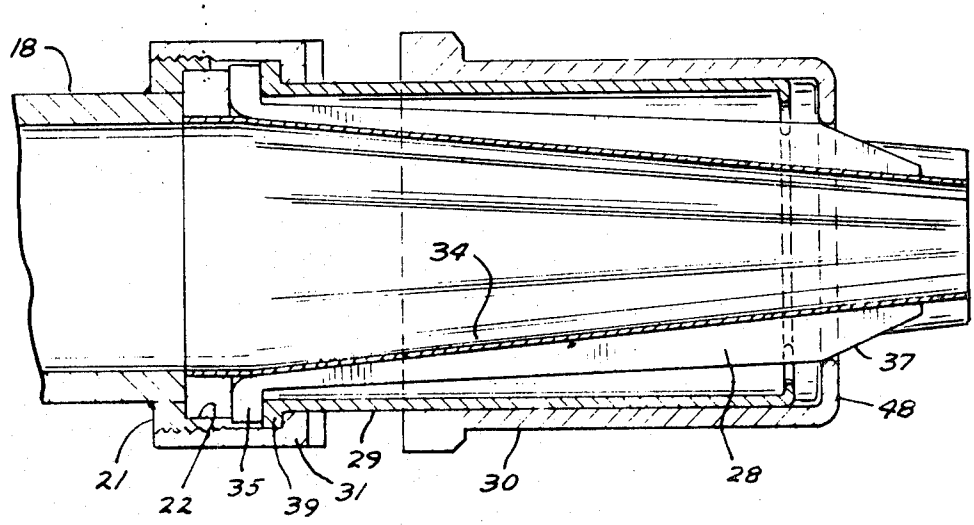
Assistant Examiner—John J. Love
Attorney—Anthony A. Juettner et al.

[57] **ABSTRACT**

A nozzle system is provided having a nozzle with variable and controllable orifice.

9 Claims, 8 Drawing Figures



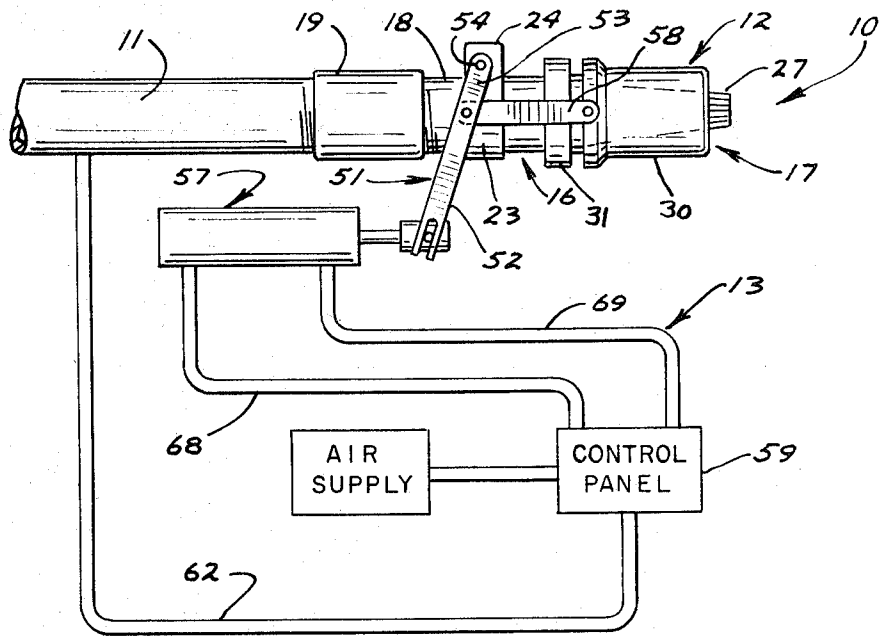


FIG. I

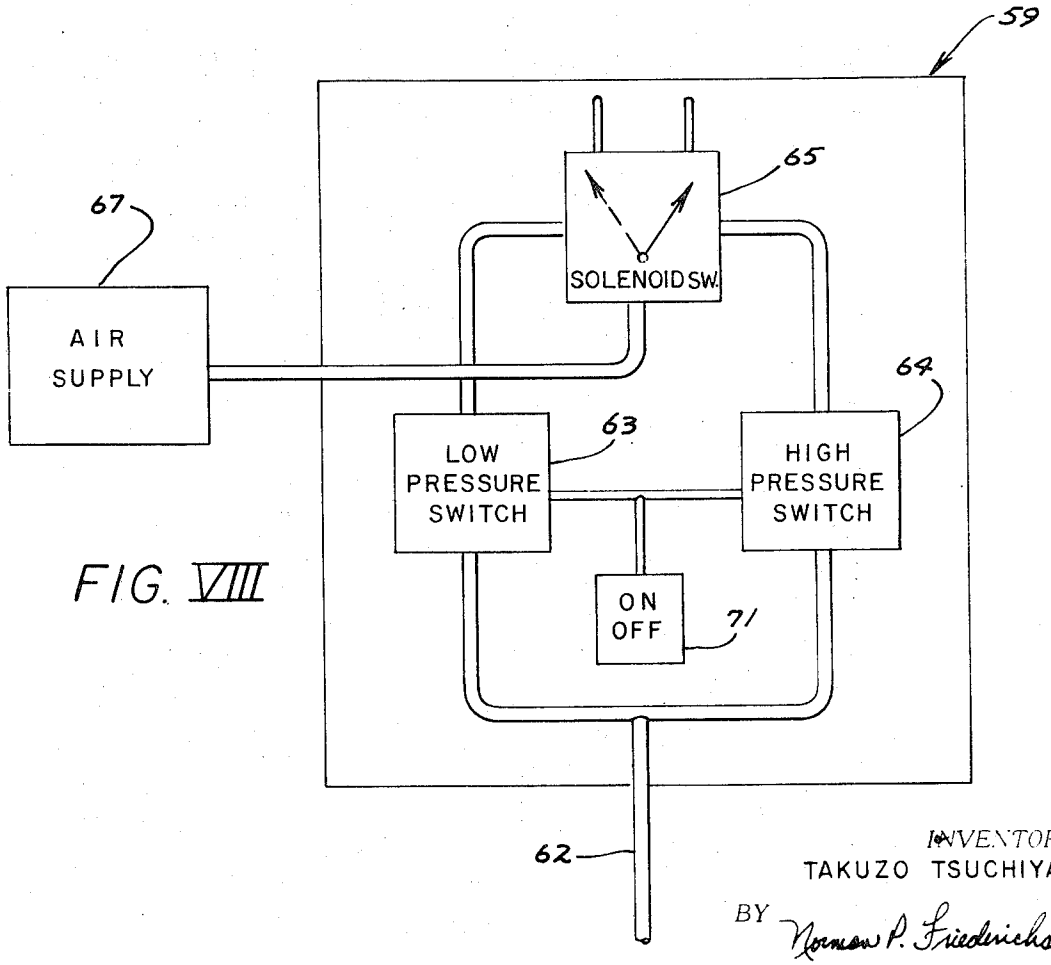


FIG. VIII

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FIG. III

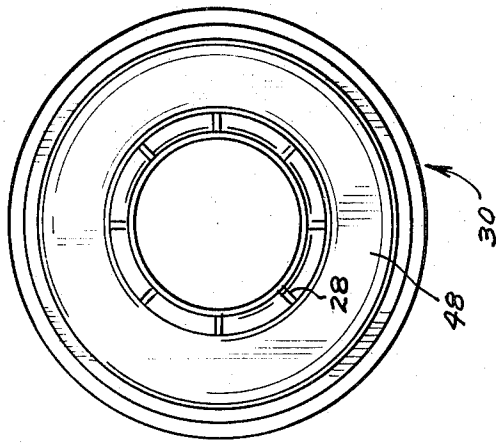


FIG. V

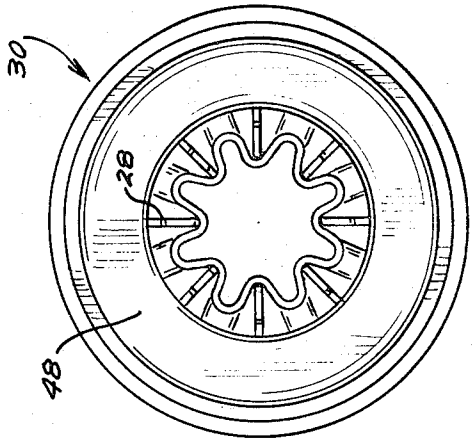


FIG. II

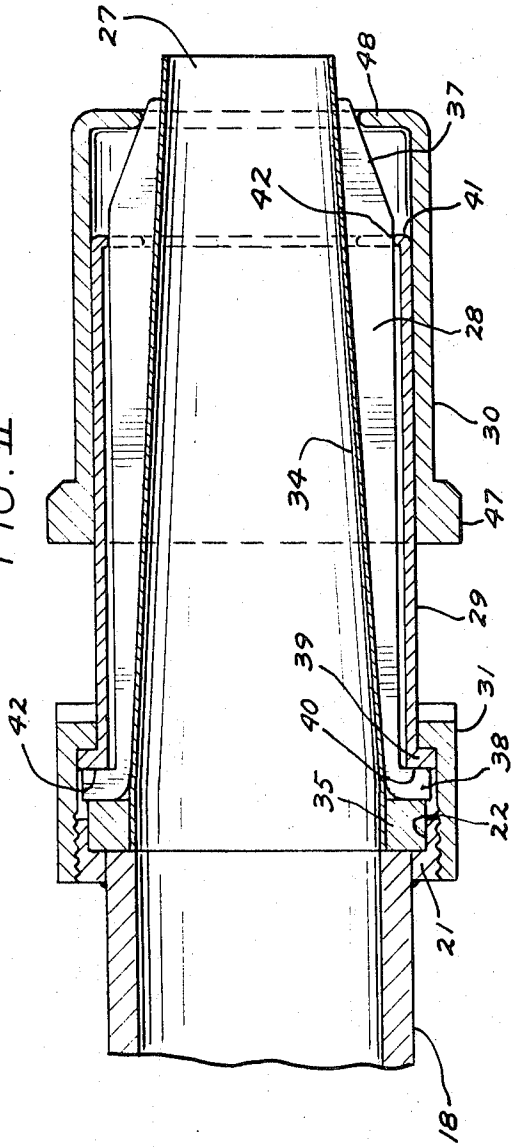
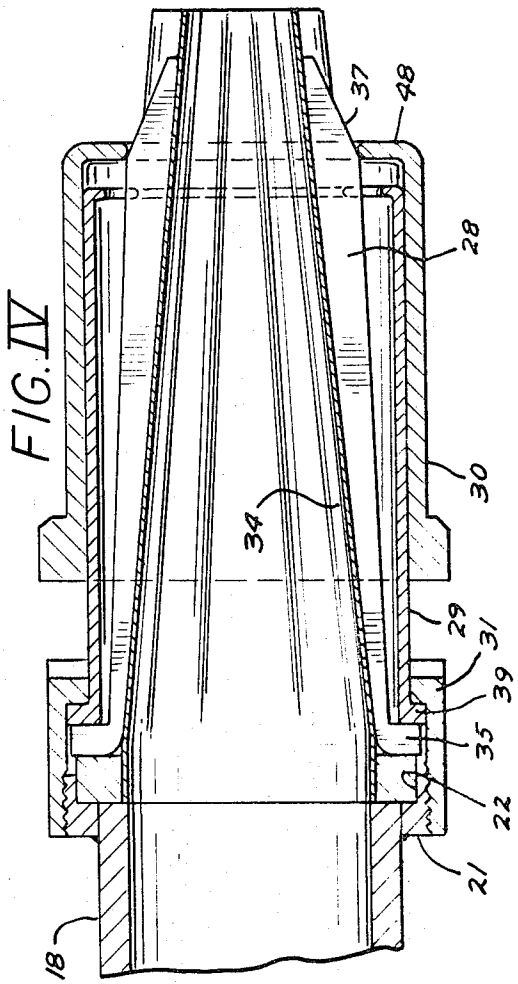


FIG. IV



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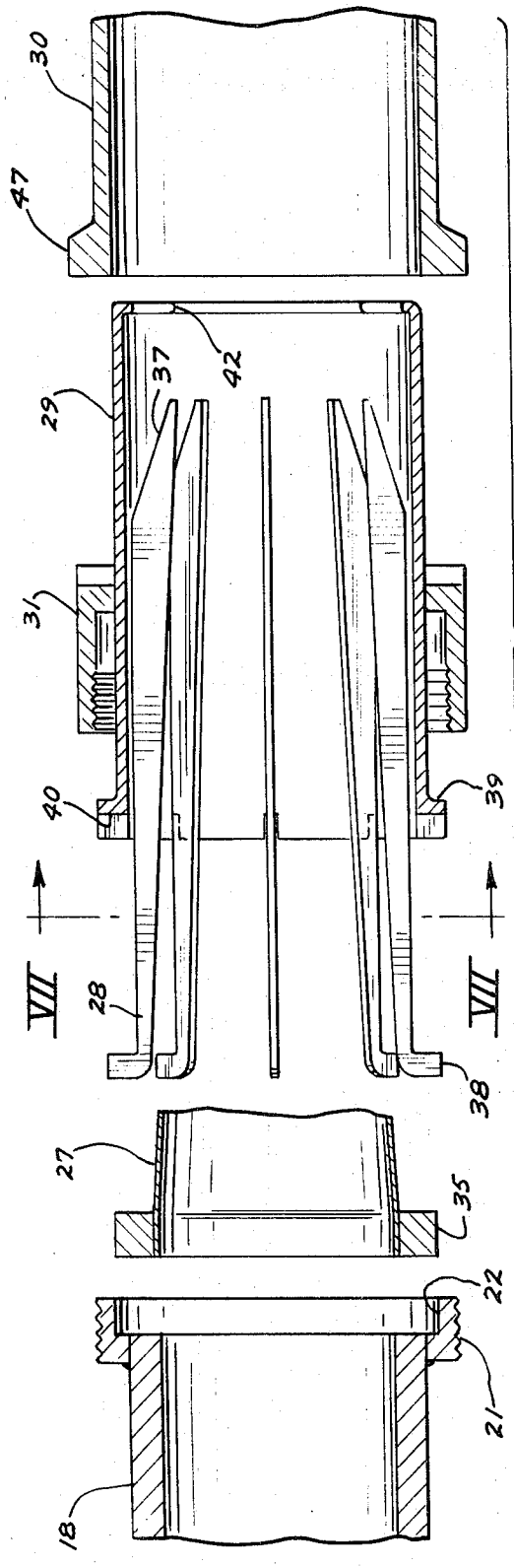

FIG. VI

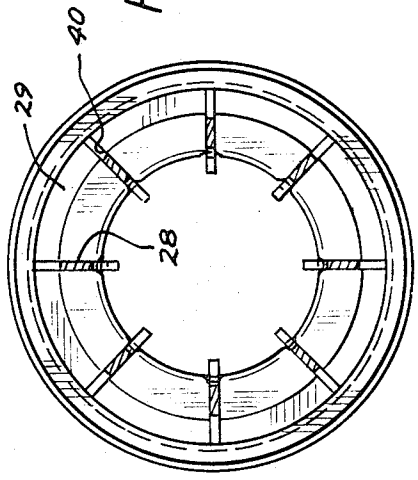

FIG. VII

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VARIABLE NOZZLE

This invention relates to fluid pressure devices and more particularly to systems including nozzles.

Nozzles with variable orifices have been known in the past. Typically, such nozzles have been used in situations where a fluid stream carries non-fluid (i.e., solid) material through a restricted zone. The variable nozzle reduces or eliminates the tendency of the restricted zone to become plugged or obstructed by an accumulation of the non-fluid material. The nozzle may also to a certain extent control the pressure within the system. In the past such variable nozzles commonly have been a frusto-conical tube constructed of resilient material such as rubber or flexible material such as converging spring metal blades. The natural resistance of the material to stretch or flex has been the sole means for maintaining and controlling the restriction of the orifice. Such construction has certain inherent disadvantages foremost of which is the general lack of control. The particular material used in such construction possesses certain defined resistance to stretch or flex and the resistance cannot be varied as desired. The rubber resilient materials may be used only under very limited temperature conditions. The flexible spring metal blades do not provide a continuous surface around the orifice. Moreover, the resilient or flexible material tends to become fatigued over a period of time and thus gradually loses its effectiveness.

The present invention provides a variable nozzle system that overcomes such disadvantages. The present invention provides a system including a variable nozzle and a control that permits opening of the variable nozzle when the pressure exceeds a desired value. In one embodiment of the present invention the control may be adjusted to permit opening of the nozzle at any of various pressures.

In the drawings:

FIG. I shows an embodiment of the present nozzle system;

FIG. II shows a cross-sectional view of the nozzle portion of the present system in one position of operation;

FIG. III shows an end view of the nozzle portion of FIG. II;

FIG. IV shows a cross-sectional view of the nozzle portion of the present system in another position of operation;

FIG. V shows an end view of the nozzle portion in the operation position of FIG. IV;

FIG. VI shows an exploded view of the nozzle portion of FIG. II;

FIG. VII shows a cross-sectional view taken along the line VII—VII of FIG. VI; and

FIG. VIII shows a control panel of FIG. I.

The nozzle assembly **10** of the present invention, one embodiment of which is shown in FIG. I, may include a fluid carrying feed line **11**, a nozzle **12** and a control system **13**.

The feed line **11** may carry any of various types of fluid streams issuing from any of various types of apparatus. The line **11** feeding nozzle **12**, for example, may be the gun barrel of the puffing apparatus shown in U.S. Pat. No. 3,231,387, the disclosure of which is incorporated herein by reference. Alternatively, the line **11** may be the processing tube of the apparatus disclosed in commonly assigned patent applications Ser. No. 58,318 and Ser. No. 58,317, which disclosure is incorporated herein by reference. The line **11** may be carrying any pressurized flowable stream such as a gaseous stream, a gaseous stream carrying solid or liquid particles, a liquid stream, a liquid stream carrying solid particles, or a stream of flowable solid particles.

The nozzle **12** of FIGS. I–VII has a rear portion **16** and a forward portion **17**. The rear portion **16** (FIG. I) includes a pipe or tube **18** that may be of the same internal diameter as line **11**. The pipe **18** may be mounted on line **11** such as by coupling **19**. The pipe **18** (FIG. II) has an enlarged threaded portion **21** at the forward end. The threaded portion **21** may be provided by sliding a short threaded piece of a larger pipe over pipe **18** and welding the portion **21** in place. A recess **22** is machined in the enlarged threaded portion **21**. The pipe **18** (FIG. I) has a bracket **23** mounted thereon. The bracket **23** may be a U-shaped member prepared by bending a metal strap. The bracket **23** may be secured to pipe **18** by welding. The bracket **23** has a pair of upwardly extending legs **24** each having a pin receiving opening therein.

The forward portion **17** of nozzle **12** (FIG. II) includes a frusto-conical tube **27**, a plurality of blade-like fingers **28**, a first housing member **29**, a second housing member **30**, and a retaining cap **31**. The frusto-conical tube **27** has a flexible or expandable sleeve **34** that may be fabricated from stainless steel sheet material. The frusto-conical tube **27** further involves a shoulder **35** which may be a ring that is welded to sleeve **34**. The shoulder **35** has an external diameter small enough for snug insertion into recess **22** of pipe **18**.

The blade-like fingers **28** over-lay the sleeve **34** of tube **27** and are held in place by first housing member **29**. Each finger **28** is a thin, elongated bar having a forwardly and radially inwardly sloping surface **37** approaching the forward end thereof. Each finger **28** also has a radially outwardly extending flange **38** at the rear end thereof.

The first housing member **29** is cylindrically shaped and has a shoulder portion **39** with a plurality of slots **40** therein. Each slot is for reception of the flange **38** of one of the fingers **28**. The slots **40** retain the fingers in place and prevent either circumferential or forward displacement of the fingers. The housing member **29** further includes a radially inwardly extending wall **41** at the forward end with a plurality of slots **42** defined therein. The slots **42** receive the fingers **28** and help maintain the fingers **28** in proper alignment with tube **27**. The cap **31** slides over housing member **29** and is threadedly engaged with the enlarged portion **21** of pipe **18**. The shoulder **39** of housing member **29** and the shoulder **35** of tube **27** are securely held between the cap **31** and the pipe **18**.

The second housing member **30** is cylindrically shaped and snugly slides over the first housing member **27**. The housing member **30** has a shoulder **47** at the rear end thereof and a radially inwardly extending wall **48** at the forward end thereof.

The nozzle assembly **10** further includes a control linkage **51** (FIG. I) for controlling the movement of the second housing member **30** with respect to the fingers **28**. The control linkage **51** has a yoke **52** with a pair of upper ends **53** that are attached to legs **24** of bracket **23** by a pivot pin **54**. The yoke **52** is attached at the lower end **56** to actuating apparatus **57** which may be a two-way piston system. The actuating apparatus **57** alternatively may be any other type of apparatus that

is capable of moving the lower end of yoke **52** in a forward and rearward motion. The control linkage **51** further includes a push-pull rod **58.** The rod **58** is attached at one end to yoke **52** and at the other end to housing member **30.** The rod **58** transmits the movement from the yoke **52** to the housing member **30.**

The actuating apparatus **57** may be coupled to a control panel **59** which is capable of recognizing pressure changes in the line **11.** The control panel **59** then causes the actuating apparatus **57** to either open or close the nozzle as hereinafter described. The control panel **59** shown in FIG. I is connected to the line **11** by sensing line **62,** which may be a small diameter pipe. The control panel **59** is shown in detail in FIG. VIII and includes a low pressure switch **63** and a high pressure switch **64** that control a solenoid switch **65.** The solenoid switch **65** controls the flow of air from the air supply **67** to the two-way piston **57** and either sends the air pressure through line **68** to one side of piston **57** or through line **69** to the other side of the piston **57,** thus driving the piston in one direction or the other. A master switch **71** may be provided for turning the control panel on and off.

It is believed that operation of the present invention is apparent from the preceeding description; however, the operation will be set forth in even further detail hereinafter.

The present nozzle assembly **10** is first assembled by holding the housing member **29** in a vertical position and inserting the fingers **28** one by one into housing member **29** with flange **38** lying in slot **40.** The frusto-conical tube **27** is then inserted into housing member **29** and holds fingers **28** in place as retaining cap **31** is guided over member **29** and secured to threaded portion **21** of pipe **18.** The second housing member **30** is guided over first housing member **29** and the control linkage **51** is attached to member **30.** The nozzle system **10** is placed in operating condition by turning on the master switch **71.** The low pressure switch senses the low pressure in line **11** and actuates the solenoid switch **65** which in turn directs the air supply through line **69** to the two-way piston system **57.** The two-way piston system **57** pulls the yoke **56** and thus housing member **30** rearwardly. The wall **48** of housing member **30** produces a caming action on surface **37** of fingers **28** as the housing member **30** moves rearward thereby forcing the fingers **28** radially inwardly. The fingers **28** in turn force the flexible sleeve **34** into the fluted position of FIG. V thereby reducing the cross sectional area of the orifice or opening in the tube **27.** If pressure builds up in line **11** above the predetermined value, such as when plugging of the nozzle occurs, the high pressure switch is activated thereby reversing the position of solenoid switch **65** sending the air supply through line **68** which shifts the position of the piston system **57** forward thus moving housing member **30** forward. The wall **48** of housing member **30** no longer holds the fingers **28** in the innermost position and the internal pressure in tube **27** forces the tube to expand to the position of FIG. III thus opening the orifice. Once the nozzle opens the pressure drops in line **11** and the low pressure switch is operated thereby closing the nozzle to the position of FIG. IV.

I claim:

1. a nozzle comprising an elongated flexible metal tube including an outlet end, means for attaching said tube to a fluid feeding line, and means for releasibly moving circumferentially spaced portions of said tube radially inwardly, said moving means comprising a plurality of fingers lying longitudinally along said tube and extending substantially the length of said tube, said fingers being pivotable toward and away from the center axis of said tube, and reciprocable sliding means for pivoting said fingers, whereby said fingers act on circumferentially spaced points around said tube thereby flexing the tube to restrict and open the passageway through said tube and whereby said fingers act longitudinally along said tube to strengthen said tube.

2. The nozzle of claim **1** wherein said tube is a flexible tube and wherein the moving means include a plurality of elongated blade-like pivotable fingers overlaying said tube, said fingers laying substantially in the direction of fluid flow through said tube and means for pivoting the end of said fingers adjacent said outlet end toward the center axis of said tube thereby moving said spaced portions inwardly toward said axis, and means for releasing said pivoted fingers whereby fluid pressure within said tube moves said inwardly moved portions outwardly to open the passageway through said tube.

3. The nozzle of claim **2** wherein said finger pivoting means comprise caming means.

4. The nozzle of claim **3** wherein said caming means comprise radially inwardly sloping surfaces on said fingers and ring-shaped means for movement along said surfaces to move said fingers radially inwardly.

5. The nozzle of claim **4** wherein said tube is a frusto-conically shaped metal tube.

6. A nozzle assembly comprising:

a flexible elongated frusto-conical tube having an inlet at one end and an outlet at the opposite end, said tube being comprised of flexible sheet metal;

a plurality of elongated fingers lying along the outer surface of said tube, said fingers being spaced around the circumference of said tube, said fingers each including a pivot means at the end toward said tube inlet and a cam surface adjacent the end toward said tube outlet, said fingers each acting in a plane that extends along the axis of said tube;

first cylinder means overlying said fingers, said first cylinder means holding said fingers in said acting plane;

second cylinder means overlying said first cylinder means, said second cylinder means being mounted for reciprocably sliding along said first cylinder means, said second cylinder means including wall means, said wall means engaging said cam surface of each finger;

whereby said second cylinder means may be moved in a first direction to pivot the cam end of said fingers radially inwardly and moved in the opposite direction to permit said fingers to move radially outwardly and whereby said fingers move circumferentially spaced portions of said tube radially inwardly to reduce the cross-sectional area of said tube and permit said spaced portions to move radially outwardly to increase the cross-sectional area of said tube.

7. The nozzle of claim **6** wherein said fingers extend substantially along the entire length of said tube and act as strengthening ribs.

8. The nozzle assembly of claim **6** wherein said first cylinder means includes a radially inwardly extending wall means, said wall means including guideways for maintaining said fingers in alignment.

9. The nozzle assembly of claim **8** wherein said guideways comprise slots defined in said first cylinder wall means.

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