July 22, 1958 W. V. RYDER, JR 2,844,415

HYDRAULIC PIVOT

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Fig. 2

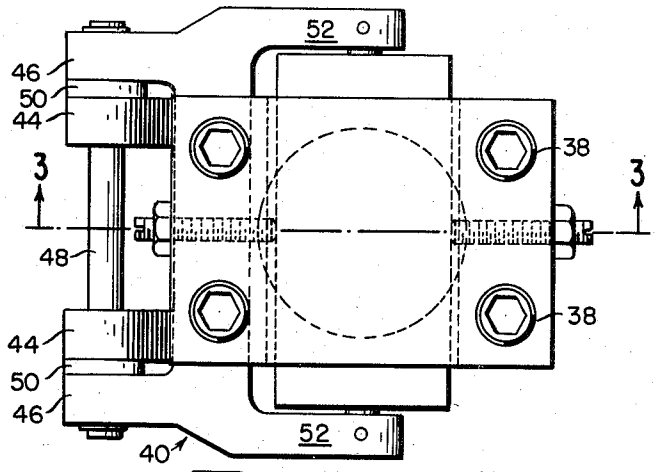


Fig. 3

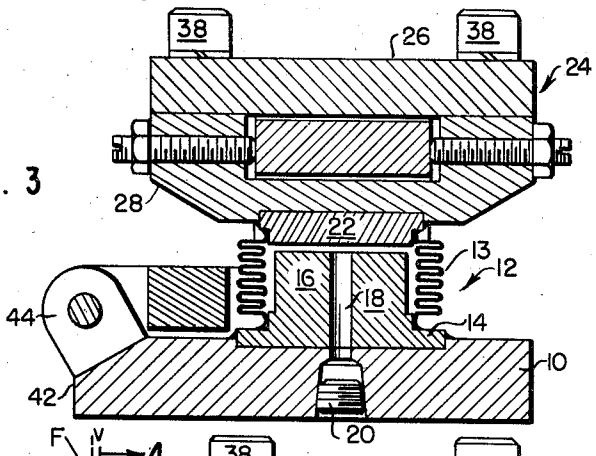


Fig. 1

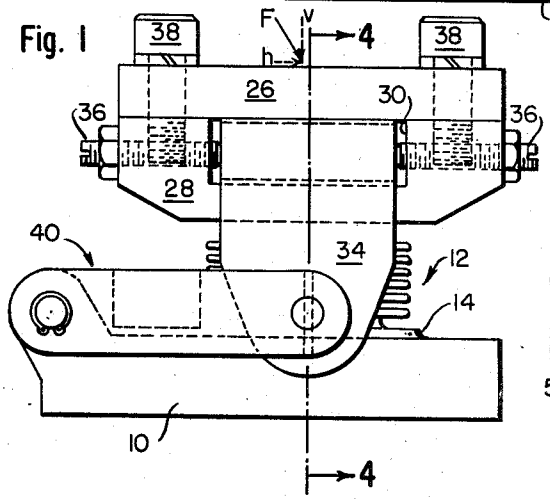
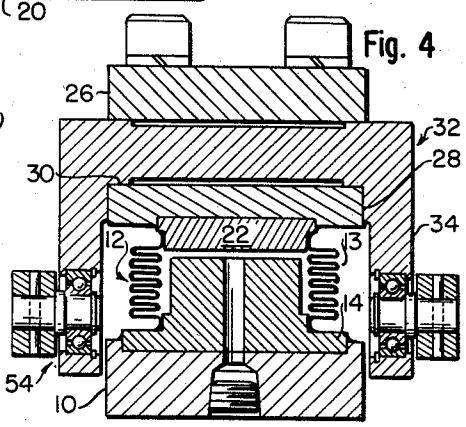


Fig. 4



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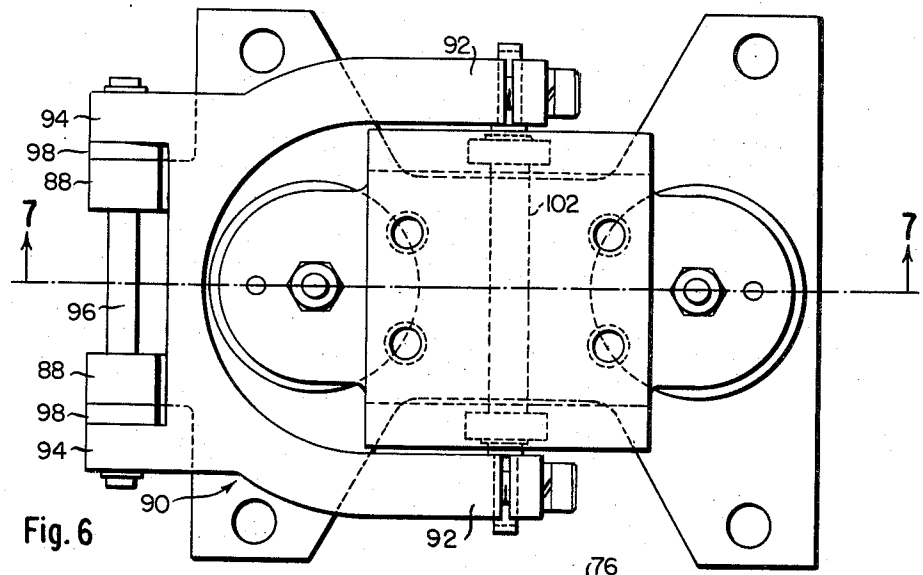


Fig. 6

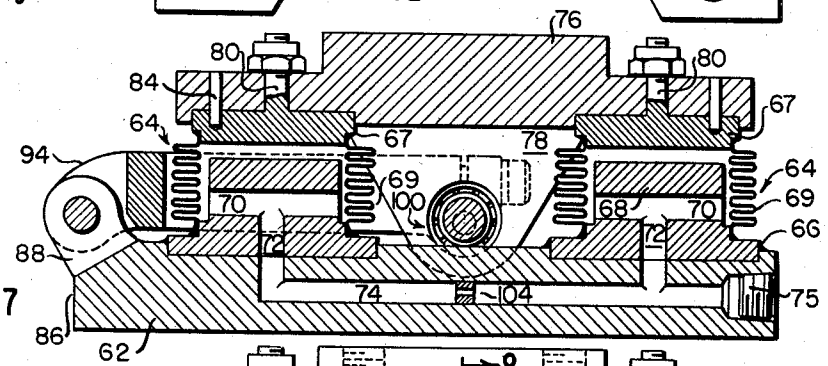


Fig. 7

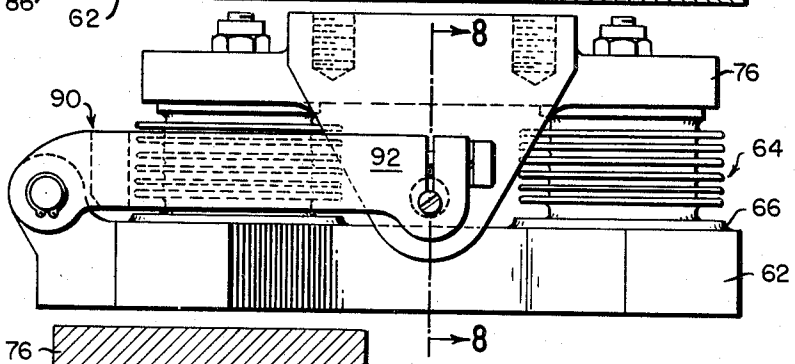


Fig. 5

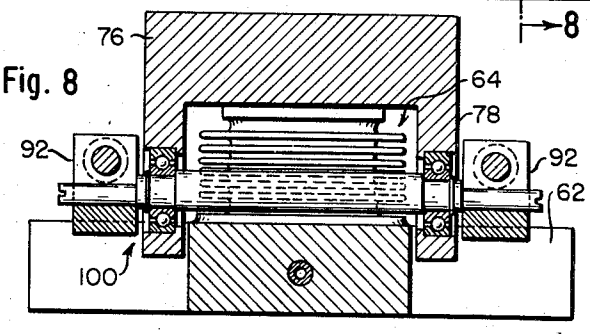


Fig. 8

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2,844,415

Patented July 22, 1958

2,844,415

HYDRAULIC PIVOT

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Application September 27, 1955, Serial No. 537,017

7 Claims. (Cl. 308—2)

This invention relates to pivotal mountings and provides a new and improved pivot suitable for use in many types of measuring instruments where large compressive forces are encountered.

One important object of my invention is to increase the lateral and compressive load carrying capacity of pivoted mountings while retaining free frictionless motion.

Another important object of my invention is to reduce frictional losses in a pivot which employs bearings to define the pivotal axis by reducing the load on the bearings.

To accomplish these and other objects my new and improved pivot includes as one important feature a sealed bellows filled with a substantially incompressible fluid having a low coefficient of expansion. The fluid gives to the pivot great compressive load carrying capacity.

As another important feature my pivot includes a fixed plate rigidly connected to one end of the bellows, a second plate secured to the other end of the bellows, and a link pivotally connected to each of the plates. This assembly furnishes lateral stability to the pivot.

These and other objects and features of my invention along with incident advantages will be better understood and appreciated from the following detailed description of a number of embodiments thereof selected for purposes of illustration and shown in the accompanying drawing in which:

Fig. 1 is a view in side elevation of a hydraulic pivot constructed in accordance with this invention,

Fig. 2 is a plan view of the pivot illustrated in Fig. 1,

Fig. 3 is a view in cross-section of the pivot shown in Fig. 1, taken along section line 3—3 of Fig. 2,

Fig. 4 is a view in cross-section of the pivot, taken along section line 4—4 of Fig. 1,

Fig. 5 is a view in side elevation of another hydraulic pivot constructed in accordance with this invention,

Fig. 6 is a plan view of the pivot shown in Fig. 5,

Fig. 7 is a view in cross-section of the pivot shown in Fig. 5, taken along section line 7—7 of Fig. 6, and

Fig. 8 is a view in cross-section of the pivot taken along section line 8—8 of Fig. 5.

The embodiment of my invention illustrated in Figs. 1–4 includes in its general organization a base 10, a bellows assembly 12 vertically mounted on the base 10, and a block 24 surmounted on the bellows assembly. The bellows assembly 12 includes a bellows 13 which may be constructed of extremely thin sheet steel, aluminum, or other material capable of withstanding high internal pressures.

The bellows is mounted coaxially about a cylindrical plug 16 formed with a base flange 14 which is soldered or welded to the bottom of the bellows, and the assembly is secured by the base flange to the upper surface of the base 10. To give the bellows 13 high compressive stability, the remaining portion of the bellows cavity is

filled with a substantially incompressible fluid such as glycerin or corn oil, and the cavity is sealed by a second flange 22 connected to the upper end of the bellows.

The block 24 is secured by an upper flange 22 to the top of the bellows assembly. The method of assembling the bellows mechanism will first be described. Initially, the flange 14 of the plug 16 and the flange 22 are secured to the ends of the bellows, and the assembly is mounted on the base 10. A bore 18 extending through the plug 16 and flange 14 registers with a threaded pipe connection 20 in the base to provide means for evacuating the bellows cavity. After the bellows is evacuated, a deaerated liquid is introduced into the cavity through the passage 18. A plug or similar device screwed into the connection 20 seals the passage. Although the bellows will permit lateral movement of the block relative to the base in the absence of some restraining means, the charged bellows restrains movement of the block toward the base and provides a flexible support having high compressive load carrying capacity. The block 24 consists essentially of a plate 28 having a recess 30 formed in its upper surface, and a cover 26 secured to the plate by a number of screws 38. A saddle 32 having vertical legs 34 extending downwardly on each side of the bellows is supported in the recess. The saddle 32 is somewhat narrower than the recess (see Fig. 3) and may be adjusted laterally by horizontal adjusting screws 36 extending through the plate 28 into the recess. The cover 26 secured to the plate retains the saddle in the recess but does not interfere with its lateral movement under the influence of the adjusting screws.

The saddle 32 is provided with downwardly extending legs 34 which are pivotally mounted by ball bearings 54 between opposed arms 52 of a bifurcated link 40. The link 40 is hinged at its other end to the base 10 by means of ears 44 formed in the base and ears 46 formed in the link and connected to the studs by a pin 48.

The saddle 32 and link 40 provide a connection between the block 24 and the base 10 resisting relative lateral motion but free to pivot and permitting motion of the block and base toward each other.

It will be noted that the axis of the bearings perpendicularly intersects the bellows axis approximately through the lowermost bellows convolution. It has been experimentally determined that such a location of the axis minimizes the tendency for varying pressures within the bellows to cause angular deflection of the pivot.

From the foregoing detailed description of the embodiment of the invention illustrated in Figs. 1–4 it will be seen that a force exerted vertically down on the block with its line of direction passing through the center of the bearing axis is opposed by the incompressible bellows; thus the block does not move appreciably. The bearings, therefore, receive substantially none of the load applied vertically to the device, and any couple which tends to pivot the block about the bearings is not resisted by large bearing friction. Since, however, all liquids are to some degree compressible, the bellows does not completely eliminate vertical movement of the block. The hinged connection between the support 42 and the link 40 is provided to compensate for any foreshortening of the bellows under the influence of the impressed forces, i. e. the connection allows the bearing assembly to move downwardly with the block so that the entire vertical load is borne by the slightly compressed bellows.

Assume that the vector F illustrated in Fig. 1 represents the impressed force. As has been demonstrated, the vertical component V of the vector does not substan-

tially affect the position of the block or the bearings. The link 40 and the member 32 resist translational movement of the block under the influence of the horizontal component *h* of the force. However, the bearing assembly does permit the horizontal component *h* to displace the block angularly about the bearing axis, and the pivotal movement of the block will be substantially frictionless.

If the force F is applied 90 degrees from the position illustrated so that the horizontal component *h* lies perpendicular to the plane of the paper, translational movement of the block will be opposed by the hinge support 42 rigidly connected to the link. A spacer 50 separating the studs 44 and ears 46 prevents axial movement of the link 32 on the hinge pin 48. Because the bellows resists movement of the block 24 under the influence of the vertical component *v* of the force and the horizontal component *h* is opposed by the support 42 and the hinge 40, the position of the block does not change.

The foregoing analysis demonstrates that the mechanism establishes a fixed pivotal axis comparable to that of a knife edge and anvil. Frictional losses are extremely small because the vertical component of a load applied to the block 24 is supported by the bellows and not the bearings. Bearing friction may be affected only by increases in the horizontal component of forces impressed on the block. These characteristics of the device render it particularly well suited to resist forces having large vertical components as compared to the magnitude of its horizontal component. The device will render long service without appreciable wear.

The instrument illustrated in Figs. 5–8 is very similar to the embodiment of this invention described above. The addition of a second bellows in the assembly, however, permits damping of the movement of the block and otherwise provides advantages not obtained from the simpler embodiment. In detail, a base 62 carries a pair of bellows assemblies 64 comprising flanges 66 and 67, plugs 68 and the bellows 69. The lower bellows flanges 66 may be secured to the base by welding or other appropriate means. Lateral passages 70 in each of the plugs communicate with vertical passages 72 formed in the flanges 66 and the base 62, and together with the interconnecting passage 74, provide access to the bellows chambers. A threaded pipe connection 75 at the end of the passage 74 permits evacuating and charging of the bellows chambers in the manner described in the preceding embodiment.

Studs 80 integrally formed with the flanges 67 hold a block 76 on top of the bellows assemblies 64. Dowel pins 84 driven through the block 76 and into the flanges 67 prevent relative twisting of those elements. Vertical flanges 78 extend downwardly from the block 76 and receive a horizontal pivot shaft 102 positioned between the bellows assemblies 64.

The components which complete the mechanism are similar to the corresponding components of the preceding embodiment. A hinge support 86 cast with the base has a pair of ears 88 which mate with ears 94 of a link 90. A hinge pin 96 interconnects the ears 88 and 94 and permits the link to pivot about the pin axis. A pair of arms 92 forming part of the link 90 extend horizontally from the ears 94 and terminate about the axis of the shaft 102. Bearing assemblies 100 support the shaft 102 in the terminal portions of the arms 92. The shaft 102, the bearing assemblies 100, and the bellows 69 define the pivotal axis about which the block moves under the influence of impressed forces.

In use, the bellows chambers along with the passages 70, 72, and 74 are filled with an incompressible liquid. Unable to compress, each of the bellows resists vertical movement of the block, thus shielding the bearing assemblies 100 from all vertical forces passing through the pivotal axis. If a torque is applied about the axis of the shaft 102, fluid transfers from one bellows to the other through the interconnecting passages. The transfer of liquid results in substantially frictionless angular displacement of the block 76 about the axis of the shaft 102. The link 90 and the hinge support 86 resist all translational movement of the block in the same manner as set forth in the description of the preceding embodiment.

It is often desirable to deaden the effects of sudden extraneous forces sensed by the device. The passage 74 provides ready means for dampening the system. By introducing a partial restriction or orifice 104 into the passage, the rate of flow of the fluid between the bellows is reduced and instantaneous forces applied to the block have little or no effect.

From the foregoing description, the advantages of the hydraulic pivots may be fully appreciated. Either of the assemblies may be incorporated into any device which requires a substantially frictionless fulcrum. They provide a pivotal axis as clearly defined as the fulcrum of a knife edge assembly.

Those skilled in the art will readily appreciate that numerous modifications of the illustrated embodiments may be made without departing from the spirit of my invention. Therefore, it is not intended that the scope of my invention be limited to those embodiments illustrated and described, but that its breadth be determined by the appended claims and their equivalents.

Having thus disclosed my invention what I claim as new and desire to secure by Letters Patent of the United States is:

1. A hydraulic pivot comprising a pair of spaced apart rigid members, a pair of parallel bellows rigidly secured between said members charged with an incompressible fluid, a passage providing fluid communication between said bellows, and linking means interconnecting said members having hingedly connected portions providing a pivotal axis for said members between said bellows perpendicular to the bellows' axes.

2. A hydraulic pivot as defined in claim 1 further characterized by damping means in said passage retarding fluid flow through said passage.

3. A hydraulic pivot comprising a pair of spaced apart members, an incompressible bellows assembly rigidly secured to each of said members with the assembly axis perpendicular to each of said members, a link pivotally secured to one of said members along an axis perpendicular to and intersecting the axis of said bellows assembly, and a pivotal connection between said link and the other of said members disposed parallel to the pivotal connection of said link and the first named member.

4. A hydraulic pivot comprising a pair of spaced members, a pair of parallel bellows each of which is secured at each end to one of said members, a passage providing fluid communication between said bellows, said passage and said bellows being charged with a substantially incompressible fluid, and a link hinged upon a first one of said members and having a pair of arms pivotally connected to the second member, the pivot connection of the arms of the link and said second member being disposed along an axis perpendicular to and intermediate the long axes of said bellows.

5. A hydraulic pivot as defined in claim 4 wherein the hinge connection of the link to said first member is disposed about an axis parallel to the axis of the pivot connection between the arms of the link and said second member.

6. A hydraulic pivot as defined in claim 4 wherein damping means is provided in said passage to retard the flow of fluid therethrough.

7. A hydraulic pivot comprising first and second members, a bellows secured at each end to one of said members, a saddle-shaped member adjustably secured to the first of said members and having parallel end members extending toward the second member, a link hinged to said second member and having a pair of arms pivotally

connected to the end members of said saddle-shaped member, the pivot connection between the end members and arms of the link being disposed along an axis perpendicular to the long axis of the bellows, and means disposed in one of said members forming a passage to the interior of the bellows.

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