Aug. 17, 1965 C. S. EINSIEDLER 3,200,717

HYDRAULIC PRESSURE VOLUME TRANSFORMER

Filed April 11, 1963

2 Sheets-Sheet 1

FIG. 1

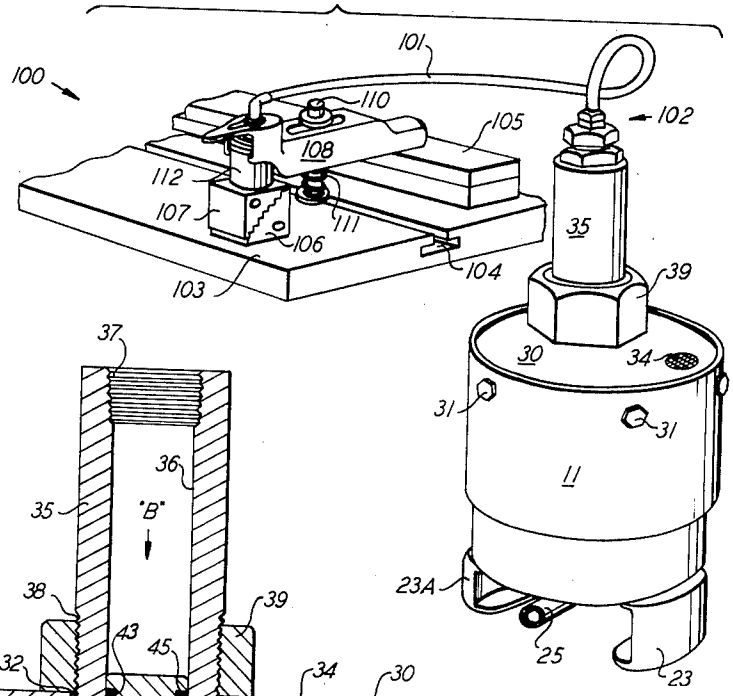
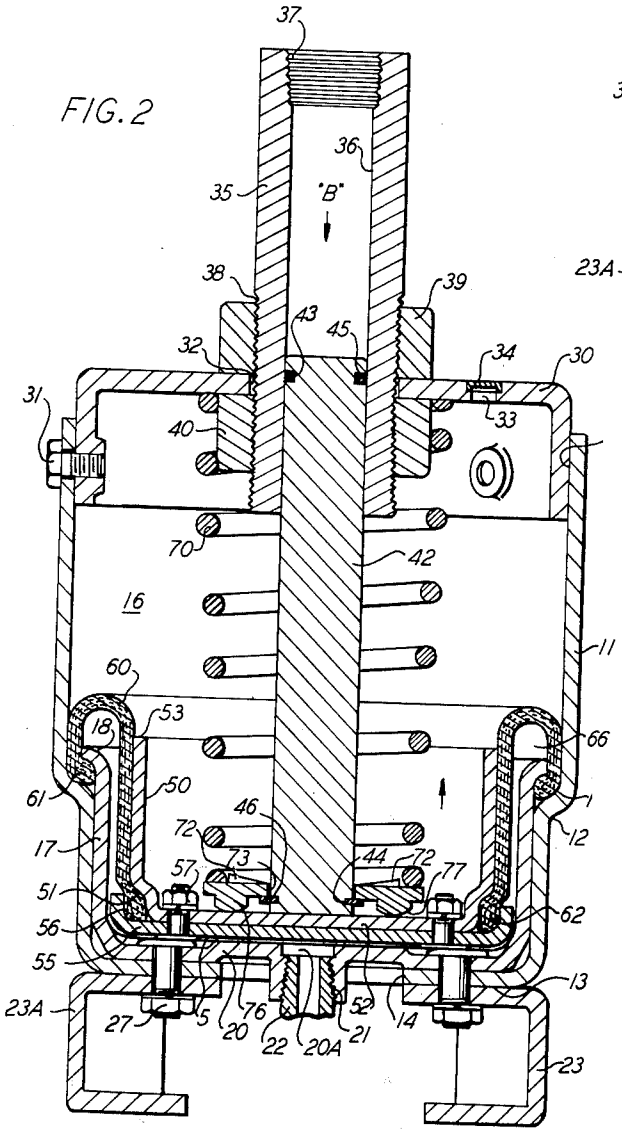


FIG. 2



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2 Sheets-Sheet 2

FIG. 3

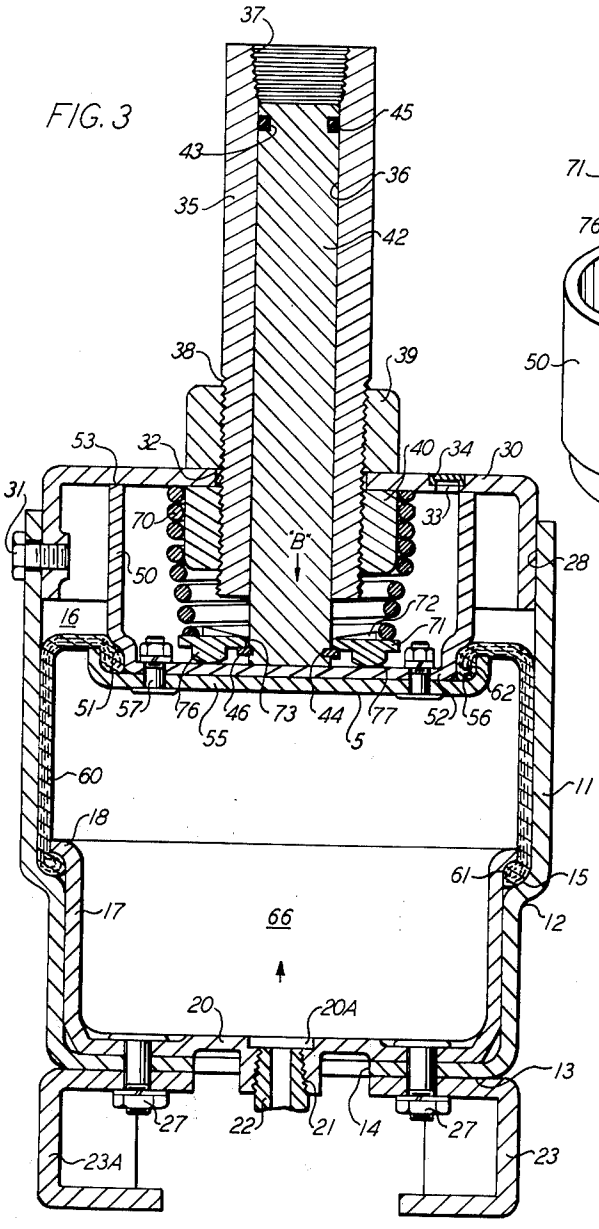
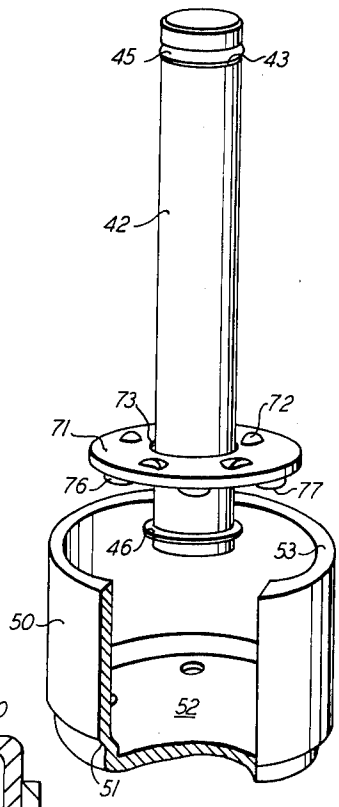


FIG. 4



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HYDRAULIC PRESSURE VOLUME TRANSFORMER

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4 Claims. (Cl. 92—94)

The present invention relates to hydraulic presure volume transformers and more particularly to a piston having a large area low pressure surface on one end and a small area high pressure surface on the other end.

An object of the present invention is to transform a relatively large volume of fluid under low pressure acting on a piston head into a smaller volume of fluid having a relatively high pressure at the opposite end of a piston rod; the piston rod being actuated by but disconnected from a piston head.

The present invention has particular application to fluid pressure clamps, such as disclosed in my U.S. Patent #3,078,088 for a Fluid Pressure Actuated Clamp where the small volume of high fluid pressure is used to actuate the fluid pressure clamp.

Another object of the present invention is to provide a piston with rod separated from the head and with a tiltable spring seat connection between rod and head in one direction of movement of the piston and with the rod abuting the head in the opposite direction of movement of the head.

Another object of the present invention is to provide a low friction, self centering, long life, leak free, hydraulic piston.

Applicant submits that the present hydraulic pressure volume transformer embodies a new structural concept over prior art devices. For example U.S. Patent #2,909,035 for a Pressure Amplifying Device, is in effect a structually complicated multiple piston valve requiring many parts. Each part requires complicated machinery and highly skilled machine operations resulting in a very costly product of very limited pressure variation.

U.S. Patent No. 2,478,575 is for a Fluid Pressure Actuator wherein the push rod is rigily secured to a cup shaped follower.

The follower is located in a chamber and is attached to a flexible diaphragm. Fluid pressure acting on the base of the follower extends the flexible diaphragm which is free to float within the chamber. Consequently, the piston rod is seldom in absolutely vertical or centrally located position. While this patent does not disclose the concept of the push rod being a piston rod; to attach the push rod to a piston cylinder would cause binding and malfunction due to a misalignment of the rod within the piston cylinder. The misalignment is aggravated when the cup shaped follower is subjected to the pressure of a coil spring and gravity. This misalignment is partly due to the fact that the flexible diaphragm varies in wall thickness and uniform wall elasticity. In addition the spring does not exert a uniform pressure on a complete circumferential surface.

Applicant has adapted this construction and converted a fluid pressure actuator into a fluid pressure transformer, while solving the problem of piston rod alignment with a unique construction as will hereinafter appear.

Other objects of the present invention will become apparent in part and will be pointed out in part in the following specification and claims.

Referring to the drawings, in which like reference numerals refer to like parts:

FIGURE 1 is a perspective view of the new and improved hydraulic pressure volume transformer as applied to a fluid pressure actuated clamp.

FIGURE 2 is a medial vertical cross sectional view

of the new and improved hydraulic pressure volume transformer, with the piston at rest, and with pipe connections and fluid pressure actuated clamp left off.

FIGURE 3 is a view, similar to FIGURE 2, showing the piston at the top of a work stroke.

FIGURE 4 is an exploded perspective view of the piston rod, cup shaped follower and spring seat.

In proceeding with this invention there is provided a casing 11, which may take the form of a cylinder, and having a circular flange 12 and a bottom portion 13 provided with an opening 14. A seat 15 is formed in cylindrical casing 11 by means of circular flange 12. A chamber 16 is formed in cylindrical casing 11.

An annular clamping ring 17 is provided with a flared end 18 and a bottom 20 having a port 21 which may be threaded to receive a pipe fitting 22 for suitable connection to a source of air pressure.

A plurality of stanchions or legs 23, 23A are provided to hold cylindrical casing 11 in upright position above a floor, bench or table (not shown), to allow a pipe 25 (see FIG. 1) to be united with pipe fitting 22.

A plurality of nut and bolt combinations 27 fasten bottom 20, bottom portion 13 and legs 23, 23A in relative position.

The top or open end 28 of cylindrical casing 11 is closed by means of a cover plate 30 inserted into the end 28 and maintained in this position by means of suitable cap screws 31. An enlarged bore 32 is centrally located in cover plate 30. A vent 33, having a screen 34 secured therein, is provided in cover plate 30.

A piston housing 35 provided with a piston rod seat 36, an internal thread 37 and an external thread 38 is located in enlarged bore 32 and maintained in relative position to cover plate 30 by means of nuts 39, 40. A piston rod 42 provided with an upper circular recess 43 and a lower circular recess 44 is slidably mounted in piston rod seat 36. An O ring 45 is located in upper circular recess 43. A snap ring 46 is located in lower circular recess 44.

A cup shaped follower 50 is provided with a beveled face 51, a base 52 and a top edge 53.

An upper clamping plate 55 is provided with a circular seat 56. A plurality of nut and bolt combinations 57 fasten upper clamping plate 55 and cup shaped follower 50 into relative position.

A flexible diaphragm 60 is provided with a lower annular portion 61 and an upper annular portion 62.

Lower annular portion 61 is gripped and thereby fastened between seat 15 and flared end 18. Nut and bolt combinations 27 are released and tightened to provide the gripping action. Upper annular portion 62 is gripped and thereby fastened between beveled face 51 and circular seat 56. Nut and bolt combinations 57 are released and tightened to provide the gripping action.

Annular clamping ring 17, flexible diaphragm 60 and upper clamping plate 55 form a pressure cavity 66 within chamber 16 (see FIGURE 3)

It will be observed (see FIG. 2) that air entering pipe fitting 22 will act against the bottom of upper clamping plate 55 to push or lift said upper clamping plate 55, cup shaper follower 50 and flexible diaphragm 60 upward in the direction of the arrow and into the position shown in FIGURE 3 wherein top edge 53 abuts cover plate 30. It will be noted that cup shaped follower 50 is free to float freely in chamber 16. The unfolding of the flexible diaphragm from the position shown in FIGURE 2 to the position shown in FIGURE 3 has no guide means to assure that the base 52 of cup shaped follower 50 will move (vertically) upward in a horizontal plane without tilting. On the contrary, base 52 will normally move upward in a tilted position. As base 52 moves

upward it pushes piston rod 42 into piston rod seat 36. Since the bottom of piston rod 42 is not attached to base 52 the tilting of said base 52 does not affect the sliding movement of the piston rod 42 within piston rod seat 36. However, the release of air pressure through pipe fitting 22 is not sufficient to cause cup shape follower 50, upper clamping plate 55 and flexible diaphragm 60 to move from the extended position, FIGURE 3, to folded position, FIGURE 2. Also piston rod 42 will not move downward under the force of gravity with any degree of speed because of the "sliding fit" relationship between it and piston rod seat 36.

In order to effect a rapid positive acting return of the piston rod 42 from extended position, FIGURE 3, to initial starting position, FIGURE 2, a coil spring 70 is provided with one end abutting the underside of cover plate 30. A spring seat 71, which may take the form of a disk, and be provided with a plurality of ears 72, is slidably mounted through an axial orifice 73 upon piston rod 42. One end of coil spring 70 bears against spring seat 71, with ears 72 engaging the inside of the last convolution of coil spring 70 to centrally position coil spring 70 in relation to piston rod 42. Nut 40 will center the other end of coil spring 70.

In order to prevent the tilting of base 52 from being transferred to spring seat 71 in the downward travel of cup shaped follower 50 under the force of coil spring 70, spring seat 71 is provided with a plurality of buttons 76 having crowned faces 77. Snap ring 46 is engaged by the underside of spring seat 71 to move piston rod 42 downwardly, in the direction of arrow B FIGURE 3. The crowned surfaces 77 engage cup shaped follower 50 so that tilting of said follower 50 is not transferred to spring seat 71. The angle of tilt is not reflected in spring seat 71 which is held in a horizontal plane by the force of coil spring 70 and the engagement of one or more of the crowned faces 77 against the bottom 52 of cup shaped follower 50.

In operation air under pressure is admitted through pipe fitting 22 into said cavity 66 where the air pressure acts against the underside 5 of upper clamping plate 55 and against the force of coil spring 70. The air pressure will move upper clamping plate 55 from the position shown in FIGURE 2 to the position shown in FIGURE 3, thereby distending flexible diaphragm 60.

It will be observed in FIGURE 2 that bottom 20 is provided with a counterbored area 20A so that the fluid under pressure may always directly contact upper clamping plate 55 or in the broader sense, contact the piston head in an area sufficiently large to initially start the work stroke of the piston.

Attention is now directed to FIGURE 1 wherein is illustrated a fluid pressure actuated clamp, generally designated by reference numeral 100, connected by means of a hose or conduit 101 to internal thread 37 by means of a threaded pipe connection generally indicated by reference numeral 102.

The clamp 100 is mounted upon a table 103 having a T slot 104. Table 103 may represent a machine tool such as a milling machine. A work piece 105 or piece to be clamped is placed upon table 103. A set of height blocks 106, 107 are also placed upon table 103 and are adjusted to a height substantially equal to the height of work piece 105. A clamping lever 108 is positioned over table 103 by means of a T bolt 110 and spring 111. The bolt 10 is slidably adjustable in T slot 104. Clamping lever 108 engages work piece 105 with one end. A fluid pressure actuated piston 112 is positioned between blocks 106, 107 and the other end of clamping lever 108. Conduit 101 is connected to piston 112 whereby hydraulic fluid located in the chamber defined by piston rod seat 36, and in conduit 101 will actuate piston 112 to perform the work clamping function of clamping lever 108 upon movement of piston rod 42 in piston rod seat 36. The movement of piston rod 42 in the direction of arrow B relieves the pressure acting on piston 112. The pressure required to provide the clamping action for clamp 100 through piston 112 is very high. Pressures in the eight to ten thousand p.s.i. range are contemplated. Piston rod 42 must function rapidly and freely without binding in piston rod seat 36. Binding would create a malfunction. It will be noted that piston rod 42 is free to slide in piston rod seat 36 regardless of the angle of tilt assumed by follower 50. It also will be noted that follower 50 is free to float out of vertical alignment anywhere in chamber 16 due to the inherent flexibility of flexible diaphragm 60. Since a permanent connection is lacking between piston rod 42 and follower 50, the floating and tilting characteristics of follower 50 do not affect the vertical alignment of piston rod 42 in piston rod seat 36. The return stroke of piston rod 42 under the influence of spring 70 reassures horizontal alignment of follower 50 through spring seat 71.

Having shown and described preferred embodiments of the present invention, by way of example, it should be realized that structural changes could be made and other examples given without departing from either the spirit or scope of this invention.

What I claim is:

1. A hydraulic pressure volume transformer consisting of a casing defining a chamber, means providing a conduit connection to said chamber, a cover plate, means fastening said cover plate to said casing, a piston housing provided with a positon rod seat, means fastening said piston housing to said cover plate, a piston rod slidably mounted in said piston rod seat and extending into said chamber, a follower, a flexible diaphragm provided with an annular portion, means securing said annular portion to said casing, and means fastening said follower to said flexible diaphragm, a spring seat, means mounting said spring seat upon said piston rod for sliding angular movement of said spring seat upon said piston rod, and abutting means on said piston rod engageable and disengageable with said spring seat to limit the sliding movement of said spring seat on said piston rod in one direction, said spring seat engaging said follower, and resilient means acting upon said spring seat to yieldingly force said piston rod through said abutting means, said follower and said flexible diaphragm into a preselected position within said chamber; said conduit connection to said chamber providing means to move said flexible diaphragm, said follower and said spring seat against the force of said resilient means and to move said piston rod in said piston rod seat through engagement of one end of said piston rod with said follower.

2. A hydraulic pressure volume transformer consisting of a casing defining a chamber, means providing a conduit connection to said chamber, a cover plate, means fastening said cover plate to said casing, a piston housing provided with a piston rod seat, means fastening said piston housing to said cover plate, a piston rod slidably mounted in said piston rod seat and extending into said chamber, a follower, a flexible diaphragm provided with a lower annular portion, and an upper annular portion, means securing said lower annular portion to said casing and means securing said upper annular portion to said follower, a spring seat, means mounting said spring seat upon said piston rod for sliding movement and for angular movement, said spring seat engaging said follower, and resilient means acting upon said spring seat to yieldingly force said piston rod, said follower and said flexible diaphragm into a preselected position within said chamber.

3. A hydraulic pressure volume transformer consisting of a cylindrical casing forming a chamber, an annular clamping ring, means fastening said annular clamping ring to said cylindrical casing, and means providing a conduit connection to said chamber, a cover plate having an enlarged bore, means fastening said cover plate to said cylindrical casing, a member provided with a piston

rod seat, means fastening said member to said cover plate, said member being located in said enlarged bore and in communication with said chamber, a piston rod slidably mounted in said piston rod seat, a cup shaped follower, an upper clamping plate, means fastening said upper clamping plate to said cup shaped follower, a flexible diaphragm provided with a lower annular portion and an upper annular portion, said lower annular portion located and secured between said annular clamping ring and said cylindrical casing, said upper annular portion located and secured between said cup shaped follower and said upper clamping plate, a spring seat having a central aperture, means mounting said spring seat upon said piston rod through said central aperture for sliding angular movement, and resilient means acting upon said spring seat to yieldingly urge said piston rod into a preselected position within said piston rod seat with said spring seat engaging said cup shaped follower to yieldingly hold said cup shaped follower in a preselected position within said chamber, the end of said piston rod engaging said cup shaped follower upon movement of said cup shaped follower against the forces of said resilient means.

4. A hydraulic pressure volume transformer consisting of a cylindrical casing having a circular flange, a bottom portion having an opening, and a seat formed in said circular flange, said circular casing defining a chamber, an annular clamping ring provided with a flared end and a bottom having a threaded port, means removably securing said annular clamping ring to said bottom portion, a cover plate provided with a centrally located enlarged bore and a venting orifice, means fastening said cover plate to said cylindrical casing to form one end of said chamber, said venting orifice venting said chamber to the atmosphere, a member provided with a piston rod seat located in said enlarged bore, means adjustably securing said member to said cover plate with said member projecting into said chamber, a piston rod provided with an upper circular recess and a lower circular recess, slidably mounted in said piston rod seat, fluid tight packing

located in said upper circular recess and slidably engaging said piston rod seat, a snap ring located in said lower circular recess, a cup shaped follower provided with a beveled face, a bottom and a top edge, an upper clamping plate provided with a circular seat, means removably securing said upper clamping plate to said cup shaped follower, a flexible diaphragm provided with a lower annular portion and an upper annular portion, said lower annular portion being gripped between said seat formed in said circular flange and the flared end of said annular clamping ring, said upper annular portion being gripped between said beveled face and said circular seat, a spring seat provided with a plurality of ears, an axial orifice, and said spring seat being slidably mounted upon said piston rod through said axial orifice, said spring seat provided with a plurality of buttons, having crowned faces, said spring seat being slidably mounted upon said piston rod with said crowned faces engageable with said cup shaped follower and abutting said snap ring, and a coil spring located in said chamber with one end of said coil spring abutting said cover plate and the other end of said coil spring engaging said spring seat with said plurality of ears centrally locating said coil spring end, whereby said coil spring through said spring seat yieldingly urges said cup shaped follower, said piston rod and said flexible diaphragm into a preselected position within said chamber, the end of said piston rod engaging said cup shaped follower upon movement of said cup shaped follower against the forces of said coil spring.

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