Oct. 7, 1969 R. RIMMER 3,470,894

FLUID JET DEVICES

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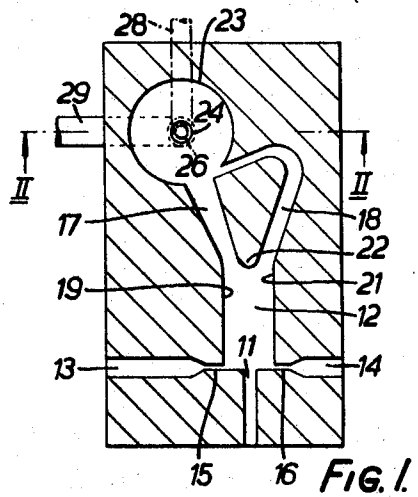

FIG. 1.

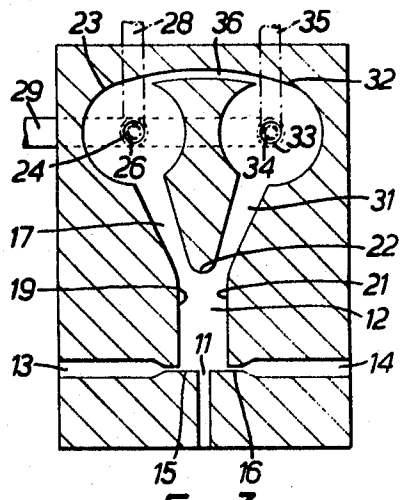

FIG. 3.

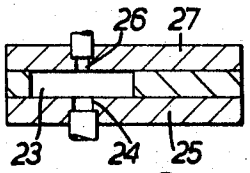

FIG. 2.

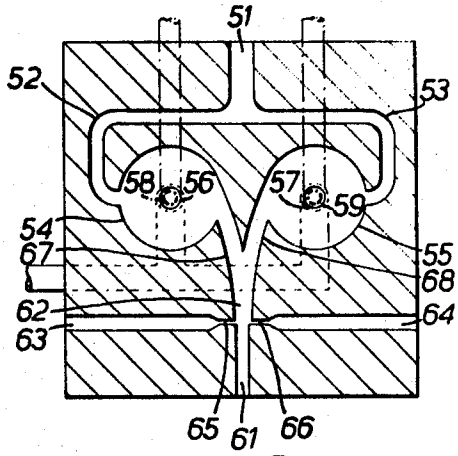

FIG. 5.

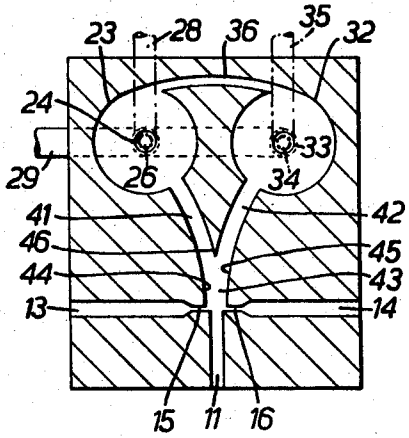

FIG. 4.

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FLUID JET DEVICES

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Int. Cl. F15c 1/14
U.S. Cl. 137—81.5 5 Claims

ABSTRACT OF THE DISCLOSURE

A fluid jet device having a power jet nozzle and two outlet passages arranged to operate either as a fluid switch or as a fluid amplifier, includes a vortex chamber into which one outlet passage opens radially and into which the other outlet passage opens tangentially, the vortex chamber having a power outlet on its central axis.

BACKGROUND OF THE INVENTION

Field of the invention

Fluid switches and fluid amplifiers.

Description of the prior art

In known forms of fluid switch or fluid amplifier, the deflection of a fluid jet into one or other of two outlet passages is controlled by the fluid pressure acting on opposite sides of the jet.

The object of the present invention is to reduce fluid energy losses which diminish the maximum pressure obtainable at the fluid power outlet.

SUMMARY

The invention provides a vortex chamber into which the flow of fluid from a source under pressure is controlled by a deflectable jet whereby fluid flows either radially across the vortex chamber, or as a vortex, to a fluid power outlet, while the pressure at the periphery of the vortex chamber is fed back to the discharge side of the jet and thus reduces the fluid pressure difference between the inlet and the discharge side of the jet.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 shows a fluid jet device having a single output,

FIGURE 2 is a section on the line II—II of FIGURE 1,

FIGURE 3 shows a fluid jet device having a double output,

FIGURE 4 shows another fluid jet device having a double output, and

FIGURE 5 shows a further fluid jet device having a double output.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIGURE 1, a power jet nozzle **11** opens into a switch chamber **12**. Control passages **13** and **14** open through fixed restrictors **15** and **16** respectively into the switch chamber **12** on opposite sides of the nozzle **11**. Two outlet passages **17**, **18** lead from the chamber **12** at positions which are spaced from the nozzle **11** and which lie on opposite sides of the central axis of the nozzle. The side walls **19**, **21** of the switch chamber **12** are parallel and their separation is considerably greater than the width of the nozzle **11**. The side walls **19**, **21** blend into side walls of the respective outlet passages **17**, **18**, while the other side walls of the outlet passages are joined by a rounded jet divider surface **22**. The outlet

passage **17** is slightly divergent to provide pressure recovery of a fluid stream therein, and it opens radially into a circular vortex chamber **23**. The other outlet passage **18** turns to open tangentially into the vortex chamber **23**.

A circular vent **24** is formed on the central axis of the vortex chamber **23** in one end wall **25**, FIGURE 2. The cross-sectional area of the vent **24** is less than that of the power jet nozzle **11**. A fluid power outlet **26** is formed in the opposite wall **27**, also on the central axis, and it has a diameter less than that of the vent **24**. The power outlet **26** opens into a delivery pipe **28** for operation of a servomotor or the like, and the vent **24** opens into a pipe **29** which is connected to low pressure.

The fluid jet device operates as a bi-stable switch which is controlled by a fluid pulse, or by continuously applied pressure, selectively in either the control passage **13** or the control passage **14**. Thus, a pulse or continuously applied pressure in the control passage **13** deflects a jet flowing from the nozzle **11** into the outlet passage **18**, and from this tangentially into the vortex chamber **23**. Due to the swirling motion of the fluid, the pressure falls rapidly towards the centre where the fluid is discharged with whirling motion through the vent **24**. The pressure in the smaller diameter power outlet **26** is then substantially equal to the low pressure in the pipe **29**. Fluid returned in the pipe **28** as the result of servomotor operation may then discharge with the vortex fluid to the low pressure pipe **29**. The pressure at the periphery of the vortex chamber **23** is fed back through the passage **17** to the switch chamber **12**.

A pulse, or continuously applied pressure, in the control passage **14** deflects the jet flowing from the nozzle into the outlet passage **17**. The kinetic energy of the jet is partially recovered as pressure in the divergent passage **17** and the pressure prevails without loss from the periphery to the centre of the vortex chamber **23** since there is substantially no rotation of fluid. The peripheral pressure is also fed back through the outlet passage **18** to the control chamber **12** wherein it reduces the pressure difference across the nozzle **11** between the fluid source and the chamber **12**. The velocity of the power jet from the nozzle is therefore low, and hence the kinetic energy losses are small. When there is no rotation of fluid in the vortex chamber **23**, the pressure at the centre is at a maximum and is therefore present in the power outlet **26** for operation of the servomotor or the like. The discharge area of the vent **24**, being less than the area of the nozzle **11**, is chosen whereby there is no substantial pressure loss in the vortex chamber **23** due to fluid flow through the vent **24**, though the vent is not so small as to produce a substantial pressure in the power outlet **26** when the power jet flows into the outlet passage **18** to cause a vortex in the chamber **23**.

When the power jet flows into the outlet passage **17** and the output pressure is applied to the power outlet without any substantial flow therethrough, a maximum pressure is available which may be up to 80% or thereabouts of the pressure supplied to the nozzle **11**.

Although the fluid switch may be operated as described by the application of fluid pressure to the control passage **13** or **14**, it is possible to connect each control passage to low pressure through a pilot valve. If, for example, the pilot valve controlling the passage **13** is opened, there will be a fall of pressure on the side of the power jet adjacent to the restrictor **15** whereby the power jet is deflected into the outlet passage **17**, and remains so deflected even when the pivot valve is closed.

In the embodiment of the invention shown in FIGURE 3, each element having its counterpart in FIGURE 1 is given a like reference numeral. The arrangement differs

in that a second divergent outlet passage **31** from the switch chamber **12** opens radially into a second vortex chamber **32** which is similar to the vortex chamber **23**. A central vent **33** in the vortex chamber **32**, and the vent **24** are connected to the low pressure pipe **29**, while a central power outlet **34** opens into a delivery pipe **35**. An interconnecting passage **36** opens tangentially at its opposite ends into the respective vortex chambers **23** and **32**.

The control of the power jet from the nozzle **11** is similar to that in the embodiment of FIGURE 1. If, for example, the power jet enters the outlet passage **17**, the recovered pressure acts across the vortex chamber **23** in the power outlet **26** and the delivery pipe **28**. Fluid under pressure also leaves the chamber **23** through the passage **36** and enters the chamber **32** tangentially to induce a vortex therein. The pressure at the periphery of the vortex is fed back through the outlet passage **31** to the switch chamber **12** with substantially the same effect as in FIGURE 1, but there is low pressure, or substantially no pressure at the centre of the vortex in the central power outlet **34** and the delivery pipe **35**.

Similarly, if the power jet enters the outlet passage **31**, there will be high pressure in the outlet **34** and delivery pipe **35**, but little or no pressure in the power outlet **26** and delivery pipe **28**. This embodiment provides a fluid jet device with two delivery pipes suitable, for example, for moving a double-acting piston to one end or the other of a cylinder.

FIGURE 4 shows a fluid amplifier, which has a configuration generally similar to that of FIGURE 3, but which differs in the form of the outlet passages **41** and **42**. These passages open from a chamber **43** having side walls **44**, **45**, the spacing of which at the nozzle end of the chamber does not greatly exceed the width of the nozzle **11**. The flow divider **46** formed between the passages **41** and **42** is sharp edged. The outlet passages **41** and **42** are not divergent and they do not cause attachment of the power jet to the side walls **44**, **45**.

The power jet will, in the absence of a control signal, divide substantially equally between the outlet passages **41** and **42** and flow without rotation into the chambers **23** and **32**. Since only half the power jet flows into each chamber, the loss of fluid through the vents **24** and **33** will produce a pressure at the power outlets **26** and **34** intermediate the maximum and minimum values. The proportion of the flows in the outlet passages **41**, **42** is varied by differentially controlling the control pressures in the passages **13**, **14** whereby the deflection of the power jet varies. If, for example, the flow in the outlet passage **41** is the greater, the pressure is increased in the chamber **23** while the pressure is decreased in the chamber **32**, partly due to the effect of the vents **24** and **33**, and partly due to the vortex set up in the chamber **32** by fluid flow through the passage **36** from the chamber **23**. When the power jet is fully deflected into the outlet passage **41**, the pressure will be at a maximum in the power outlet **26** and at a minimum in the power outlet **34**.

In the embodiment of FIGURE 5, a fluid supply passage **51** is provided having branches **52**, **53** which open radially into vortex chambers **54** and **55** respectively. The vortex chambers have vents **56**, **57** and power outlets **58**, **59** respectively as in FIGURES 3 and 4. A power jet nozzle **61** is connectable with the same fluid supply and the jet flows through a fluid amplifier chamber **62** under the control of a pair of control passages **63**, **64** which have fixed restrictors **65** and **66** therein. The outlet passages **67** and **68** from the chamber **62** enter the respective chambers **54** and **55** tangentially. The nozzle **61**, chamber **62**, and outlet passages **67** and **68** are arranged as a fluid amplifier as in FIGURE 4.

In operation, the jet when wholly deflected into the outlet passage **67**, imparts rotation to fluid entering the chamber **54** from the branch supply passage **52** so that minimum output pressure prevails at the power outlet **58**. There is no rotation of fluid entering the vortex chamber **55** from the branch passage **53** so that maximum output pressure prevails at the power outlet **59**. When the flow into the outlet passages **67** and **68** is equally divided, there is reduced rotation of fluid in the chamber **54** and an equal rotation in the chamber **55**. The pressures at the power outlets **58** and **59** are then substantially equal at a value intermediate the minimum and maximum output pressures.

The device of FIGURE 5 can be modified by forming the nozzle **61**, chamber **62**, and outlet passages **67**, **68** to act as a fluid switch.

A further modification possible is to form the single vortex chamber device of FIGURE 1 as a fluid amplifier.

I claim as my invention:

1. A fluid jet device comprising

(A) a power jet nozzle adapted for connection to a source of fluid pressure,

(B) two outlet passages,

(C) pressure control means situated adjacent the nozzle and operable to deflect a power jet issuing from the nozzle into one or other of the outlet pasages,

(D) a vortex chamber,

(E) a radial opening at the periphery of the vortex chamber which is connected to one of said outlet passages and which is adapted to receive fluid from said source, said fluid flowing into the vortex chamber without rotation when the power jet is directed into said one outlet passage,

(F) a tangential opening at the periphery of the vortex chamber which is connected to the other of said outlet passages whereby fluid flowing from the source forms a vortex in said chamber when the power jet is directed into said other outlet passage,

(G) a circular vent opening to low pressure from the vortex chamber on the central axis thereof, the vent forming a fluid flow restrictor having a cross-sectional area which is less than that of the power jet nozzle, and

(H) a circular power outlet also opening from the vortex chamber on the central axis thereof, the power outlet having a diameter less than that of the vent, whereby when the power jet flows through the tangential opening into the vortex chamber and fluid is discharged with whirling motion through the vent, the pressure in the power outlet is substantially equal to the said low pressure, and when the power jet flows through the radial opening into the vortex chamber, the discharge of fluid through the vent occurring substantially without rotation, the pressure in the power outlet is substantially equal to that in the radial opening.

2. A fluid jet device according to claim **1**, wherein the vent and the fluid power outlet are formed in opposite end walls of the vortex chamber.

3. A fluid jet device comprising

(A) a power jet nozzle adapted for connection to a source of fluid pressure,

(B) two outlet passages spaced from the nozzle,

(C) pressure control means situated adjacent the nozzle and operable to deflect the power jet issuing from the nozzle into one or other of the outlet passages,

(D) a vortex chamber into which one of the outlet passages opens radially and into which the other of the outlet passages opens tangentially,

(E) a circular vent opening to low pressure from the vortex chamber on the central axis thereof, the vent forming a fluid flow restrictor having a cross-sectional area which is less than that of the power jet nozzle, and

(F) a circular power outlet also opening from the vortex chamber on the central axis thereof, the power outlet having a diameter less than that of the vent, whereby when the power jet flows through the passage opening tangentially into the vortex chamber

and fluid is discharged with whirling motion through the vent, the pressure in the power outlet is substantially equal to the said low pressure, and when the power jet flows through the passage opening radially into the vortex chamber, the discharge of fluid through the vent occurring substantially without rotation, the pressure in the power outlet is substantially equal to that in the radially-opening passage.

4. A fluid jet device comprising

(A) a power jet nozzle adapted for connection to a source of fluid pressure,

(B) a first outlet passage and a second outlet passage both spaced from the nozzle,

(C) pressure control means situated adjacent the nozzle and operable to deflect the power jet issuing from the nozzle into one or other of the outlet passages,

(D) a first vortex chamber into which the first outlet passages opens radially,

(E) a second vortex chamber into which the second outlet passage opens radially,

(F) a passage having opposite ends opening tangentially into the respective vortex chambers, and

(G) a fluid power outlet on the central axis of each vortex chamber.

5. A fluid jet device comprising

(A) a power jet nozzle adapted for connection to a source of fluid pressure,

(B) a first outlet passage and a second outlet passage both spaced from the nozzle,

(C) pressure control means situated adjacent the nozzle and operable to deflect the power jet issuing from the nozzle into one or other of the outlet passages,

(D) a first vortex chamber into which the first outlet passage opens tangentially,

(E) a second vortex chamber into which the second outlet passage opens tangentially,

(F) a fluid pressure supply passage having branches which open radially into the respective vortex chambers, and

(G) a fluid power outlet on the central axis of each vortex chamber.

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SAMUEL SCOTT, Primary Examiner