

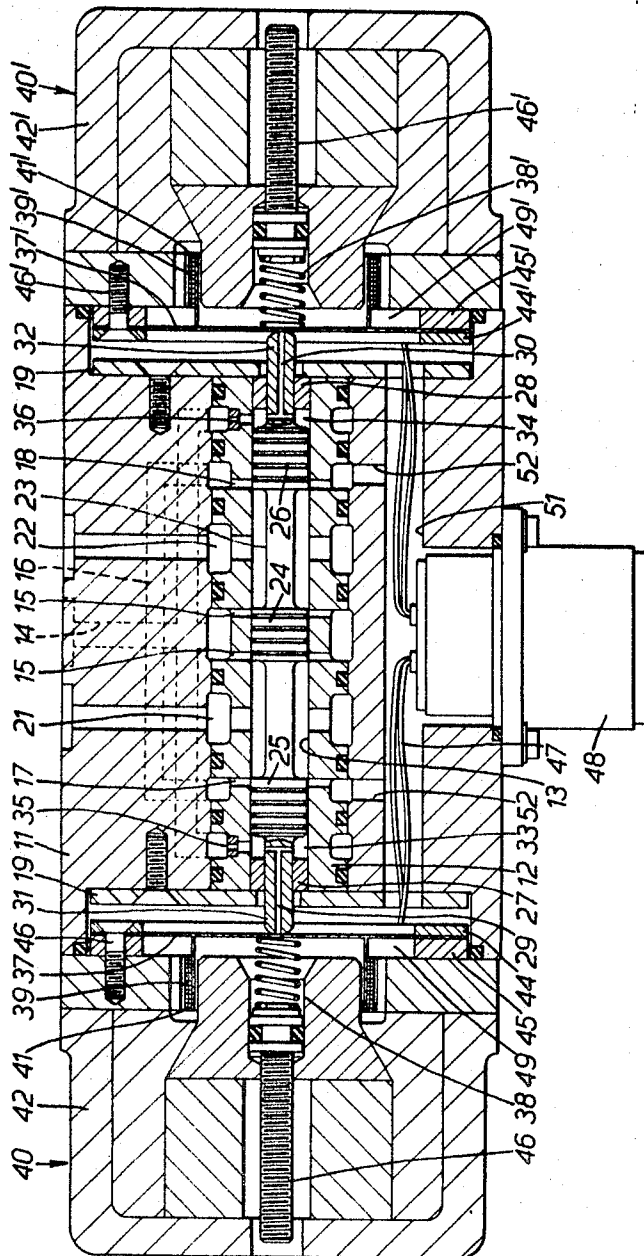
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ELECTRO-HYDRAULIC SERVO CONTROL VALVE

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ELECTRO-HYDRAULIC SERVO CONTROL VALVE
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2 Claims

ABSTRACT OF THE DISCLOSURE

An electro-hydraulic servo control valve comprises a main valve having a fluid pressure operated movable member with pilot valve nozzles extending from opposite ends thereof. Each pilot valve nozzle is variably restricted to control fluid pressure actuation of the main valve, by a diaphragm which is loaded by a voice coil movable in the field of a permanent magnet.

BACKGROUND OF THE INVENTION

Field of the invention

Servo control valves having a main valve controlled by a pilot valve, and an electrically operated transducer controlling the pilot valve.

Description of the prior art

An electro-hydraulic servo control valve is known in which the main valve includes a movable valve spool having pilot valve nozzles extending from opposite ends thereof, and valve-actuating areas each of which is fluid-pressure-loaded in dependance upon the flow of fluid through an associated one of said nozzles, and wherein the flow through said nozzles is varied differentially by pivoted members which are actuated by the armature of an electro-magnetic control device.

In other arrangements of servo control valve it is, moreover, known to actuate the member which controls the flow of fluid through a pilot valve nozzle by means of a voice coil which moves in the field of a permanent magnet under the influence of an input current signal.

One object of the present invention is to provide a compact construction of servo control valve in which manufacture is simplified by providing a generally co-axial arrangement of moving parts.

SUMMARY

According to the present invention, an electro-hydraulic servo valve comprises a valve body having therein a fluid pressure supply passage, a fluid return passage, and at least one motor port, a main valve member slidably mounted in the valve body and adapted to provide a controllable connection between said motor port and, alternatively, either said supply passage or said return passage, a pilot valve nozzle extending from each end of the main valve member in the direction of movement thereof, each of said nozzles having an inlet which is connected continuously to the fluid pressure supply passage, and a discharge orifice at the other end of the nozzle opening into a low pressure chamber which is connected to the fluid return passage, an electro-magnetic control device arranged at each end of the main valve to co-operate with the pilot valve nozzle extending therefrom, and including a voice coil mounted in the direction of movement of the main valve member, and a closure member mounted for movement with the voice coil variably to restrict the nozzle orifice and thus to vary the flow of fluid through said orifice in response to an input current signal in the voice coil, and two fluid pressure loading

means arranged to act oppositely on the main valve member, each loading means having a fluid connection with a respective one of said nozzles and being arranged to produce a force on the main valve member which varies in response to the rate of flow of fluid through said nozzle.

DESCRIPTION OF THE PREFERRED EMBODIMENT

One embodiment of the invention is illustrated in the accompanying drawing which is a partly sectional longitudinal view.

In the drawing, a valve body 11 is fitted with a cylindrical bushing 12 which has a central bore 13 from end to end. A fluid pressure supply passage 14 leads to a pair of supply ports 15 in the bushing at the axially central part of the bore. A fluid return passage 16 connects two return ports 17, 18 in the bushing which are spaced from the supply ports 15 towards opposite ends of the bore, though that portion of the return passage 16 which extends to the exterior of the valve body 11 is not shown.

Two motor ports 21, 22 are disposed in the bushing between the supply ports 15 and the respective return ports 17, 18. A spool 23 mounted in the bore 13 has an axially central land 24, which in the central or neutral position of the spool, closes the supply ports 15, and two outer lands 25, 26 which close the return ports 17 and 18 respectively. The ported bushing 12 and the spool 23 form the main valve of the servo valve.

Pilot valves for controlling the main valve, include two cylindrical stems 31, 32 which extend from opposite ends of the spool 23 along the central axis through closely fitting bushes 27 and 28 respectively which are retained at opposite ends of the bore 13 by discs 19. The stems 31, 32 are formed with central bores 29 and 30 respectively and they constitute nozzles having their inlets in annular chambers 33 and 34. The chamber 33 is defined in the axial direction by the land 25 and the bush 27, while the chamber 34 is likewise defined by the land 26 and the bush 28. The chambers 33 and 34 lie downstream of fixed orifices 25 and 26 respectively in connections from the fluid pressure supply passage 14.

The other ends of the nozzle bores 29, 30 form discharge orifices from which the flow of fluid is controlled by the electro-magnetic devices 40, 40', which are mounted at opposite ends of the valve body 11.

The device 40 includes a permanent magnet 42 having an annular gap 41 formed between the pole pieces in which a voice coil 39 is movable. The voice coil 39 is carried by a diaphragm 37 which is fixedly supported at its periphery between rings 44 and 45, these rings being secured to the outer pole piece by screws 46. The voice coil 39 and the diaphragm 37 are concentric with the central axis of the main valve, and the central part of the diaphragm forms a pilot valve closure member which is movable with variable force against the discharge orifice of the nozzle 31 in accordance with an input signal current in the voice coil 39. The diaphragm 37 is also loaded against the nozzle 31 by a central coil spring 38 with a load which can be varied by an adjustable screw abutment 46 for the spring 38. The springs 38, 38' are pre-loaded to provide initial restriction of the discharge orifices in both nozzles 31, 32.

The electric wires 47 to the voice coil 39 lead from a terminal block 48 which is secured to the valve body 11.

The diaphragm 37 is spaced between the magnet 42 and the disc 19 in a low pressure chamber 49, in which the diaphragm is perforate to equalise fluid pressure on opposite sides thereof. The low pressure chamber 49 is connected to the fluid return passage 16, each connection being illustrated for convenience by a bore 51 in the valve body 11 through which the wires 47 pass, and a transverse connection 52 to the return port 16.

The electro-magnetic device 40' at the other end of the valve body 11 is similar, and the parts at this end are denoted by similar reference numerals with a suffix.

In operation, the application of an input current signal in one direction through the voice coil 39 causes the diaphragm increasingly to restrict fluid flow from the nozzle 31. The resulting increased pressure in the chamber 33 acting on the annular area between the circumference of the land 25 and the nozzle 31 urges the valve spool 23 away from the electro-magnetic device 40. This movement causes a reduction of the construction of the discharge orifice of the nozzle 31 by the diaphragm 37 whereby the pressure in the chamber 33 falls from the initially increased pressure. The valve spool 23 is therefore servo-operated by fluid pressure and it substantially follows movement of the diaphragm 37 under the combined forces of the voice coil 39 and the spring 38. Movement of the valve spool 23 from the neutral position away from the electro-magnetic device 40 progressively opens the left hand one of the pressure ports 15 to the motor port 21, while the return port 18 is progressively opened to the motor port 22. Movement of the valve spool 23 in response to a current signal in the voice coil 39' similarly connects the right hand pressure port 15 to the motor port 22 and the return port 17 to the motor port 21. The movement of the valve spool 23 may be controlled by current signals flowing in the voice coils 39, 39' separately, or it may be controlled differentially by current signals flowing in both voice coils.

The displacement of the spool may be substantially proportional to the current signal in either voice coil, or to the difference of the current signals in the two coils.

I claim as my invention:

1. An electro-hydraulic servo valve comprising:

(A) a valve body having therein a fluid pressure supply passage, a fluid return passage, and at least one motor port;

(B) a main valve member slidably mounted in the valve body and adapted to provide a controllable connection between said motor port and, alternatively either said supply passage or said return passage;

(C) a pilot valve nozzle extending from each end of the main valve member along the axis of movement thereof, each of said nozzles having

(1) an inlet which is connected continuously to the fluid pressure supply passage, and

(2) a discharge orifice at the outer end of the nozzle opening into a low pressure chamber which is connected to the fluid return passage;

(D) an electro-magnetic control device arranged concentrically with the main valve adjacent each end thereof and including,

(1) a perforate flexible diaphragm supported around its periphery and having a central part which is adapted to act as a closure co-operable with the discharge nozzle and which is movable, upon flexure of the diaphragm, along the axis of movement of the main valve member, and

(2) a coil which is attached to the diaphragm radially inwardly of the periphery thereof and which is movable in the field of a permanent magnet in response to an input current signal in the coil whereby the central part of the diaphragm is operable variably to restrict the nozzle orifice;

(E) two fluid pressure loading means arranged to act oppositely on the main valve member, each loading means having a fluid connection with a respective one of said nozzles and being arranged to produce a force on the main valve member which varies in response to the rate of flow of fluid through said nozzle; and

(F) spring means operable to urge the central part of the diaphragm towards the nozzle orifice.

2. An electro-hydraulic servo valve comprising:

(A) a valve body having therein a fluid pressure supply passage, a fluid return passage, and at least one motor port;

(B) a main valve member slidably mounted in the valve body and adapted to provide a controllable connection between said motor port and, alternatively either said supply passage or said return passage;

(C) a pilot valve nozzle extending from each end of the main valve member along the axis of movement thereof, each of said nozzles having

(1) an inlet which is connected continuously to the fluid pressure supply passage, and

(2) a discharge orifice at the outer end of the nozzle opening into a low pressure chamber which is connected to the fluid return passage;

(D) an electro-magnetic control device arranged concentrically with the main valve adjacent at least one end thereof and including,

(1) a perforate flexible diaphragm supported around its periphery and having a central part which is adapted to act as a closure co-operable with the discharge nozzle and which is movable, upon flexure of the diaphragm, along the axis of movement of the main valve member, and

(2) a coil which is attached to the diaphragm radially inwardly of the periphery thereof and which is movable in the field of a permanent magnet in response to an input current signal in the coil whereby the central part of the diaphragm is operable variably to restrict the nozzle orifice;

(E) two fluid pressure loading means arranged to act oppositely on the main valve member, each loading means having a fluid connection with a respective one of said nozzles and being arranged to produce a force on the main valve member which varies in response to the rate of flow of fluid through said nozzle; and

(F) spring means operable to urge the central part of the diaphragm towards the nozzle orifice.

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