# United States Patent

[11] 3,621,880


[72] Inventors **James M. Jessee**
**Granada Hills;**
**Ernest Niederer, Hollywood, both of Calif.**



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[73] Assignee **Bell Aerospace Corporation**


[54] **JET PIPE SERVO VALVE**
**1 Claim, 4 Drawing Figs.**


[52] **U.S. Cl.** ..... **137/625.64,** 137/83, 137/625.63
[51] **Int. Cl.** ..... **F15b13/044**
[50] **Field of Search** ..... 137/83, 625.64, 625.63; 91/3



[56] **References Cited**
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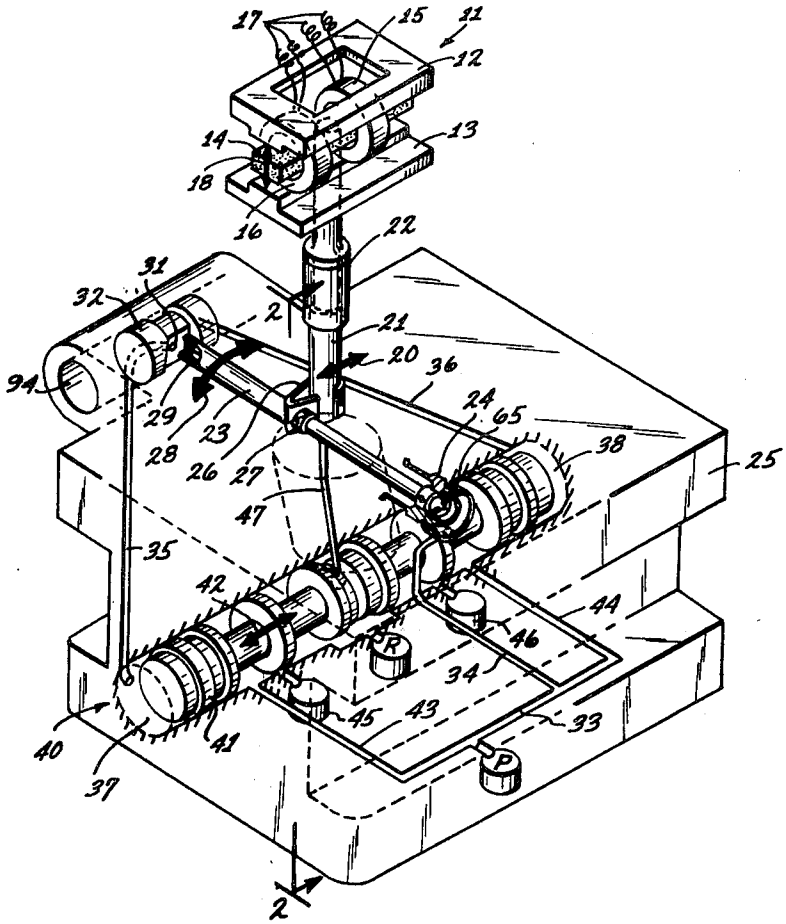
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*Primary Examiner*—Alan Cohan
*Attorney*—Nilsson, Robbins, Wills & Berliner



**ABSTRACT:** Disclosed is a jet pipe-type servo valve wherein the feed tube is disposed angularly with respect to a flapper to which it is affixed and which is movable by a torque motor the armature of which is connected to the flapper. The feed tube has one end thereof affixed rigidly to the housing and the other end thereof terminating in a nozzle which is positioned adjacent a receiver. The output ports of the receiver are connected to the end chambers of a cylinder within which a power control valve is slidably positioned so as to control the flow of fluid under pressure from a source thereof to an apparatus to be positioned such as an actuator. The jet pipe stage and the power control valve stage are isolated from each other.

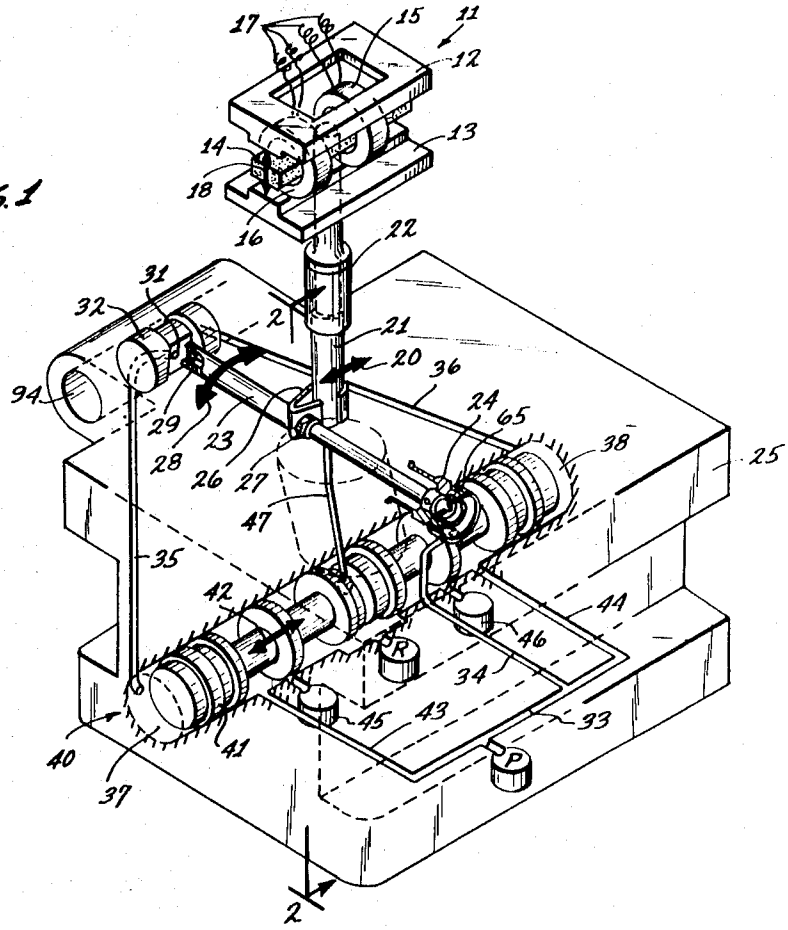



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SHEET 1 OF 2

FIG. 1



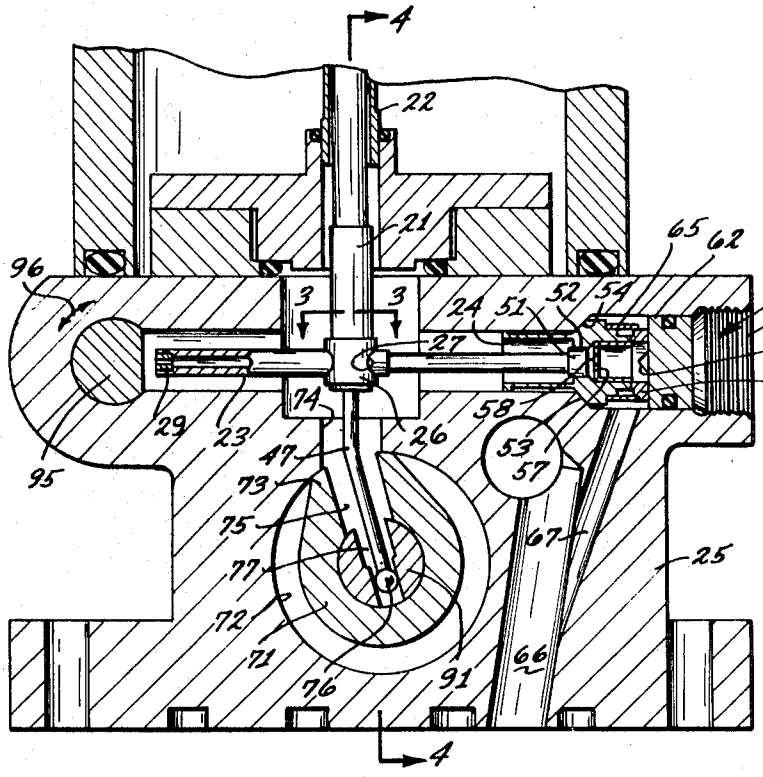




FIG. 2

INVENTORS
JAMES M. JESSEE
ERNEST NIEDERER

BY Wilson & Robbins
ATTORNEYS

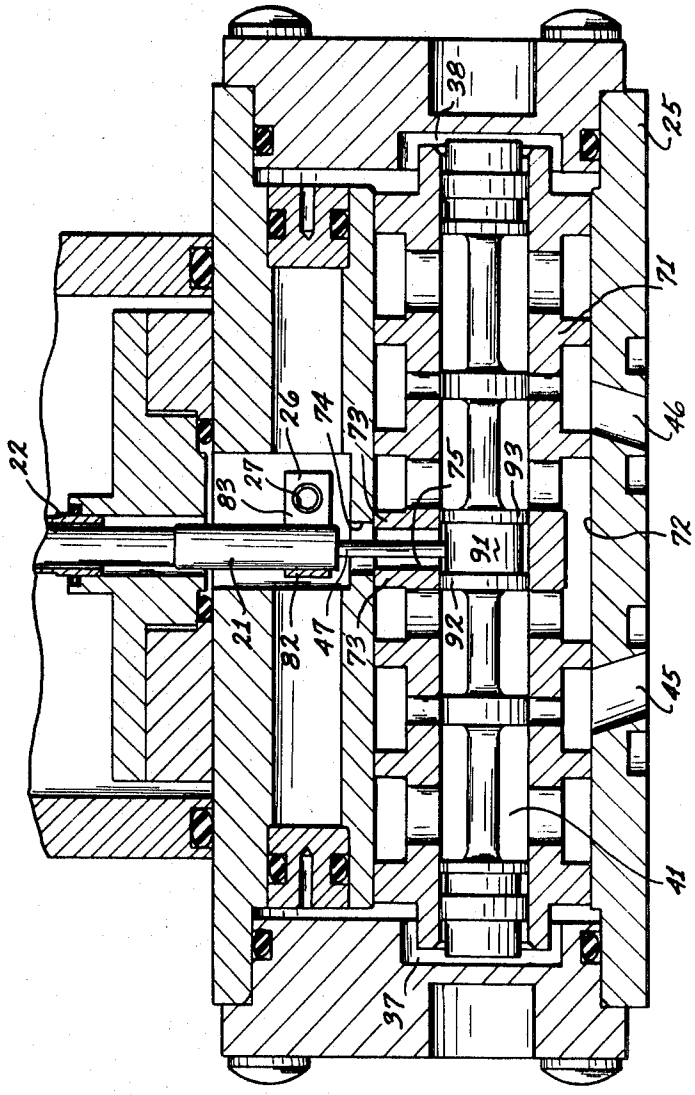



FIG. 4

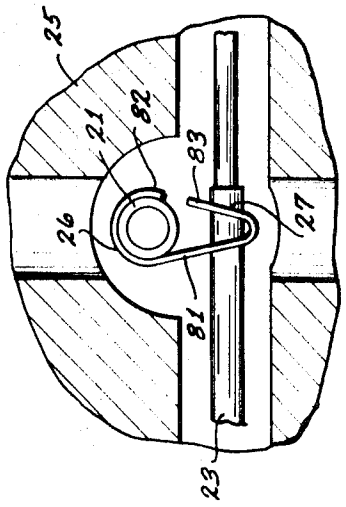



FIG. 3

INVENTORS
JAMES M. JESSEE
ERNEST NIEDERER

BY Wilson & Robbins
ATTORNEYS

# JET PIPE SERVO VALVE

## BACKGROUND OF THE INVENTION

Jet pipe servovalves have long been known and typical examples of such apparatus are shown in U.S. Pat. Nos. 2,884,906; 2,884,907; 2,996,072 and 3,017,864. As can be seen from these prior art patents, typical jet pipe servovalves are constructed in such a manner that the feed tube and the armature of the torque motor are an integral unit or at the most the feed tube is axially an extension of the torque motor armature. As a result the degree of movement of the nozzle tip, which terminates the feed tube, is limited by the amount of movement of the armature in the torque motor. Furthermore, alignment between the jet pipe nozzle orifice and the receiver ports is somewhat difficult to obtain and there is little or no adjustment available.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram shown in perspective of a jet pipe servovalve constructed in accordance with the present invention;

FIG. 2 is a cross-sectional view of the servovalve illustrated in FIG. 1, taken about the line 2—2;

FIG. 3 is a fragmentary cross-sectional view taken about the line 3—3 of FIG. 2; and

FIG. 4 is a cross-sectional view taken about the line 4—4 of FIG. 2.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1 there is illustrated a jet pipe servovalve which includes a torque motor **11** having pole pieces **12** and **13** with an armature **14** disposed therebetween. A pair of coils **15** and **16** are disposed to received an input signal upon leads **17** thereby to provide movement of the armature and, as indicated by the arrow **18**, which is proportional to the magnitude of the input signal.

A flapper **21** is rigidly connected to the armature **14** so as to move as indicated by the arrow **20** in response to movement of the armature **14**. The flapper **21** is suspended within a torque tube **22** so as to provide a seal between the fluid sections of the servovalve and the torque motor. Such a suspension is well known and, for example, is illustrated in U.S. Pat. No. 3,221,760. A feed tube **23** has one end thereof rigidly affixed to a retainer member **24** which in turn is rigidly affixed to the body portion **25** of the housing. The feed tube **23** is constructed of a hollow flexure tube which is movable with respect to the housing. Movement is imparted to the tube **23** by way of a flexible connection such as the link or spring clip **26** which is rigidly affixed to the flapper **21**, but is releasably attached to the tube **23** by being inserted through an opening **27** defined by the clip **26**. Thus, as the flapper **21** moves the feed tube **23** also is caused to move as indicated by the arrow **28**. As is illustrated by the difference in arrows **20** and **28**, the mechanical interconnection provides amplification of movement of the nozzle tip as compared to the flapper **21**. Thus, small armature movement results in larger nozzle tip movement. The feed tube terminates in an ejector end having a nozzle **29** which is positioned adjacent openings **31** in a receiver port means **32**.

Fluid under pressure is provided from a source thereof (not shown) through conduits **33** and **34** to the fixed or receiving end portion of the feed tube **23**. As the nozzle **29** moves with respect to the receiver ports **31**, differential pressure is applied through conduits **35** and **36** to the end chambers **37** and **38**, respectively, of the power control valve spool shown generally at **40**. The structure of a flow control valve spool is well known in the prior art and, for example, detailed description thereof may be found in the above referenced patents. Generally movement of the valve spool **41** in response to differential pressure thereacross in the end chambers **37** and **38** as indicated by the arrow **42**, causes fluid under pressure to flow through the conduits **33**, and **43** or **44** to an actuator connected to cylinder ports **45** and **46** depending upon the direction of movement of the valve **41**. As the valve **41** thusly moves, such movement is transmitted by way of a feedback spring **47** which is affixed to the armature **14**.



Referring now more particularly to FIG. **2**, the manner in which the feed tube is rigidly affixed to the body **25** is illustrated. As is therein illustrated, the end **51** of the feed tube is rigidly affixed as by brazing or the like to an opening **52** provided in the retainer **24**. The retainer **24** defines a bevelled surface **53** which mates with a bevelled shoulder **54** defined by the bore **55** into which the retainer **24** is inserted. The retainer **24** defines a reentrant bore **56** which receives a cup-shaped member **57** defining a restriction orifice **58**, the function of which is well known in the art. It should be understood that the restriction orifice is used only in instances of high fluid pressure where it is deemed desirable to drop some pressure prior to the fluid reaching the nozzle orifice. A plug **59** is also received within the bore **55** and is utilized to force the surface **53** into engagement with the shoulder **54** thereby effecting a metal-to-metal seal against the leakage of fluid under pressure. This function is accomplished through the shoulder **62** which abuts the end edge **63** of the retainer **24**. A lock screw **64** is then threaded into the bore **55** and urges the plug **59** against the retainer **24** thereby causing the entire assembly to firmly seat in place. A wire screen filter **65** is seated within a reduced diameter area of the retainer **24** and is also held in place by the plug **59**. Fluid under pressure enters the body **25** through an opening **66** provided therein. An auxiliary opening **67** is also provided in the body and communicates between the opening **66** and the reentrant bore **56** provided in the retainer **24** through the openings **68** formed in the rear edge **63** of the retainer **24**.

As is also illustrated in FIG. **2**, the valve spool **41** is slidably disposed within a sleeve **71** which is seated within a bore **72** provided in the body **25**. The sleeve **71** is provided with a land **73** which provides a seal about an opening **74** defined by the body **25** and through which the feedback spring **47** passes. The land **73** is relieved to provide an opening **75** through which the feedback spring **47** also passes. As is illustrated, the feedback spring **47** terminates in a ball **76** which is disposed within an opening **77** provided in the spool valve **41**. As is clear from FIGS. **1** and **2**, the feed tube is positioned solely within the body of the housing thus eliminating the usual external plumbing to provide fluid under pressure to the feed tube.

By reference to FIG. **3**, a more detailed understanding in the manner which the feed tube **23** is connected to the flapper **21** can be had. As is therein shown, the spring clip **26** comprises a body section **81** terminating in one end portion **82** which is wrapped around the flapper **21** and is rigidly affixed thereto as by brazing or the like. The body **81** terminates in a second end portion **83** which is bent so as to provide a V-shaped section with the body portion **81**. The body **81** and the end portion **83** each define axially aligned openings therethrough and through which the feed tube **23** is disposed. The end portion **83** may be compressed toward the body section **81** to align the various portions of the apparatus. Once such alignment has occurred, the end portion **83** may be released and the spring tension of the body portion **81** and the end portion **83** moving outwardly causes the spring clip **26** to grip the feed tube **23** and holds it firmly in place with respect to the flapper **21**. As can clearly be seen the axes of the feed tube **23** and the flapper **21** are offset and nonintersecting.

Referring now more particularly to FIG. **4**, various details, as above described, are further illustrated and particularly the valve spool **41** is shown to have a central land **91** having sealing edges **92** and **93** which engage the sleeve **71** to provide the isolation between the jet pipe stage and the power valve stage as above described. It should also be particularly noted that the axes of the flapper **21** and feedback spring **47** are aligned.

As is illustrated, particularly in FIGS. **1** and **2**, the receiver port means **32** is received within a bore **94** defined in the body portion **25** of the housing. To accomplish alignment between the receiver ports **31** and the nozzle **29** orifice the receiver

port means **32** may be rotated about its axis **95** as shown by arrow **96**. Also the receiver port means may be moved axially within the bore **94**. Thus, once the feed tube is positioned within the body portion **25** of the housing and affixed to the flapper **21**, the receiver ports may be adjusted to effect the desired null balance relationship (assuming no input signal to the torque motor).

What is claimed is:

**1**. A jet pipe servovalve comprising:

a housing having a body portion;

a torque motor mounted on said body portion and including a movable member adapted for pivotal movement in response to electrical signals applied thereto, said member defining a first longitudinal axis;

a feed tube mounted in said body portion, separate from said movable member, adapted to receive fluid under pressure, having a receiving end portion and an ejecting end portion and defining a second longitudinal axis, said second axis being angularly positioned with respect to



said first axis and offset therefrom so that said axes do not intersect;

means fixedly securing said receiving end portion of said feed tube to said body portion;

flexible link means securing said feed tube to said member thereby to cause said ejection and portion of said feed tube to move responsive to pivotal movement of said member;

receiver port means positioned adjacent said ejector end portion of said feed tube for receiving fluid ejected therefrom, said receiver port means being rotatable to effect adjustment;

a control valve connected to receive fluid pressure from said receiver port means and to move responsively thereto to control the flow of fluid from a source thereof to a load; and

means isolating the fluid in said control valve area from the fluid in said ejection-receiver port area.

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