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Wilmot, Jr.

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[54] **EJECTOR WITH VARIABLE MIXING SECTION AND PRIMARY NOZZLE AREAS**

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[52] U.S. Cl. **239/416.4**, 239/417.3, 239/417.5

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

[58] **Field of Search**.....239/416.4, 416.5, 417.3

[56] **References Cited**

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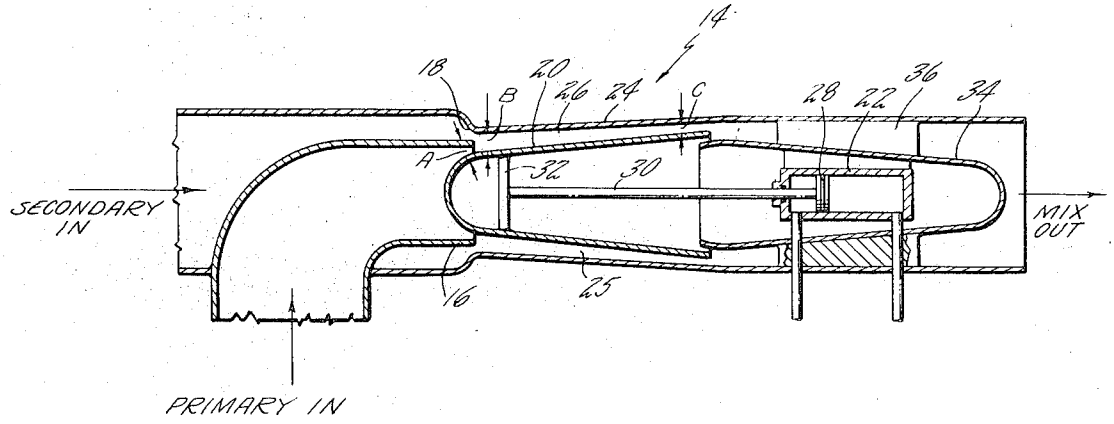
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[57] **ABSTRACT**

The effectiveness of a jet pump is increased over a wide range of operating pressures by varying the areas of the primary nozzle and mixing chamber so that the ratio of the two is held at a substantially constant value by a plug designed such that the ratio of any cross-sectional areas of two spaced stations of the mixing chamber along the longitudinal axis of the plug is also substantially constant for each position of the primary nozzle.

4 Claims, 2 Drawing Figures



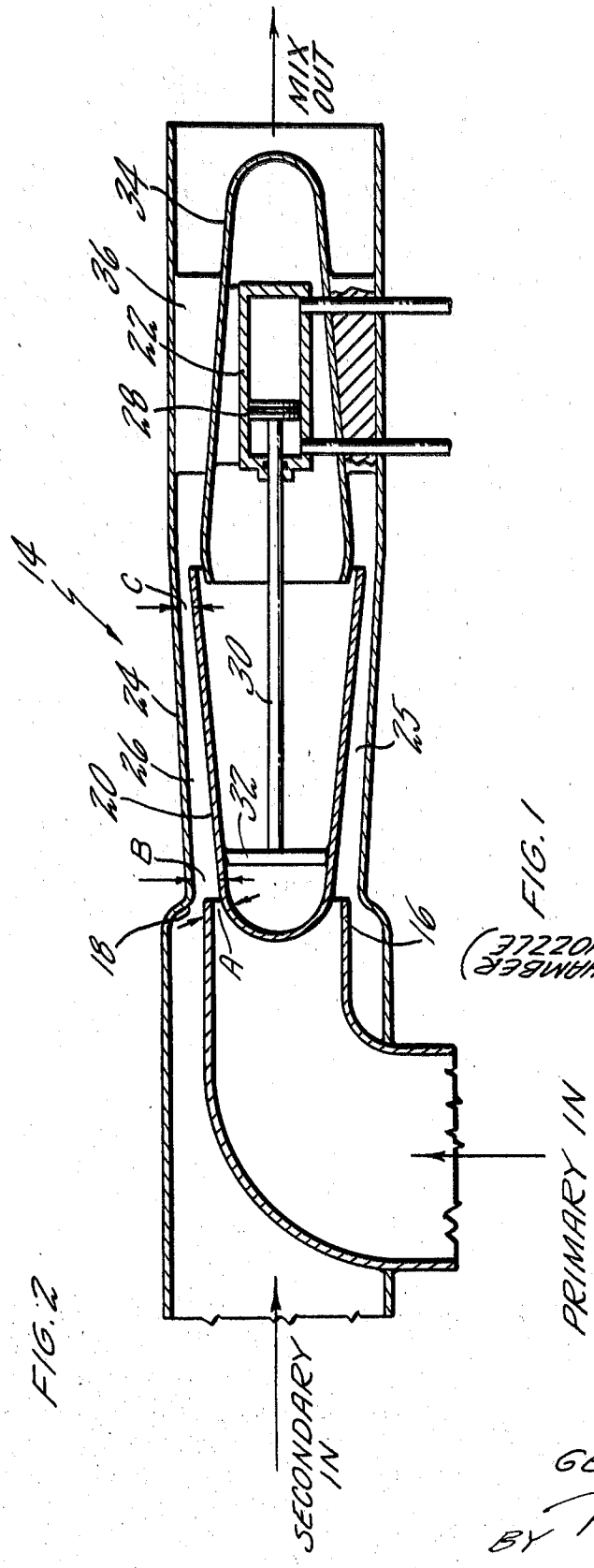


FIG. 2

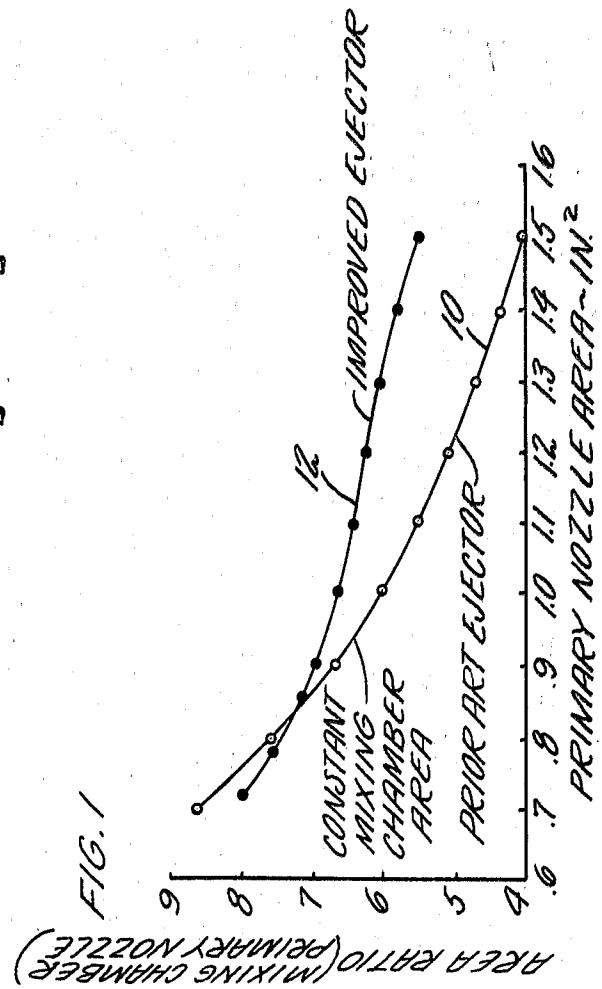


FIG. 1

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EJECTOR WITH VARIABLE MIXING SECTION AND PRIMARY NOZZLE AREAS

BACKGROUND OF THE INVENTION

This invention relates to jet pumps and more particularly to an ejector having variable primary nozzle area and mixing chamber area.

This invention constitutes an improvement over the ejector claimed and disclosed in U.S. Pat. No. 3,531,218 granted to J. L. Warner on Sept. 29, 1970, and assigned to the same assignee. As is disclosed in that patent, a hinged gate type of valve on the end of the primary nozzle of the ejector serves to concomitantly open and close the primary and secondary nozzles. In this arrangement the mixing chamber, that is, where the primary flow and secondary flow intermingle immediately downstream of the nozzles, remains fixed. For situations where it is necessary for the ejector to operate over wide range of operating conditions, the ejector disclosed in the patent noted above and the prior art devices have proven to be less efficient at the high flow ranges although quite satisfactory during the low flow ranges. Thus, I have found that I can improve the effectiveness of an ejector by providing means for varying the mixing area and primary nozzle area simultaneously. In order to obtain an effective ejector over the entire operating range in accordance with this invention, it is necessary to maintain the ratio between the areas of the primary nozzle and the mixing chamber at substantially a constant value and also maintain the cross-sectional areas of any two stations taken along the longitudinal axis of the mixing chamber at a substantially constant value.

By utilizing a plug in the mixing area serving to vary the area of the primary nozzle and also changing the size of the length of the mixing chamber, the ejector provides a minimum pressure drop while assuring that the efficiency of the ejector is maintained at an acceptable level over the entire operating range.

Such a configuration results in an overall shorter ejector affording an efficient device within a smaller envelope than heretofore achieved which is of paramount importance particularly in an aircraft application.

SUMMARY OF INVENTION

An object of this invention is to provide an improved ejector.

A further object of this invention is to provide an ejector with a variable area of the primary nozzle and the mixing chamber while maintaining the ratio of the areas of the primary nozzle and the mixing chamber at a substantially constant value and also maintaining the ratio of the cross-sectional areas of any two stations along the longitudinal axis of the mixing section at a substantially constant value.

Other features and advantages will be apparent from the specification and claims and from the accompanying drawings which illustrate an embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a graph plotting the values of the area of the primary nozzle and the ratio of the mixing chamber and primary nozzle areas for both an ejector of the present invention and a prior art ejector having a variable primary nozzle and a fixed mixing chamber.

FIG. 2 is a view, partly in section and partly in schematic, illustrating the details of the preferred embodiment of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The graph shown in FIG. 1 is a plot of a prior art ejector having a fixed mixing chamber and variable primary nozzle showing the dimensions illustrated by line **10** and the plot of the improved ejector illustrated by line **12**. It is apparent that between primary nozzle areas of 1 to 1.5 the improved ejector is dimensioned so that the area ratio of the mixing chamber to primary nozzle is substantially constant whereas the prior art ejector illustrated by line **10** shows that this relationship is not constant. While plugs have been used in heretofore known ejectors, these types of ejectors do not maintain the area ratio of any two stations taken along the longitudinal axis thereof at a substantially constant value and thus not affording the effectiveness obtained by the present invention.

Referring next to FIG. 2 which shows an ejector generally illustrated by the numeral **14** having a primary nozzle **16** and a secondary nozzle **18**. A substantially conically shaped plug member **20** is positioned by the actuator generally illustrated by the numeral **22** for moving it relative to the primary nozzle **16** for varying its area and changing the volume of the mixing chamber. The inner diameter of duct **24** and the outer diameter of the plug **20** define an annular space (mixing chamber **25**) which receives the flow from the primary nozzle and the secondary nozzle. As is apparent, the length of the mixing chamber and volume are varied by varying the position of plug **20**. Thus, positioning of the plug **20** concomitantly changes the area of the primary nozzle **16** and the length and volume of the mixing chamber **26**. Actuator **22** may be a cylinder having movable piston **28** for receiving pressurized fluid to effectuate movement thereof. Connecting rod **30** connects member **32** which is firmly affixed to the inner diameter of the plug **20**. The actuator **22** may be supported in fixed plug **34** which is secured by suitable struts **36** to the inner diameter of the duct **24**. The actuator may take any form since it is not deemed part of the invention. It will be noted that the duct **24** and the fixed plug **34** may be dimensioned to form a diffuser section for the ejector so as to effectively recover static pressure. To enhance the flow it is desirable that the plug **34** be nested in movable plug **20**.

It is an important aspect of this invention that the mixing chamber be dimensioned such that the cross-sectional area of any two stations taken along the longitudinal axis of plug **20** will be so dimensioned that its area ratio remains substantially constant. For example, a cross-sectional area taken along station B will be such that the cross-sectional area taken along station C will remain substantially constant for any position of the plug. This will hold true for any other two stations taken along the longitudinal axis. Additionally, the area of the primary nozzle illustrated by reference letter A ratioed to the entire sectional area of the mixing section taken through a longitudinal plane of the mixing chamber will also remain substantially constant.

As this invention is used for an air-conditioning system for aircraft and utilizes the engine bleed air, it is apparent that the materials selected are selected to withstand high pressures and temperatures.

It should be understood that the invention is not limited to the particular embodiments shown and described herein, but that various changes and modifications may be made without departing from the spirit or scope of this novel concept as defined by the following claims.

I claim:

1. An ejector having a primary nozzle and a secondary nozzle disposed in a duct,

an elongated movable plug disposed in said duct immediately downstream of said primary and secondary nozzles defining with said duct an annular mixing chamber,

means for positioning said elongated movable plug relative to said primary nozzle for changing the area of said primary nozzle,

said plug being dimensioned such that the ratio of the area of said mixing chamber to the area of said primary nozzle remain substantially constant and the ratio of cross-sectional areas of any two stations along the longitudinal axis of said plug also remains substantially constant.

2. An ejector as claimed in claim 1 including an elongated fixed plug disposed in said duct in axial alignment with said elongated movable plug and defining with said duct a diffuser nozzle.

3. An ejector as claimed in claim 1 wherein said movable plug concomitantly changes the area of the primary nozzle and the longitudinal cross-sectional area of said mixing chamber.

4. An ejector disposed in a duct having a primary nozzle and a secondary nozzle,

an elongated movable plug disposed in said duct immediately downstream of said primary and secondary nozzles defining with said duct an annular mixing chamber and having one end portion movable into and out of the exit opening of the primary nozzle,

means for positioning said elongated movable plug relative to said primary nozzle for varying the opening of said primary nozzle to a full open and full closed position,

said plug being conically-like dimensioned such that the ratio of the area of said mixing chamber to the area of said primary nozzle remain substantially constant and the ratio of cross-sectional areas of any two stations along the longitudinal axis of said plug also remains substantially constant,

the space between said elongated movable plug and said duct being wider adjacent the primary nozzle and fairing to a narrower space at the opposite end of said plug.

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