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Keller et al.

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[54] HYDRAULIC CONTROL SYSTEM

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[58] **Field of Search** 91/388, 387, 47, 1

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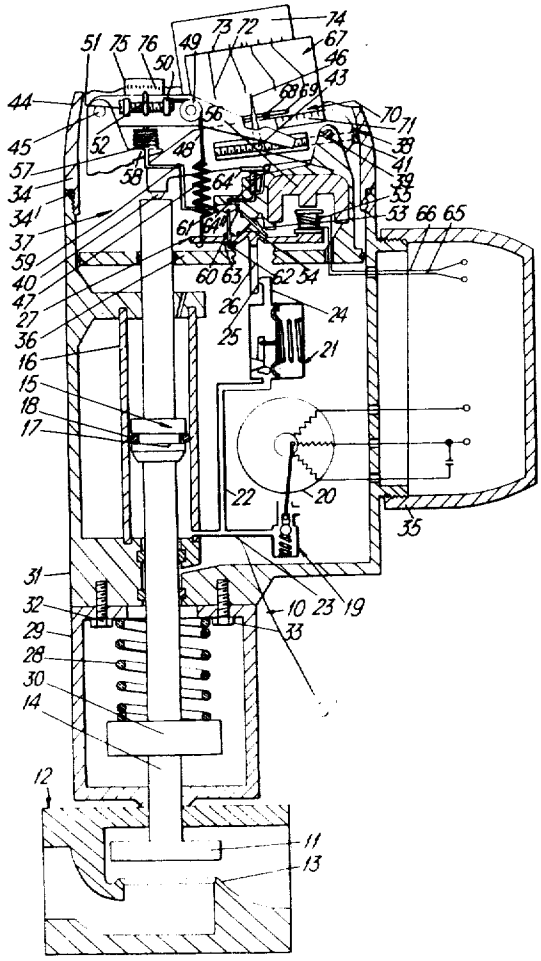
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[57] **ABSTRACT**

An hydraulic system having calibration, bandwidth, and dash pot controls with indicators for each, and a dash pot adjustment.

3 Claims, 2 Drawing Figures



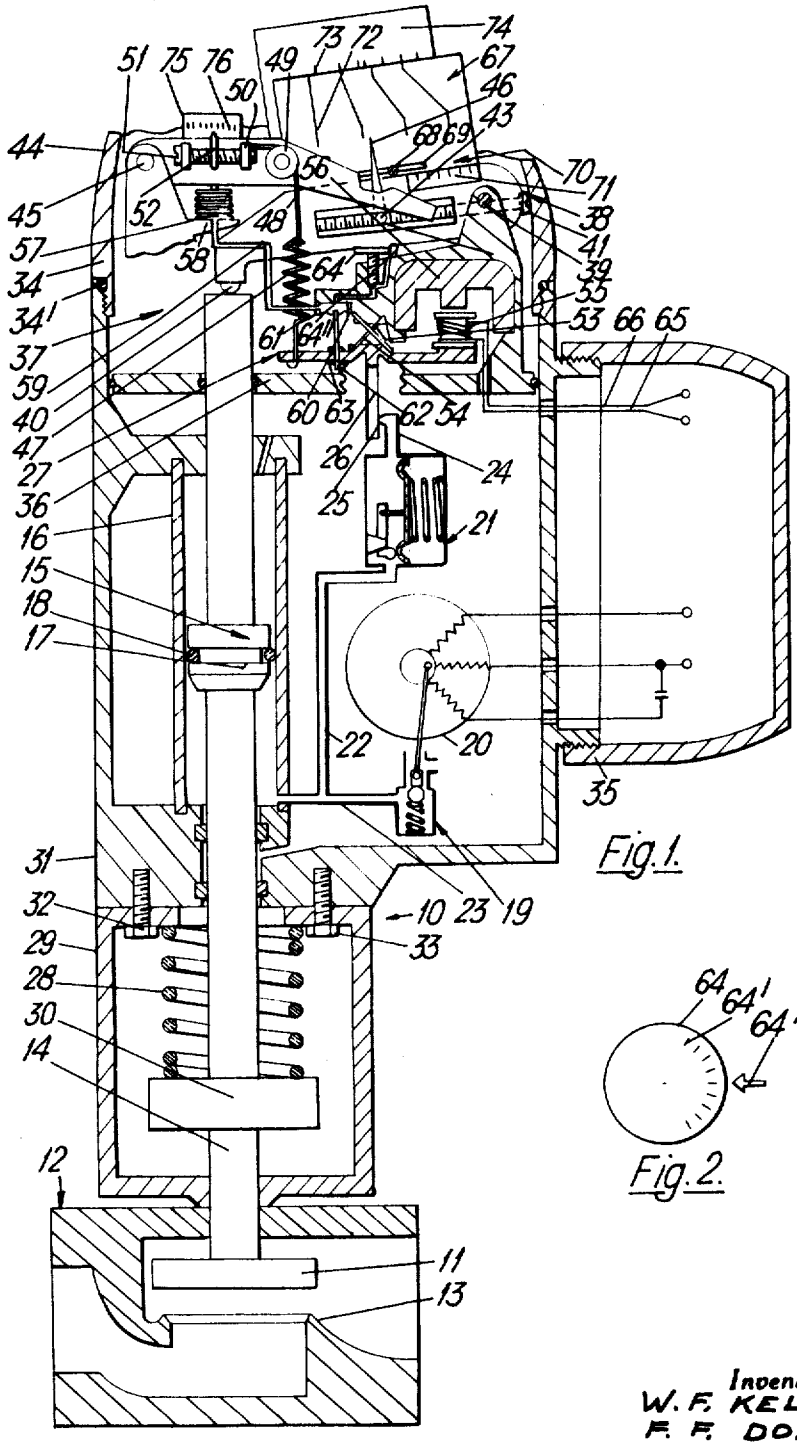


Fig. 1.

Fig. 2.

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HYDRAULIC CONTROL SYSTEM

This application is a division of co-pending application, Ser. No. 855,937 filed Sept. 8, 1969, now U.S. Pat. No. number 3,620,185, and having the same title. The benefit of the filing date of said co-pending application is hereby claimed for this application.

BACKGROUND OF THE INVENTION

This invention relates to hydraulic systems and, more particularly, to valve positioners or the like.

In the past, it has been the practice to calibrate a valve positioner by adjusting the position of a threaded shaft to vary the tension of a feedback spring. Such a device is disclosed in U.S. Pat. No. 3,101,031. Such devices are inaccurate and have no visual indication of calibration.

Bandwidth adjustments are also old in the art; however, these have required clumsy adjustment procedures. Further, no bandwidth indicators have been provided with a correction which is a function of stroke length.

It is also old in the art to provide negative feedback to a valve positioner and to adjust the feedback rate. However, such devices are complicated and have no visual indication of feedback rate.

SUMMARY OF THE INVENTION

In accordance with the devices of the present invention, the above-described and other disadvantages of the prior art are overcome by providing a movable suspension system for the feedback spring. The set point may, thus, be adjusted accurately.

In accordance with a feature of the invention, a visual indication of the set point adjustment is provided.

According to another feature of the invention, a bandwidth adjustment is provided including a lead screw and a nut therefor to operate a feedback lever.

Still another feature of the invention includes a bandwidth indicator scale having a lined connecting plate extending from the nut to the scale. The plate may, thus, be adjusted to make the scale read accurately for a particular length of stroke.

A further feature of the invention resides in the use of, for example, a pneumatic bellows or feedback. The output of the bellows operates a diaphragm. The diaphragm chamber is vented through a needle valve which carries a scale to indicate the reset adjustments.

The above-described and other advantages of the invention will be better understood from the following description when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, which are to be regarded as merely illustrative:

FIG. 1 is a vertical sectional view of a hydraulic control system constructed in accordance with the present invention; and

FIG. 2 is a top plan view of a needle valve assembly shown in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1, a valve positioner is indicated at 10. The valve to be positioned is indicated at 11 in a housing 12. Housing 12 includes a valve seat 13. Valve 11 is fixed to a piston rod 14. A piston 15 is fixed to rod 14. Cylinder 16 surrounds piston 15. Piston 15 has a groove 17 in which an O-ring 18 is positioned. O-ring 18 seals the space between piston 15 and cylinder 16. Piston 15 is moved upwardly by fluid pressure supplied by a pump 19 which is operated by an electric motor 20. The pressure below piston 15 is determined by a hydraulic amplifier 21 which receives an input from pump 19 through a conduit 22. The lower end of cylinder 16 is supplied with fluid under pressure by pump 19 through a conduit 23. Amplifier 21 has outlet conduit 24 with an orifice 25. Hydraulic fluid is bled from orifice 25 at a rate determined by the position of vane 26. Vane 26 is fixed to a beam 27. When amplifier 21 causes the pressure in conduit 23 to drop by bleeding sufficient hydraulic fluid through orifice 25, a spring 28 closes valve 11.

A body 29 encloses rod 14 and a follower 30 for spring 28, follower 30 being fixed to rod 14. Housing 29 is joined to an intermediate body portion 31 of positioner 10 at 32 and 33.

Positioner 10 has a body portion or end cover 34 and a body portion or side cover 35.

A divider and beam support 36 extends across body 31 near the upper end thereof. All of the structures shown in FIG. 1 below divider 36 may be entirely conventional. These devices may also operate in a conventional way, for example, as shown and described in U.S. Pat. No. 3,087,471. Thus valve 11 in this application corresponds to valve 10 in FIG. 5 in the patent. Conduit 23 in this application corresponds to conduit 17 in the patent. Piston 15 is the same in both. In the patent, a pump is indicated at 25, and an hydraulic amplifier is indicated between conduits 20 and 63.

In this application, in end cap 34, a control mechanism 37 is shown including an arm 38 pivoted on a shaft 39 by a ball bearing 40 carried thereby to rest on the upper end of piston rod 14. Arm 38 has a lead screw 41 threaded therethrough. Lead screw 41 may be turned to move a nut 42. Nut 42 has a projection 43 on which another arm 44 rests. Arm 44 is rotatable about a fixed shaft 45. An index marker 46 is also fixed to nut 42. A spring 47 is fixed to the left end of beam 27. The upper end of spring 47 is supported by a flexible strand 48. Strand 48 is movable over a pulley 49 with a nut 50. Nut 50 is moved by turning a lead screw 51 carried by arm 44. Lead screw 51 is threaded through an index marker 52.

Beam 27 is supported by flexure strips 53 and 54. A coil 55 is fixed to the right end of beam 27. The entire construction of the positioner 10 is made of non-magnetic materials with the exception of a body 56. Body 56 is made of a magnetic material.

A bellows 57 is located between arm 44 and a fixed projection 58. Bellows 57 has an output conduit 59 which extends into a chamber 60. Chamber 60 is enclosed with a diaphragm 61. Diaphragm 61 is connected to beam 27 by a fixed member 62. Chamber 60 has an outlet conduit 63 in which a needle valve 64 is disposed.

In the operation of positioner 10 shown in FIG. 1, the input is supplied electrically on leads 65 and 66 connected to coil 55. Piston 15 will then assume a position in accordance with the signal applied to leads 65 and 66. Should there be any variation in the system so that piston 15 assumes a position error, this will be reflected in a change in the position of beam 27. This is true because the position of piston 15 and, therefore, piston rod 14 will cause arm 38 to move up or down by engagement of ball 40 with the upper end of rod 14. This, in turn, will cause arm 44 to move because arm 44 rests on projection 43 of nut 42. Movement of arm 44 will then cause the spring 47 to supply more or less force to the left end of beam 27. The force supplied by spring 47 is, thus, balanced against the force supplied by coil 55 in its attraction for body 56. Note will be taken that when beam 27 tilts in a counterclockwise direction, orifice 25 is closed by vane 26; and the pressure in conduit 23 is increased. Tilting of beam 27 in a clockwise direction produces the opposite effect.

In accordance with the present invention, downward movement of arm 44 from the position shown causes bellows 57 to collapse. Downward movement of arm 44 is, therefore, retarded because air is not allowed to escape from bellows 57 except at a lower rate controlled by needle valve 64. Still further, negative feedback is provided in that the increased pressure in chamber 60 causes a counterclockwise movement on beam 27 through member 62.

It is a feature of the invention that bellows 57 is provided with chamber 60 for the negative feedback to provide damping. It is also a feature of the invention that needle valve 64 is provided to provide for the damping, yet insures final accurate correction.

Another feature of the invention resides in the use of indicia 64' and an index marker 64'' relative to needle valve 64 to indicate the reset action adjustment of needle valve 64.

An adjustment card 67 is fixed to arm 38 by a screw 68. Card 67 has a slot 69 therethrough. Screw 68 extends through slot 69. The position of card 67 may be adjusted along the length of arm 38 by loosening screw 68 and moving card 67 beneath screw 68. An index marker is provided on card 67 at 70. Arm 38 has an indicia 71 thereon positioned so that index marker 70 may be located relative thereto in a position corresponding to the stroke of valve 11 desired for a particular input signal on leads 65 and 66. In this position, by comparing marker 46 with indicia at 72 and 73, the percentage of proportional bandwidth may be read from indicia 73 on card 74 fixed to arm 38. The proportional bandwidth relates the range of input signal on leads 65 and 66 to the range thereon at a particular stroke setting.

Arm 44 has card 75 fixed thereto with indicia 76. Comparison of marker 52 with indicia 76 gives the set point of the positioner 10.

An airtight O-ring seal 34' keeps valve 64 and all the structures in end cap 34 dirt free.

From the foregoing, it will be appreciated that, by the use of lead screw 51, it is possible to adjust the set point accurately. Further, indicia 76 provide a visual indication of the set point adjustment. A bandwidth adjustment is also provided including lead screw 41. Percentage of bandwidth is indicated by indicia 73 for any given stroke setting of card 67. The arrangement of bellows 57 with diaphragm 61 provides for negative feedback. Damping is simultaneously provided by bleeding air from bellows 17 through needle valve 74. The reset action is visible through indicia 64'.

What is claimed is:

1. A positioning device comprising: a base; a positionable member movably mounted on said base; first means mounted on said base having a fluid tight variable size chamber, said chamber being fluid tight except for an opening thereinto; second means fixed relative to said base having a fluid tight reservoir therein except for inlet and outlet openings through said second means; a first fluid tight conduit connected from said first means at said opening thereof to said second means at said inlet opening thereof; a second fluid tight conduit having one end connected to said second means outlet opening, the other end of said second conduit being open to provide a vent; third means mounted in said second conduit in a manner such that it can rest in a stationary position restricting the flow of fluid therethrough; fourth means mounted on said base and responsive to movement of said positionable member in one predetermined direction and in another direction opposite thereto to change the size of said chamber by decreasing and increasing its size, respectively, said change in chamber size causing a corresponding decrease or a corresponding increase in the pressure of the fluid inside said reservoir in accordance with the rate of movement of said positionable member and the size of said restriction; a balance beam pivoted on said base; fifth means mounted on said base in a manner to supply a variable input torque to said beam; sixth means mounted on said base, said sixth means being responsive to the angular position of said beam for moving said positionable member in said one direction or in said other direction in accordance with plus or minus the angular position of said beam relative to a neutral position; seventh means mounted on said base in a position to apply a first negative feedback torque to said beam in accordance with the pressure of the fluid in said reservior, said first feedback torque being supplied in a direction opposite that in which said input torque is supplied; and eighth means mounted on said base and connected to said beam, said eighth means being responsive to movement of said positionable member for applying a second negative feedback torque to said beam in accordance with the position of said positionable member, said eighth means being connected to said beam in a position to supply a torque thereto in a direction opposite to that in which said input torque is supplied.

2. The invention as defined in claim 1, wherein said eighth means includes a body mounted for movement on said base, said body being mounted in a manner to move in accordance with the movement of said positionable member, and a spring having one of its ends connected to said beam and the other of its ends connected to said body to apply a force on said beam at the said connection of the said one end thereof and in a manner to establish said second negative feedback torque.

3. The invention as defined in claim 2, wherein said seventh means includes a corrugated flexible diaphragm mounted on said second means in a position enclosing said reservior and link having one end fixed relative to said diaphragm centrally thereof and another end connected to said beam, said third means including an adjustable needle valve, said valve having a control knob rotatably mounted relative to said base, said knob having indicia thereon, and an index marker fixed relative to said base in juxtaposition to said indicia to indicate the valve position by the relationship between said marker and said indicia.

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