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Ifield

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[54] **JOURNAL SUPPORT BEARINGS FOR ROTATING SHAFTS**

[75] Inventor: **Richard Joseph Ifield,** New South Wales, Australia

[73] Assignee: **Ifield Laboratories Pty. Limited,** New South Wales, Australia

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[30] **Foreign Application Priority Data**

Nov. 30, 1970 Australia 3338/70

[52] **U.S. Cl.** **308/9,** 308/73

[51] **Int. Cl.** **F16c 7/04,** F16c 17/06

[58] **Field of Search** 308/73, 122, 9

[56] **References Cited**

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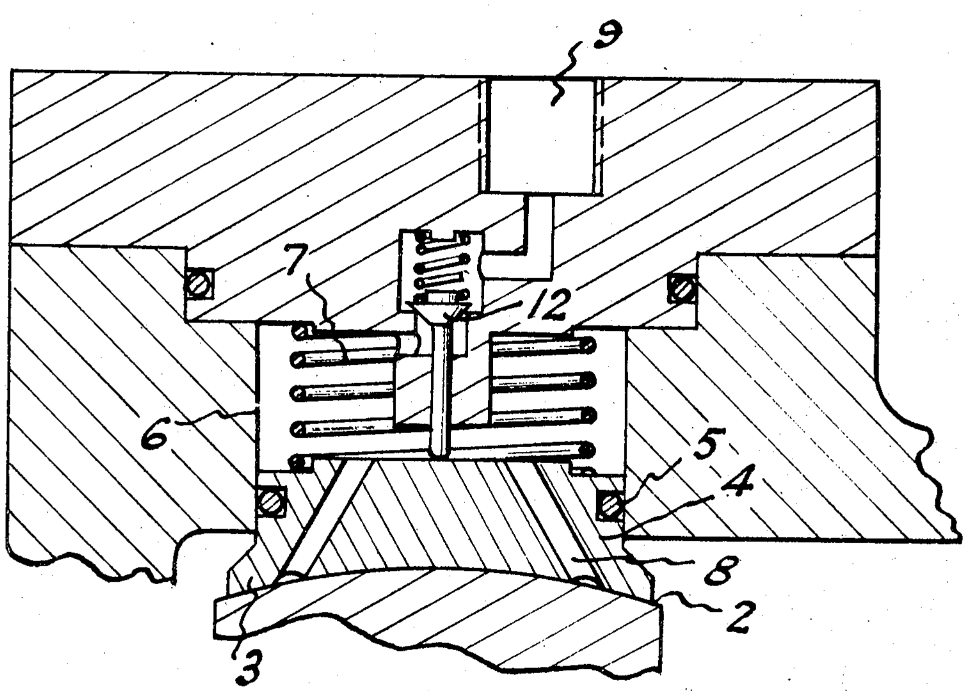
Primary Examiner—Charles J. Myhre
Assistant Examiner—Frank Susko
Attorney, Agent, or Firm—Stevens, Davis, Miller & Mosher

[57] **ABSTRACT**

Journal support bearings for rotating shafts which comprise at least one hydro-statically balanced slipper positioned within a stationary housing. Each slipper has a hollow spherical surface which is adapted to bear on a part spherical surface formed on a shaft about its axis of rotation. Each slipper is either cut out at its center or has grooves in its surface to define a narrow sealing land around the periphery of the surface.

5 Claims, 6 Drawing Figures



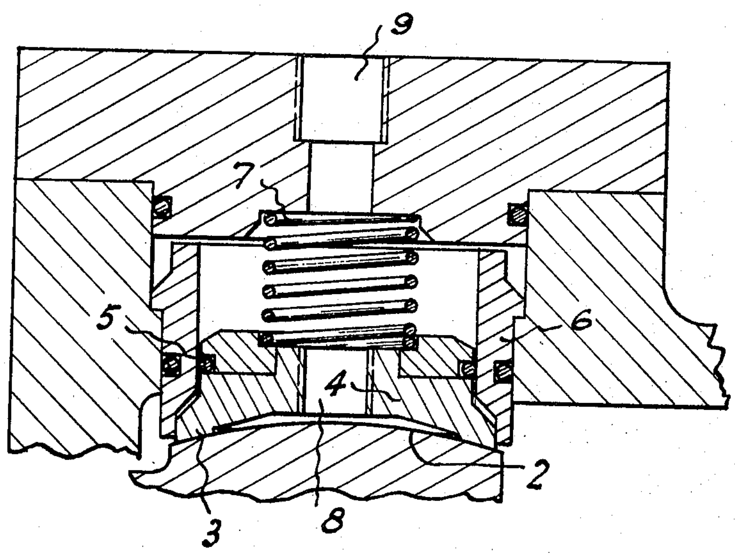


FIG. 1.

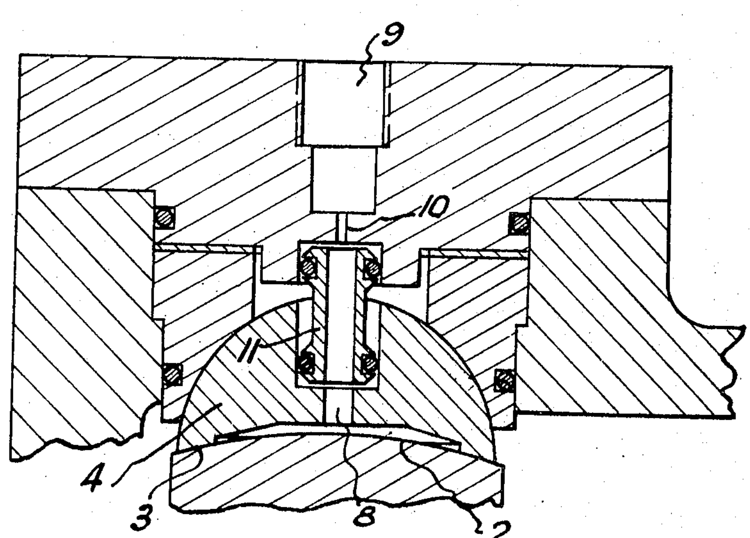


FIG 2.

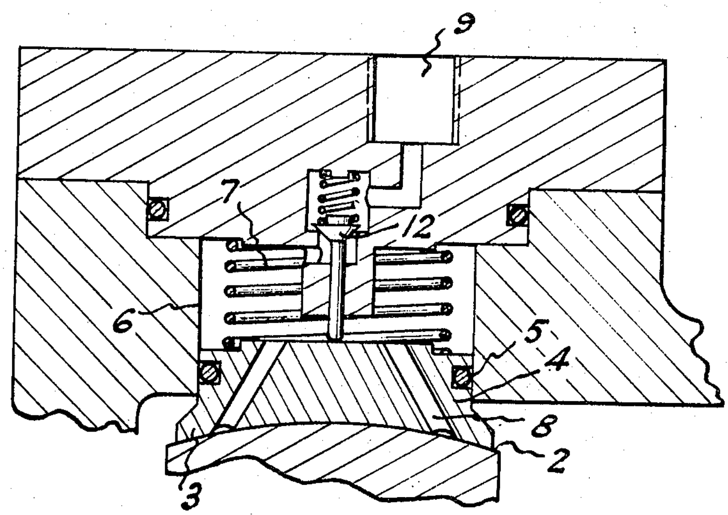


FIG. 3.

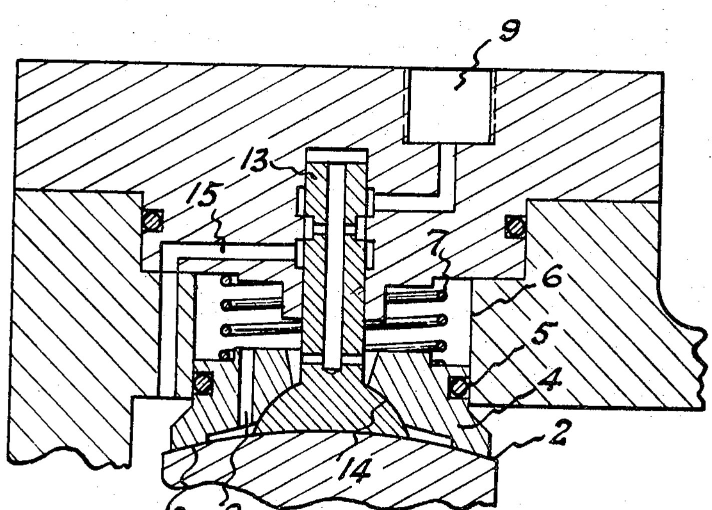


FIG. 4.

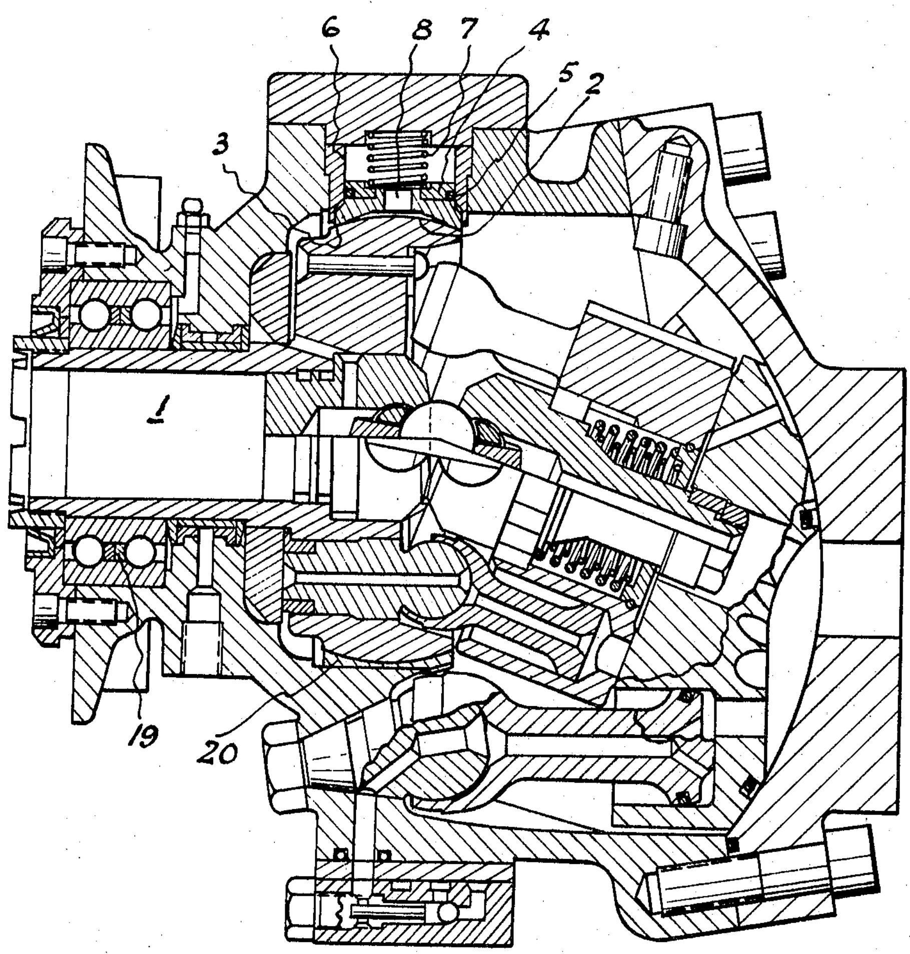
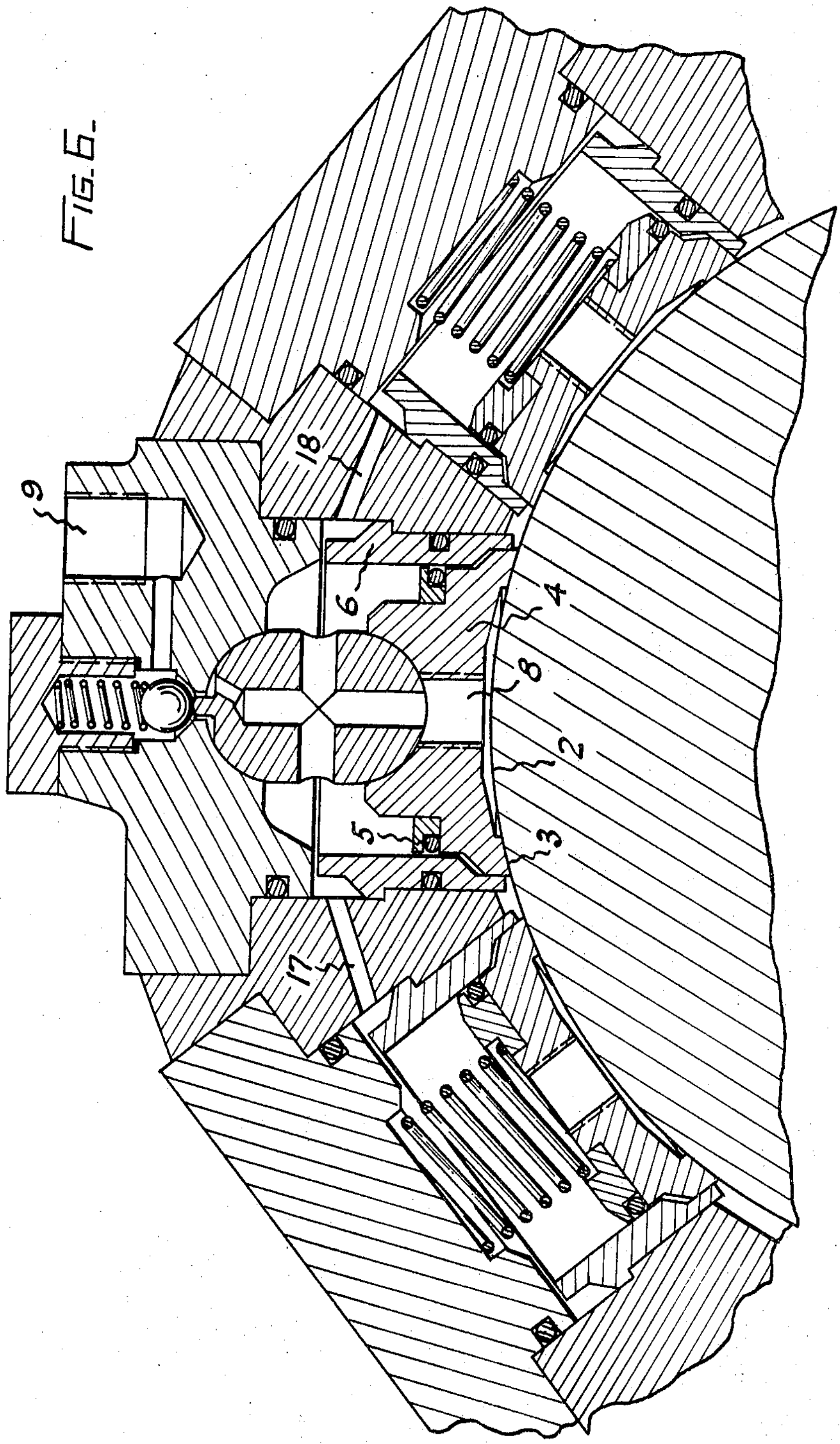


FIG. 5.

FIG. 6.



JOURNAL SUPPORT BEARINGS FOR ROTATING SHAFTS

This invention relates to a hydro-static pressure balanced journal slipper, characterised in having a hollow part spherical surface, in sliding contact with a part spherical journal surface, the slipper surface having a sliding sealing land, bounding an area fed from a high pressure liquid supply, to support the journal loading.

Normally the shaft is located by other bearings and the hydro-statically balanced slipper is appropriately positioned to support the major journal loadings.

Preferably the journal slipper according to the invention is circular in end view and is substantially symmetrical about its radial centreline, so that deformation under load is uniform and will not result in leakages at the sealing land.

In some applications the journal loading is constant; in these cases the pressure supply may be adjusted to a value appropriate to the loading and to the effective area of the slipper. In some applications, as for the journals of fixed displacement axial piston pumps or motors, the journal loading is proportional to the pressure in the ports; in these cases the port pressure may be fed directly to a slipper having an appropriate effective area. In other applications the journal loading may respond to several variables; for example, in variable displacement axial piston pumps, the journal loading may be proportional to the product of the port pressure and the pump displacement.

FIGS. **1** to **4** of the accompanying drawings show various arrangements of the journal slipper according to the invention, but the invention is not limited to these detail designs or methods for controlling the hydrostatic pressure.

FIG. **5** shows the present invention as applied to a variable displacement pump drive shaft.

FIG. **6** shows the present invention utilizing a plurality of slippers.

Referring to FIG. **1**, a shaft has a part spherical journal portion **2** sliding within the part spherical sealing lands **3** of the slipper **4**. The slipper which is circular in end view, has a cylindrical portion fitted with a seal **5** and it is free to slide radially in the stationary cylinder **6**, the effective area of which is substantially equal to the effective projected area of the sealing land at the sliding surface. A spring **7** provides a relatively light initial bias, loading the slipper against the journal. A drilling **8** provides communication from the cylinder **6** to the relieved centre of the slipper surface. The high pressure supply is via the duct **9**.

The arrangement of the slipper as shown in FIG. **1** is suitable for balancing a known journal loading against a fixed supply pressure, or for applications where the journal loading is proportional to the supply pressure, as is the case when used for fixed displacement axial piston pumps and the supply pressure is the pressure at the high pressure port of the pump. For bi-directional pumps of this type a selector valve may be used to select whichever is the higher porting pressure as the supply pressure to duct **9**. Where both ports may be at high pressure a valve may be used to select a pressure which is the mean of the two port pressures, as the supply pressure to duct **9**.

In the other slipper arrangements of FIGS. **2, 3, 4** and **6**, elements having similar functions have similar identification numbers to those shown in FIG. **1**.

The journal loading may not be proportional to the supply pressure at duct **9**; for example, in an application to variable displacement axial piston pumps, the journal loading is proportional to the product of the displacement and the port pressures. In such cases it is necessary to provide means for automatically regulating the hydro-static balance pressure at the slipper and various means are shown at FIGS. **2, 3** and **4** to achieve this.

In FIG. **2**, the slipper body **4** is of hemispherical form fitting within a hemispherical cup in the stationary housing, so that the slipper surface can align itself to the journal. The supply pressure is fed through a restricted orifice **10** and a sealed bobbin **11** to the part spherical sliding surface of the slipper. When the pressure required to support the journal loading is less than the supply pressure at duct **9**, the journal moves slightly out of contact with the slipper surface, permitting a leakage flow at the sealing land **3**; this produces a pressure drop at the orifice **10** to maintain equilibrium conditions.

Instead of relieving the whole of the slipper surface inside the sealing lands, as shown in FIGS. **1** and **2**, the effective area may be determined by a circular groove fed by the slipper pressure as in FIG **3**. In this example a small valve **12**, closed by a spring, is fitted in the high pressure supply duct, to determine the radial position of the slipper under operating conditions. Any variation in journal loading moves the slipper radially to vary the opening of the valve **12**, to maintain the desired pressure balance, with a small leakage from the sliding sealing land **3** at the slipper surface.

FIG. **4** shows a slipper similar to FIG. **1** with the exception that it includes a spool valve **13** moved radially by the slipper through a hemi-spherical ball and socket connection **14**. The spool valve housing has a high pressure gallery from duct **9** and a discharge gallery from duct **15**. The valve has a gallery from a central drilling connected to the slipper cylinder. In this case any variation of journal loading causes the spool valve to move, varying the relative openings of the high pressure and low pressure ports to maintain the balance pressure to suit the loading.

In some applications it may be impractical to employ a slipper of sufficiently large diameter to support the journal loadings from the available pressure supply. In such cases a number of slippers may be disposed angularly about the centre of loading as in FIG. **6**. Preferably an odd number of slippers would be employed in these cases. The centre slipper may be as shown or one of the types illustrated at FIGS. **2, 3** or **4** and the other slippers may be of the type shown at FIG. **1** except for the omissions of the duct **9**. The required hydro-static pressure would be determined by the centre slipper and this pressure would be fed to the other slippers via ducts **17** and **18**.

In many applications the journal loading is a function of the driving torque, as it is in the case of many hydraulic pumps. In these cases the hydro-static balance pressure is proportional to the driving torque and this is of value, as a means of recording the torque, or for use with a torque limiting device, either by controlling the power input or the displacement of a driven pump.

FIG. **5** shows the invention applied to a variable displacement piston pump drive shaft **1**, the tail end of which is located in a ball bearing **19** and the part spherical journal is located in a hollow part spherical sleeve

20. The journal slipper may be of the types illustrated at FIGS. 2, 3 or 4 or it may employ a number of journal slippers as shown at FIG. 6. The illustration shows one of the outer slippers of FIGS. 6, which is similar to that shown in FIG. 1.

I claim:

1. Journal support bearings for a rotating shaft having a spherical surface part comprising a stationary housing and one or more hydro-statically balanced slippers located in said stationary housing in relative radial movable contact therewith, each of said slippers having a part spherical surface adapted to bear on said part spherical surface formed on said shaft, said part spherical surface of each slipper having a narrow sealing land around the periphery of said surface defined by a recess formed in its surface so that said land bears on said part spherical surface formed on said shaft, the zone within said narrow sealing land being fed by fluid under pressure.

2. The journal support bearings as claimed in claim 12 including a pressure control means to regulate pressure against said slipper.

3. Journal support bearings for rotating shafts having a part spherical surface, comprising one or more hydrostatically balanced slippers located in a stationary housing, wherein each slipper has a part spherical surface, adapted to bear on the part spherical surface formed on a shaft about its axis of rotation, said part spherical surface of each slipper having a recess formed in its surface to define a narrow sealing land around the periphery of the said surface to bear on the said part spherical surface formed on the shaft, the zone within said narrow sealing land of each slipper being fed by fluid under pressure, the end of the slipper, remote from the end having the said part spherical surface, being formed as a sealed piston within a cylinder in the said housing, the cylinder area being substantially equal to the effective area of the said sealing land at the said spherical surface, so that sealing contact is made at the sealing land with negligible leakage or metal contact loadings.

4. Journal support bearings as claimed in claim 3, wherein a push rod, connected to a valve or formed as a valve, is operated by radial movement of the slipper, so that a radially outwards movement cause the pressure to increase and a radially inwards movement causes the pressure to decrease, thereby regulating the pressure at the slipper to hydro-statically balance the journal loadings.

5. Journal support bearings as claimed in claim 4 wherein an uneven number of said slippers is employed, the center slipper having a fixed abutment and a control valve to regulate pressure while said other slippers are interconnected with said center slipper for pressure regulation.

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