United States Patent

Anderson

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[54] **AXIAL PISTON PUMP**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 716,735, March 28, 1968, Pat. No. 3,535,984.

[52] **U.S. Cl.**.....**91/505**

[51] **Int. Cl.**.....**F01b 13/04**

[58] **Field of Search**.....91/507, 499, 504, 505; 417/222, 269

[56] **References Cited**

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[57] **ABSTRACT**

An axial piston pump having an improved construction for retaining the drive flange within the hanger thereof, the same including a spherical socket formed of a convex spherical hold-down ring and a concave spherical ring.

4 Claims, 8 Drawing Figures

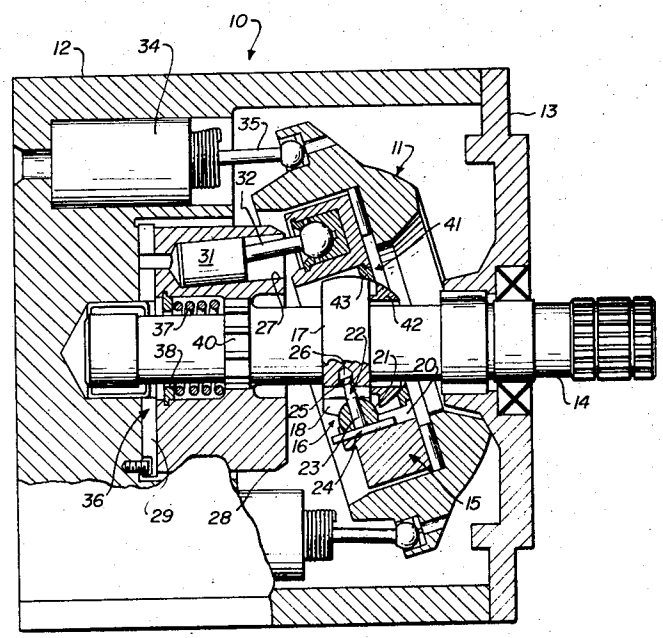
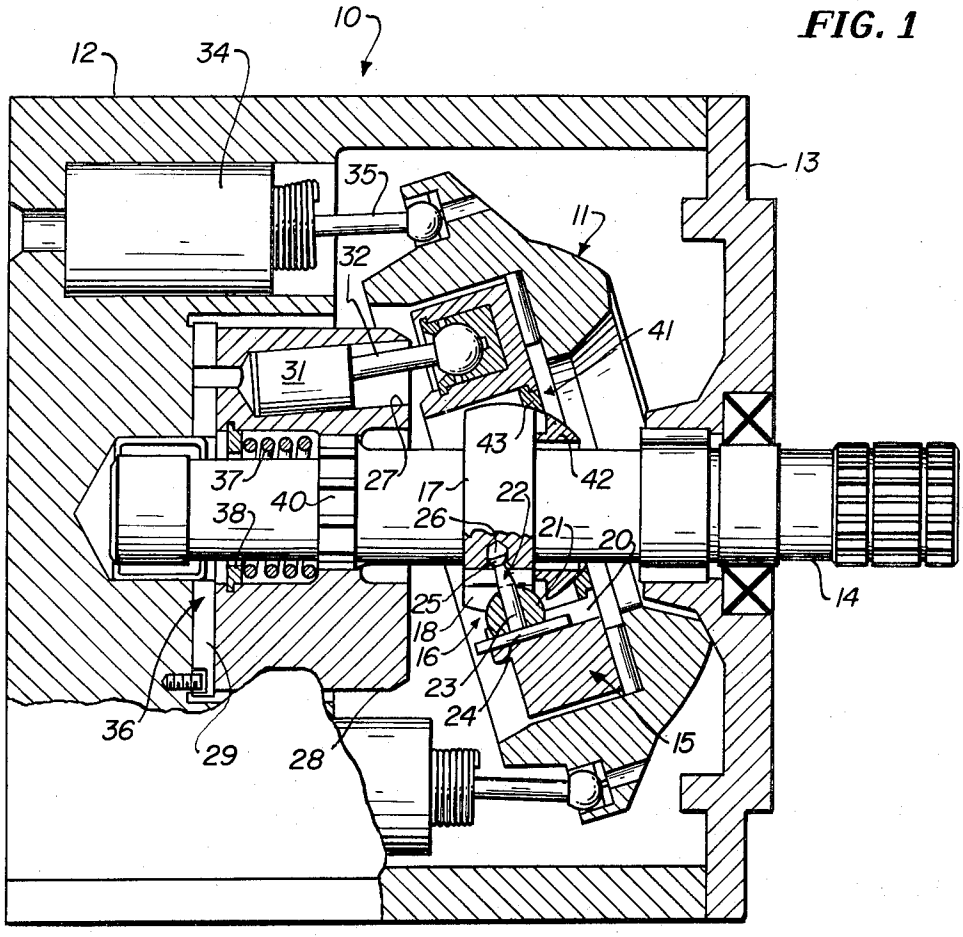


FIG. 1



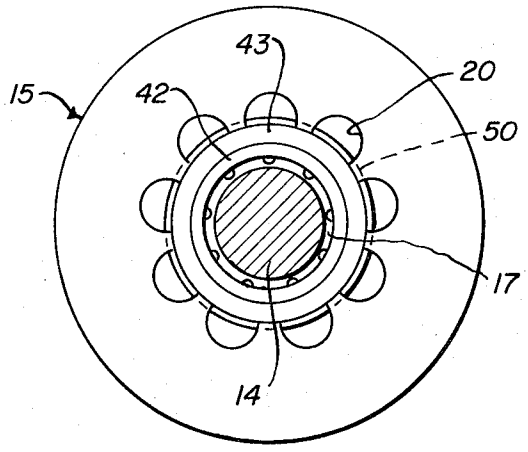


FIG. 2

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FIG. 4

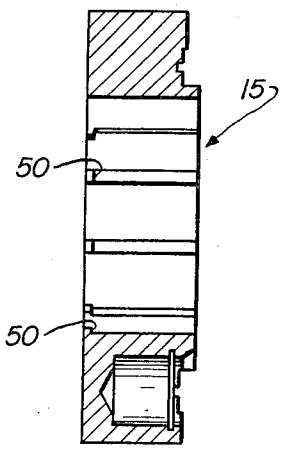


FIG. 3

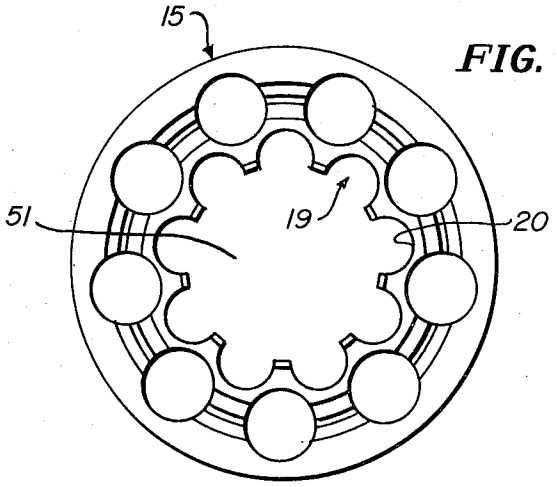


FIG. 6

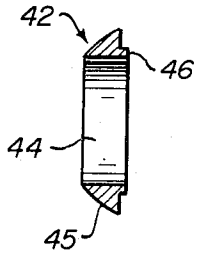


FIG. 5

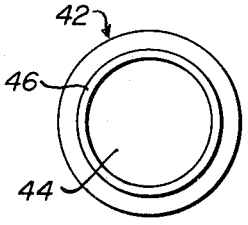


FIG. 8

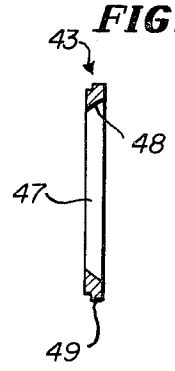
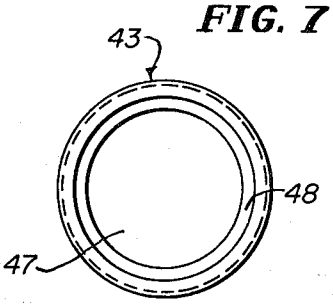


FIG. 7



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AXIAL PISTON PUMP

This application is a continuation-in-part of copending United States patent application, Ser. No. 716,735, filed on Mar. 28, 1968 now U.S. Pat. No. 3,535,984.

The present invention relates, generally, to an improved axial piston pump and, in particular, it relates to an improved construction for retaining the drive flange within the hanger thereof.

In the above-mentioned copending application, there is disclosed an improved axial piston pump which is highly compact to the extent that substantial horsepower capacities can be buried within the hub of a vehicle wheel. The axial piston pump of the present invention is of a like construction, however, it has been further modified and improved so as to provide a more compact unit, with a substantial parts reduction.

Accordingly, it is an object of the present invention to provide an improved axial piston pump.

Another object is to provide an improved axial piston pump in which a substantial parts reduction is achieved, without sacrificing the mechanical efficiency achieved at low as well as high loads and corresponding horsepower outputs.

Still another object is to provide an improved axial piston pump having an improved construction for retaining the drive flange within the hanger thereof. In this respect, it is further contemplated that the construction will permit a far more compact unit to be provided.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combination of elements, and arrangement of parts which will be exemplified in the construction hereinafter set forth, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings in which:

FIG. 1 is a transverse sectional view of a pump embodiment illustrative of the present invention;

FIG. 2 is a front plan view of the drive flange and the spherical socket;

FIG. 3 is a rear plan view of the drive flange;

FIG. 4 is a sectional view taken along lines 4—4 of FIG. 3;

FIG. 5 is a rear plan view of the convex spherical hold-down ring of the spherical socket;

FIG. 6 is a sectional view taken along lines 6—6 of FIG. 5;

FIG. 7 is a rear plan view of the concave spherical ring of the spherical socket; and

FIG. 8 is a sectional view taken along lines 8—8 of FIG. 7.

Similar reference characters refer to similar parts throughout the several views of the drawings.

Referring now to the drawings, in FIG. 1 there is illustrated an axial piston pump 10 which is like the one disclosed in the above-mentioned U.S. Pat. application, Ser. No. 716,735, filed Mar. 28, 1968 now U.S. Pat. No. 3535984, except that it has been improved to eliminate the hold-down rings that are normally required to position the hanger 11 thereof in place. In addition, the thrust bearing which is normally required

is eliminated. These improvements which eliminate the need for a number of parts, also simplify the construction of the pump 10 and permit a more compact pump to be provided.

More specifically, the pump 10 has a cylindrical or box-like housing 12 which is closed at one end by a cover 13. A drive shaft 14 runs through the center of the pump, and has one end thereof protruding for connection to a drive motor. The other end of the drive shaft 14 may optionally extend through the housing 12, for connection to an auxiliary and charge pump assembly (not shown).

The drive shaft 14 is coupled to a drive flange 15 by means of a drive flange universal joint assembly 16, and the drive flange 15 is supported within a hanger 11, in a manner described more fully below. The hanger 11 is fixed against rotation, while the drive flange 15 is rotatably driven within it and, in turn, drives the drive shaft 14.

The drive flange universal joint assembly 16 includes, generally, a universal joint inner race 17 on the drive shaft 14 which is a spline-like structure having a number (9) of cylindrical grooves 18 radially spaced about its periphery. A universal joint outer race 19 is formed on the drive flange 15 and it likewise has a number of cylindrical grooves 20 radially spaced about the periphery of its center opening. A universal joint drive ball 21 is mounted on a drive ball positioner 22 which includes a drive ball positioner stem 23 that terminates in a drive ball positioner cross head 24. The cross head 24 has a cylindrical outer surface which slidably engages the cylindrical groove 20 in the outer race 19 of the drive flange 15. The connection to the drive shaft 14 is by means of a drive ball stem pivot 25 which nests within a drive ball stem pivot hole 26 in the inner race 17 on the drive shaft 14.

The drive flange 15 is driven by a number of pistons 31 (nine in number in the illustrated embodiment) which are mounted for reciprocation within individual cylinders 27 in a cylinder block 28. A valve plate 29 selectively communicates with a hydrostatic fluid source (not shown) to permit high pressure fluid to enter the cylinders 27 to drive the pistons 31. As the pistons 31 reciprocate in the cylinders 27, the force of the pistons is transmitted to the drive flange 15, by means of the connecting rods 32.

In order to vary the total displacement of the pump 10, the hanger 11, and hence the drive flange 15, is angularly displaced with respect to the drive shaft 14. More particularly, the hanger 11 normally is pivotally mounted perpendicular to the drive shaft 14 and, in this position, a zero displacement configuration is achieved and pump 10 has a zero output. As the angular relationship of the hanger 11 is varied, the displacement of the pump 10 is likewise varied, to increase or decrease its output.

The angular relationship of the hanger 11 is varied by means of a stroke control assembly 34 which includes a pair of stroke control pistons (not shown) which are at diametrically opposed positions and are coupled to the hanger 11 by stroke control connecting rods 35. A pressure fluid is delivered to the stroke control pistons of the stroke control assembly 34, selectively, to the end that the angular position of the hanger 11 may be carefully controlled.

As explained in the above-mentioned U.S. Pat. application, Ser. No. 716,735, filed Mar. 28, 1968 now U.S. Pat. No. 3535984, the related torques and the necessity for constant spring loaded pressure between parts requires that a drive shaft thrust assembly **36** be provided to constantly urge the drive shaft **14** away from the cylinder block **28**, or conversely, to maintain a constant pressure on the cylinder block **28** against the valve plate **29**. As can be seen in FIG. **1**, this drive shaft thrust assembly **36** includes a drive shaft thrust cylinder block spring **37** which rides against a cylinder block keeper **38** at one end of the spring **37**. The other end of this spring **37** is biased against a spline spring shoulder **39** of the cylinder block shaft spline **40**.

This brief description generally describes the construction and operation of the pump **10**. If a more detailed description is desired, reference can be made to the above-mentioned U. S. Pat. application, Ser. No. 716,735, filed Mar. 28, 1968 now U.S. Pat. No. 3535984.

As indicated above, the pump **10** is generally like the pump disclosed in said patent application, however, its construction has been improved in a fashion such that the hold-down snap ring, the hold-down lock pin and the like normally used to hold the drive flange **15** from displacement from the hanger **11** can be eliminated. In the case of the pump **10**, the drive flange **15** is held in place by taking and resolving the thrust from the cylinder block spring **37** into a spherical socket **41** formed of a convex spherical hold-down ring **42** (FIGS. **5** and **6**) and a concave spherical ring **43** (FIGS. **7** and **8**), in the manner described below.

The hold-down ring **42**, as can be best seen in FIGS. **5** and **6**, is generally ring-shaped having a center opening **44** which is proportioned to receive therethrough the drive shaft **14**. The hold-down ring **42** also has an outer side wall **45** which is spherical shaped, and an annular reduced diameter support seat **46**. This hold-down ring **42**, as can be seen in FIG. **1**, is extended over the drive shaft **14** and disposed such that the support seat **46** is abutted against the universal joint inner race **17** on the drive shaft **14**.

The ring **43**, as can be best seen in FIGS. **7** and **9**, likewise is ring-shaped and has an opening **47** which is proportioned to receive therethrough the drive shaft **14** and further has a side wall **48** which is spherical-shaped corresponding to the spherical-shaped side wall **45** of the hold-down ring **42** so as to slidably and seatingly engage with the latter. The ring **43** further has an annular outwardly extending flange shoulder **49** on it which is formed to engage with an annular shoulder **50** in the drive flange **15**, to retain the spherical socket **41** within the drive flange **15**.

The drive flange **15**, as can be best seen in FIGS. **3** and **4**, has an enlarged diameter annular shoulder **50** formed within its center opening **51**, adjacent its end which is slidably engaged within the hanger **11**. The shoulder **50** forms a seat against which the flange shoulder **49** on the ring **43** abuts, to retain the latter within the drive flange **15**. The shoulder **50** can be easily and simply formed within the drive flange **15**, by under-cutting the center opening **51**, so that the material which is not cut away forms the shoulder.

As can be best seen in FIGS. **1** and **2**, in assembling the hold-down ring **42** and the ring **43** within the drive flange **15**, the flange shoulder **49** on the ring **43** is seatingly engaged with the shoulder **50** in the drive flange **15**. The hold-down ring **42** is abutted against the inner race **17** on the drive shaft **14**, with its spherical-shaped side wall **45** seatingly and slidably engaged with the spherical-shaped side wall **48** of the ring **43**. The arrangement is such that the thrust of the cylinder block hold-down spring **37** forcibly urges and maintains the drive flange **15** in sliding contact with the spherical socket **41** and against dislodgement from the hanger **11**.

The hold-down ring **42** and the ring **43** perform the function of a bearing, since they move with respect to one another. The motion between them is oscillatory rather than rotary, since the universal joint assembly **16** forms the timing between the drive shaft **14** and the drive flange **15** so that it is a rocking motion that is translated across the spherical socket **41**, at a velocity which is a function of the maximum displacement of the pump **10**.

The requirement for a precise alignment between the spherical contour of the inner race **17** on the drive shaft **14** and the drive flange **15** between which are supported the drive balls **21** which form a radial bearing as well as a torque transmitting device is eliminated with this arrangement. By having the hold-down ring **42** free-floating, it moves freely concentric to the drive shaft **14** and allows the drive flange **15** to displace forward or backward, at will, within the tolerance clearance of the drive shaft, and yet it bears against the flat surface of the inner race **17** on the drive shaft **14**.

The above-described arrangement provides still another improvement, in that the thrust bearing normally required is eliminated since the thrust of the cylinder block hold-down spring **37** now is imposed on the spherical socket **41** to retain the drive flange **15** within the hanger **11**. The fact that the thrust bearing can be eliminated, furthermore, permits a much shorter engagement between the hanger **11** and the cover **13** so that the overall size of the pump **10** can be substantially reduced.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and certain changes may be made in the above construction. Accordingly, it is intended that all matter contained in the above description or shown in the accompanying drawings whall be interpreted as illustrative and not in a limiting sense.

Now that the invention has been described, what is claimed as new and desired to be secured by Letters Patent is:

1. In an axial piston pump assembly of the type including a housing, a cover for said housing, a drive shaft rotatably supported within said housing and having an inner race thereon, a drive flange, universal means coupling said drive flange to said drive shaft, a hanger for supporting said drive flange, a cylinder block, a cylinder block spring, a plurality of pistons in said cylinder block having connecting rods coupled to said drive flange, and means for selectively delivering a pressure fluid to said plurality of pistons to transmit power to said drive flange to rotatably drive said drive shaft, the improvement comprising: a spherical socket engaged with and disposed between said inner race on

said drive shaft and said drive flange, said spherical socket comprises, in combination, a hold-down ring disposed about said drive shaft and having a spherical-shaped outer side wall, and a ring disposed about said drive shaft and having a spherical-shaped inner side wall correspondingly formed to seatingly and slidably receive the spherical-shaped outer side wall of said hold-down ring therein, said hold-down ring being formed to abuttingly engage with said inner race on said drive shaft and said ring being formed to seat within said drive flange, the thrust of said cylinder block spring being imposed on said drive shaft and transmitted by said drive shaft to said spherical socket and said drive flange to retain the latter seated within said hanger.

2. The axial piston pump assembly of claim 1, wherein said drive flange has an outwardly extending annular shoulder formed interiorly thereof, and said ring has an outwardly extending flange shoulder formed about its periphery which seatingly engages with said shoulder on said drive flange to retain said ring within said drive flange.

3. The axial piston pump assembly of claim 1, wherein said hold-down ring is free-floating on said drive shaft.

4. The axial piston pump assembly of claim 2, wherein said hold-down ring is free-floating on said drive shaft.

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