Lewis

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

REPLY TO
ATTN OF: GP

TO: USI/Scientific & Technical Information Division
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned U. S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code USI, the attached NASA-owned U. S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U. S. Patent No. : 3,583,419

Government or Corporate Employee : U.S. Government

Supplementary Corporate Source (if applicable) : NA

NASA Patent Case No. : XLE-19341

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:

Yes ☐ No ☑

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of Column No. 1 of the Specification, following the words ". . . with respect to an invention of . . ."

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Enclosure

Copy of Patent cited above

FACILITY FORM 602

N71-28741 (ACCESSION NUMBER)

(THRU)

7 (PAGES)

00 (CODE)

(NASA CR OR TMX OR AD NUMBER)

12 (CATEGORY)

N71-28741

N71-28741 35%

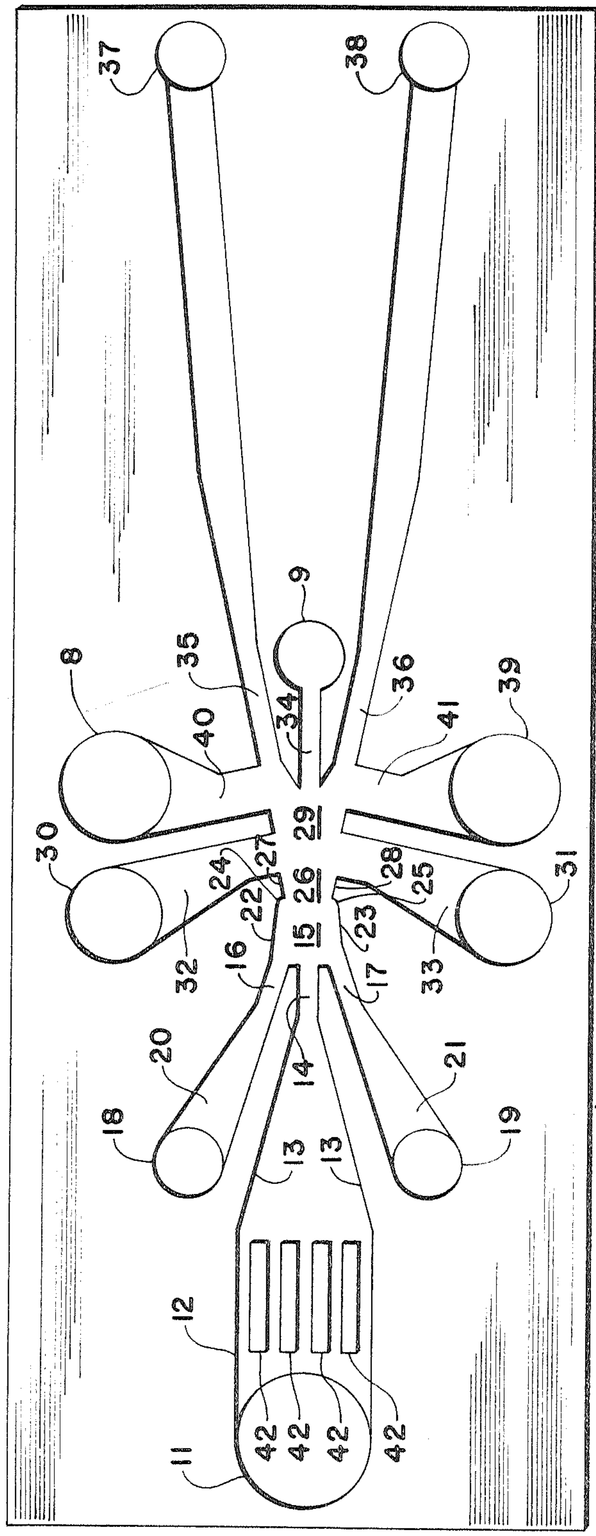

FIG. I

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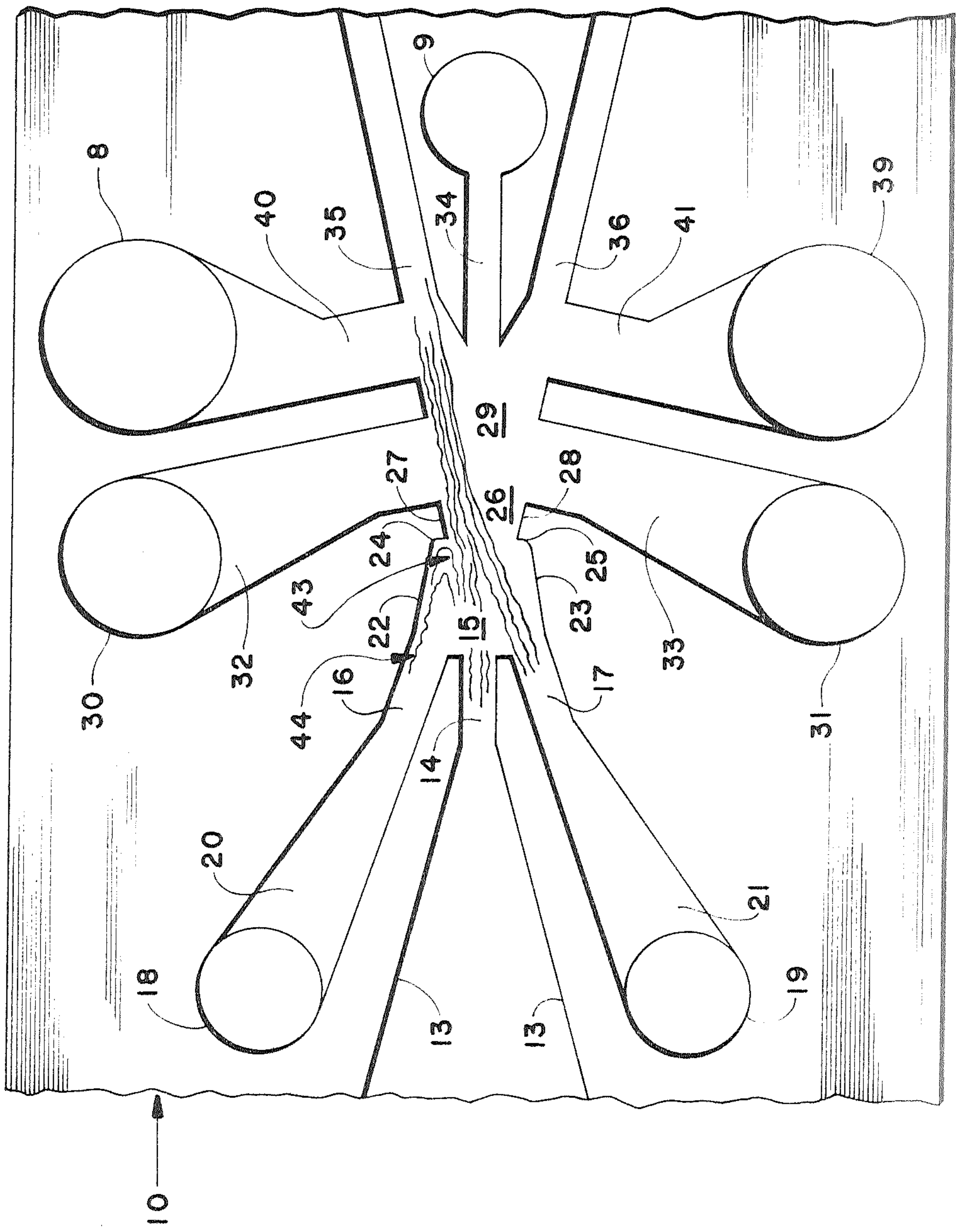

FIG. 2

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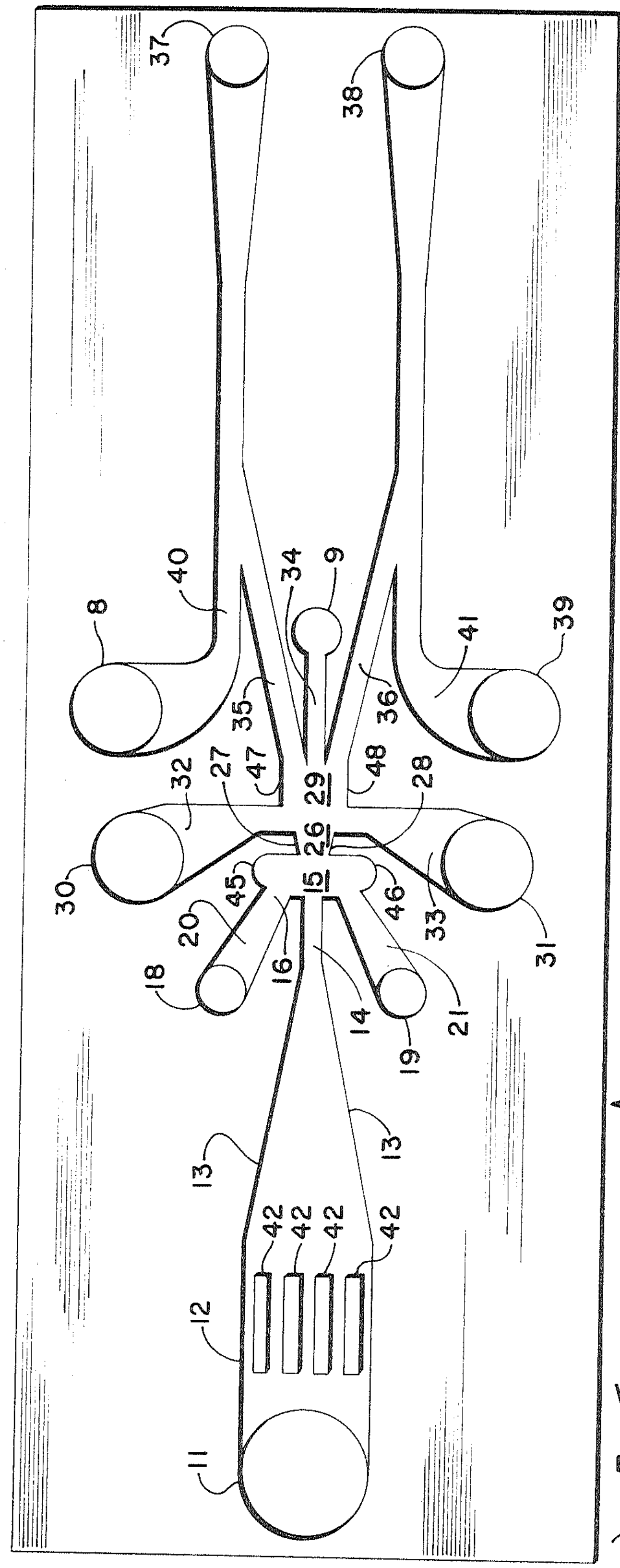

FIG. 3

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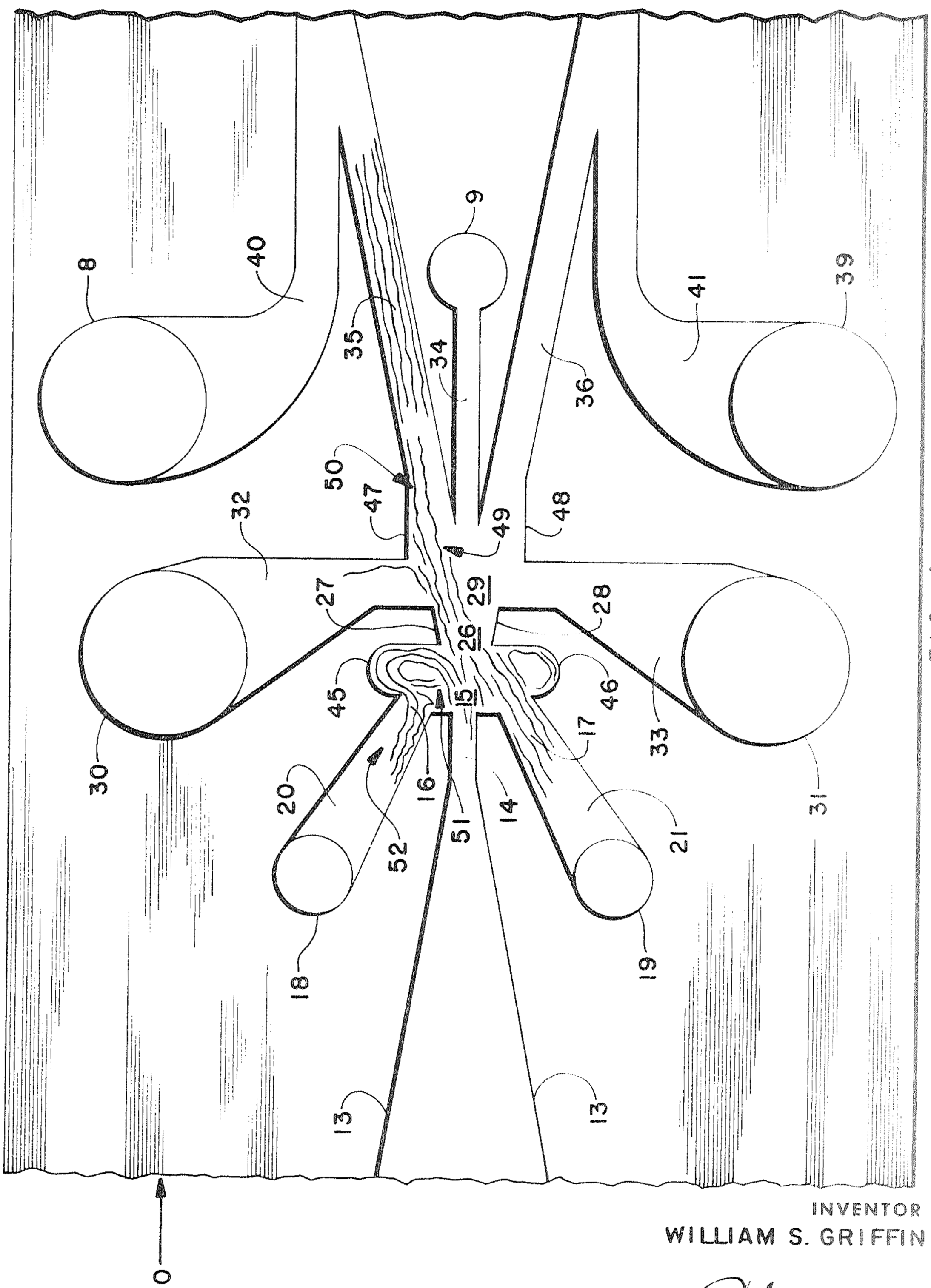

FIG. 4

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United States Patent [11] 3,583,419

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[21] Appl. No. **780,065**
[22] Filed **Nov. 29, 1968**
[45] Patented **June 8, 1971**
[73] Assignee **The United States of America as represented by the Administrator of the National Aeronautics and Space Administration**

[54] FLUID JET AMPLIFIER

7 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **137/81.5**
[51] **Int. Cl.** **F15c 1/04**
[50] **Field of Search** 137/81.5

[56] **References Cited**

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ABSTRACT: A fluid amplifier is provided in which fluid is peeled off the power jet when control nozzle pressure exceeds a prescribed magnitude. The peeled-off fluid is redirected at such an angle as to tend to recenter the power jet. Additionally, in an alternate embodiment the control nozzles are aimed at respective flat walls which form an intermediate chamber downstream of the interaction chamber and in communication with a pair of diverging receiver channels.

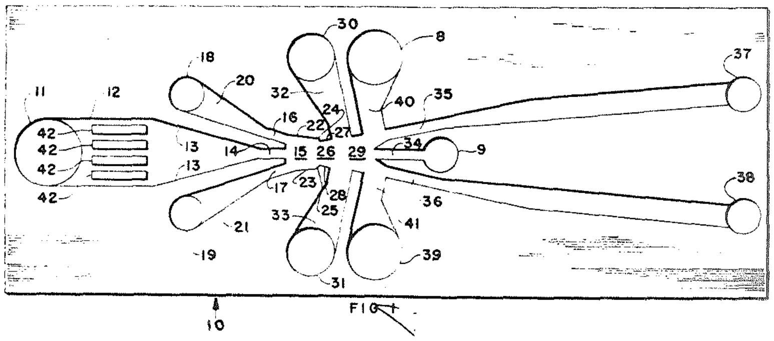

FIG. 1

FLUID JET AMPLIFIER

ORIGIN OF THE INVENTION

The invention described herein was made by an employee of the U.S. Government and may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

The invention relates to fluid control devices and is directed more particularly to fluid jet amplifiers. Fluid amplifiers in general include a power nozzle for issuing a stream or jet of fluid and control nozzles disposed on opposite sides of the power nozzle and adjacent thereto. Dependent on which control nozzle has the highest pressure, the jet of fluid from the power nozzle will be deflected to one side or the other so that it will enter one or the other of a pair of receiver channels which diverge in a direction downstream from the control nozzle. The receiver channels are in communication with respective output ports to which fluid loads are connected. Amplification or gain in the fluid amplifier results from the pressure at one of the output ports being substantially greater than that of the control port having the highest signal input fluid pressure.

In prior art fluid amplifiers of the foregoing type, it has been found that pressure at the control nozzles can become great enough to deflect the power jet past the receiver inlet passageway which is to receive the fluid. Consequently, after the control nozzle pressure becomes greater than a certain magnitude, the output pressure at the operating output port will drop. Such a characteristic will obviously cause severe distortion of the amplified output signal.

OBJECTS AND SUMMARY OF THE INVENTION

In view of the foregoing, it is an object of the invention to provide a fluid jet amplifier having flat saturation characteristics wherein output pressure after reaching a maximum value does not drop as control pressure continues to increase.

It is another object of the invention to provide a fluid jet amplifier which, in addition to the flat saturation characteristic, provides a substantially linear relationship between the input signal provided to the control nozzles and the output signal which results at the output ports.

It is a further object of the invention to provide a fluid jet amplifier of the above type having relatively low output noise.

Other objects and advantages of the invention will become apparent from the description and the drawings of a fluid jet amplifier embodying the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a first embodiment of the invention with the cover plate removed to show the arrangement of passageways, chambers, and nozzles;

FIG. 2 is an enlarged view of FIG. 1 illustrating fluid flow paths;

FIG. 3 is a plan view of another embodiment of the invention with the top cover removed; and

FIG. 4 is an enlarged view of a portion of FIG. 3 illustrating fluid flow paths.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, there is shown a body 10 of material such as metal or plastic in which passages and ports comprising the fluid amplifier are formed. Fluid under pressure enters a power input port 11 and passes through a passage 12 having converging walls 13 and issues a jet from a power nozzle 14 into an interaction chamber 15. A pair of control nozzles 16 and 17 for issuing jets of fluid into the interaction chamber 15 in interacting relationship with the jet issuing from the power nozzle 14 are disposed on opposite sides of the power nozzle 14. The control nozzles 16 and 17 communicate with respective control signal input ports 18 and 19 through tapered passages 20 and 21, respectively. It will be seen from FIG. 1 that the control nozzles 16 and 17 are at an angle of about 30° to the power nozzle 14. However, this angle may be any value between 10° and 45°.

The interaction chamber 15 is defined by flat sidewalls 22 and 23 which converge in a downstream direction. The sidewalls 22 and 23 curve sharply toward one another at the downstream end of the interaction chamber 15, as at 24 and 25, respectively, to form respective edges which define the minimum diameter of an orifice 26. The orifice 26 is formed by walls 27 and 28 which diverge in a downstream direction.

An intermediate chamber 29 is located downstream of the orifice 26 and communicates with vent ports 30 and 31 through vent passages 32 and 33 respectively. The vent ports 30 and 31 provide ambient pressure to the intermediate chamber 29. With no fluid issuing from either of the control nozzles 16 or 17 the jet of fluid issuing from the power nozzle 14 will flow straight ahead through the orifice 26 and the intermediate chamber 29 into a center vent passageway 34. This passageway is aligned with the power nozzle 14 and establishes communication between the intermediate chamber 29 and a center vent 9.

In order to utilize the jet of fluid issuing from the power nozzle 14 to drive fluid loads, the loads are connected to output ports 37 and 38 in the body 10. These ports are in communication with the intermediate chamber 29 by means of receiver inlet channels 35 and 36 which diverge in a downstream direction from the intermediate chamber 29. When fluid issues from the control nozzle 16, the power jet will be deflected so that it flows into the receiver inlet channel 36. On the other hand, when fluid issues from the control nozzle 17 or when the pressure at nozzle 17 is higher than the pressure at control nozzle 16, the power jet will be deflected and flow into the receiver inlet channel 35.

The fluid amplifier is completed by the provision of receiver vents 8 and 39. The receiver vent 8 communicates with the receiver channel 35 through a receiver vent passage 40 while the receiver vent 39 communicates with the receiver channel 36 through a receiver vent channel 41. Suitable vanes 42 may be disposed in the fluid input passageway 12 to straighten the flow path of the fluid flowing from the power input port 11 toward the power nozzle 14.

Operation of the foregoing fluid amplifier will now be described. Referring to FIG. 2, it will be seen that a jet of fluid issuing from the control nozzle 17 deflects a jet of fluid issuing from the power nozzle 14 causing the power jet to flow into the receiver channel 35. If the pressure of the fluid issuing from the control nozzle 17 becomes great enough to deflect the power jet past the receiver channel 35 an edge formed by the curvature 24 of the interaction region and the wall 27 of the orifice will peel some fluid off of the power jet. This causes a high-pressure region 43 which tends to redeflect the main power jet back towards a centered position. Thus it will be seen that the high-pressure region 43 opposes excessive deflection of the main power jet with the advantageous result that the amount of fluid being directed into the receiver channel 35 is prevented from decreasing significantly even after the pressure of the fluid issuing from the control nozzle 17 exceeds a value at which maximum output pressure is produced at the output port 37. Consequently, a desirable flat saturation characteristic is imparted to the fluid amplifier.

In the event that the fluid issuing from the control nozzle 17 has an extremely high-pressure, a substantial amount of fluid may be peeled off the main power jet and directed by the interaction chamber sidewall 22 into the control nozzle 16 as at 44. This fluid will pass out of the input control port 20 via the control passageway 20. Even with this extremely high control nozzle pressure, the output pressure at the output port 37 does not decrease because the control nozzle 17 is aimed at the receiver channel 35 and now functions substantially as a power nozzle.

It will be clear to those skilled in the art that the walls 25 and 28 function in the same manner as the walls 24 and 27, respectively, when the main power jet is being directed into the receiver channel 36 by fluid issuing from the control nozzle 16.

ALTERNATE EMBODIMENT OF THE INVENTION

Referring now to FIG. 3, there is shown an alternate embodiment of a fluid amplifier embodying the invention and numerals identical to those in FIGS. 1 and 2 identify like parts. As shown in FIG. 3, cusp-shaped walls 45 and 46 are disposed on opposite sides of the power nozzle 14 forming respective opposite ends of the interaction chamber 15 replacing, respectively, the wall portions 22, 24, and 23, 25 of the interaction chamber 15 as shown in FIGS. 1 and 2. Additionally, the intermediate chamber 29 is provided with flat sidewalls 47 and 48 which are parallel to the direction of the power nozzle 14 and to the center vent passageway 34 which is aligned with the power nozzle.

The receiver vent passageways 40 and 41 each curve around in a downstream direction and are aligned with the output ports 37 and 38, respectively. With this arrangement turbulence which may be caused by certain types of loads connected to the output ports 37 and 38 is reflected back into the vent passageways 40 and 41 so that it may be discharged through the receiver vents 8 and 39 without adversely affecting the fluid flow path through the intermediate region 29. It will be understood, of course, that the straight receiver vent passages 40 and 41 and the receiver channels 35, 36 shown in FIGS. 1 and 2 may be interchanged with the curved receiver vent passages 40 and 41 and the receiver channels 35, 36 of FIGS. 3 and 4 or vice versa.

Referring now to FIG. 4, operation of the fluid amplifier shown in FIG. 3 will be explained. Assuming that jets of fluid are issuing from both the power nozzle 14 and the control nozzle 17 the jet of fluid from the power nozzle 14 will be deflected so that it flows along a path indicated by the arrow 49 directly into the receiver channel 35 producing maximum output pressure at the output port 37. If the control nozzle 17 pressure increases further, the power jet will be deflected to strike the flat wall 47 of the intermediate chamber 49 so that substantially all of the fluid issued by the power nozzle 14 continues to flow into the receiver channel 35. The flow path under this condition is shown by a line identified by the arrow 50. An additional increase of control nozzle 17 pressure will deflect the power jet still further causing an edge formed by the orifice wall 27 and the cusp wall 45 to peel fluid off of the power jet. The peeled-off fluid is turned 180° by the cusp wall 45 and now flows toward the power jet as indicated by the arrow 51 tending to redeflect the power jet.

If the control nozzle 17 pressure becomes extremely high, most of the power jet will be peeled off and directed by the cusp wall 45 into the control nozzle 16 as indicated by the arrow 52. In this situation, the control nozzle 17 functions as a power nozzle and the fluid issuing therefrom is aimed directly at the flat wall 47 of the intermediate chamber. The wall 47 directs this fluid into the receiver channel 35. Hence, as in the fluid amplifier shown in FIGS. 1 and 2, the output pressure at the output port 37 will not drop as the control port 17 pressure increases beyond the magnitude necessary to produce maximum output pressure at the output port 37. Accordingly, a flat saturation output characteristic is established. It will be understood, of course, that the cusp wall 46 functions in the same manner as the cusp wall 45 and the flat wall 48 of the intermediate region 49 functions the same as the flat wall 47 when fluid is issued from the control nozzle 16.

It will be understood that the above-described embodiments

of the invention may be changed or modified by those skilled in the art without departing from the spirit and scope of the invention as set forth in the claims appended hereto.

I claim:

1. A fluid amplifier comprising:
an interaction chamber;
power nozzle means for issuing a power jet of fluid into said interaction chamber;
a control nozzle disposed on each side of said power nozzle for issuing fluid into said interaction chamber in intersecting relationship to said power jet of fluid, each control nozzle being inclined at an angle between 10° and 45° to said power nozzle;
a pair of walls forming an orifice adjacent to said interaction chamber at its downstream end, said interaction chamber having flat sidewalls which converge in a downstream direction and which curve towards one another at its downstream end to form edges with respective ones of said pair of walls which form said orifice;
an intermediate chamber downstream of said orifice; and
a pair of receiver channels communicating with said intermediate chamber, said channels diverging in a downstream direction.

2. The fluid amplifier as set forth in claim 1 and further including a pair of receiver vents each in communication with a respective one of said pair of receiver channels;
a center vent disposed between said pair of receiver channels downstream of said intermediate chamber and in communication therewith through a center vent passageway, said center vent passageway being aligned with said power nozzle; and
intermediate chamber vent means in communication with said intermediate chamber.

3. The fluid amplifier as defined in claim 1 wherein said walls forming said orifice diverge in a downstream direction.

4. The fluid amplifier of claim 1 wherein the sidewalls of said intermediate region diverge in a downstream direction in substantial alignment with said receiver channels.

5. A fluid amplifier comprising:
an interaction chamber;
power nozzle means for issuing a power jet of fluid into said interaction chamber;
a control nozzle disposed on each side of said power nozzle for issuing fluid into said interaction chamber in intersecting relationship to said power jet of fluid, each control nozzle being inclined at an angle between 10° and 45° to said power nozzle;
a pair of walls forming an orifice adjacent to said interaction chamber at its downstream end, said interaction chamber having walls forming cusps at respective opposite ends of said interaction region on opposite sides of the power nozzle in confronting relationship, said cusps forming edges with respective ones of said orifice walls;
an intermediate chamber downstream of said orifice; and
a pair of receiver channels communicating with said intermediate chamber, said channels diverging in a downstream direction.

6. The fluid amplifier defined in claim 5 wherein said intermediate chamber has sidewalls parallel to each other and to said power nozzle, each of said control nozzles being aimed at one of said intermediate chamber sidewalls.

7. The fluid amplifier defined in claim 5 wherein said walls forming said effective orifice diverge in a downstream direction.