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(54) AXIAL PISTON PUMP

(71) We, TELEFLEX INCORPORATED, a corporation of the State of Delaware, United States of America, of P.O. Box 218, North Wales, Pennsylvania 19454, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The subject invention relates to a pump and, specifically to an axial piston pump of the type particularly suited for use in a hydraulic steering system for controlling the movements of an outboard motor or rudder of a marine boat.

Although the pump assembly of the subject invention has uses in various environments, it is particularly well suited for use in marine steering assemblies wherein hydraulic lines extend from the steering position on the boat to a rudder or outboard engine for controlling an actuator for pivotting the rudder or outboard engine for controlling the direction of the boat. Typically a steering wheel, or the like, is connected to a shaft of an axial piston pump whereby, upon rotation of the axial piston pump, hydraulic fluid pressure is directed from the pump to one side or the other of the actuator for steering the boat. Such a pump assembly is shown in United States patent 3,738,228 granted to Robert R. Harrison on June 12, 1973.

Axial piston pump assemblies generally include a housing having first and second interconnected portions with a cylinder barrel supported in the housing and a plurality of pistons reciprocatively supported in a plurality of piston cavities in the cylinder barrel for reciprocating movement, and a cam for reacting with the pistons for causing the reciprocating movement as either the cylinder barrel or the cam is rotated. In such a construction the cam reacts with the pistons to move the pistons between a position where the cavities in which they are disposed are at a minimum pumping volume to an intake position where the cavities are at a maximum intake volume. During the compression stroke of the pistons for creating the pumping action there is a reaction force, created because of the pressure of the fluid created by the pistons, which reacts between the pistons and the cylinder barrel forming the piston cavities.

These reaction forces are transmitted to the two housing portions which are connected together in a manner to force the housing portions apart or to place the housing portions in tension. Consequently, the housing portions must be structural members.

It is an object of the subject invention to provide an axial piston pump assembly in which there is included restraining means for transferring all of the reaction forces resulting from the reciprocating movement of the pistons by the cam means solely to one of the housing portions whereby the other housing portion may be made of a non-structural low cost material.

According to the present invention, there is provided an axial piston pump assembly comprising: housing means including first and second interconnected housing portions, a cylinder barrel rotatably supported in the housing means, the cylinder barrel including a drive shaft extending therefrom and through and exteriorly of the second housing portion, a plurality of pistons reciprocatively supported in a plurality of piston cavities in the cylinder barrel for reciprocating movement parallel to an axis of rotation, cam means disposed between the pistons and the first housing portion for reacting with the pistons for causing the reciprocating movement thereof upon rotation of the cylinder barrel, shaft means extending from the first housing portion into the cylinder barrel for rotatably supporting the cylinder barrel, the cylinder barrel including fluid ports extending between each of the piston cavities and the shaft means, the shaft means including valving passages for successively communicating with the fluid ports during rotation of the cylinder barrel for directing fluid to and from the piston cavities, connecting means interconnecting the cylinder barrel and the distal end of the shaft means for transferring reaction forces resulting from the reciprocating movement of the pistons caused by the cam means through the shaft means to the first housing portion

while freely allowing rotation of the cylinder barrel on the shaft means, the cylinder barrel defining a cavity adjacent the distal end of the shaft means, the cylinder barrel including a plurality of holes extending therethrough from the exterior thereof to the cavity therein, the connecting means including a thrust bearing supported at the distal end of the shaft means and a plurality of pins secured in at least some of the holes and engaging the thrust bearing on the side thereof facing the distal end of the shaft means.

The interconnection by the thrust bearing and the pins of the distal end of the shaft means and the cylinder barrel enables the transmission of the reaction forces between the pistons and the cylinder barrel to the shaft means which, in turn, extends from the first housing portion against which the cam means is supported or abuts.

Preferably each of said holes is aligned with a respective one of the fluid ports, conveniently on diametrically opposite sides of the shaft means. The axes defined by the aligned holes and fluid ports may be disposed in an imaginary cone and preferably intersect the axis of rotation of the cylinder barrel. The alignment of the holes and fluid ports facilitates their drilling. Conveniently, at least one of said holes is empty and defines a vent passage from the cavity to the exterior of the cylinder barrel, and in a preferred embodiment approximately one-half of said holes have pins disposed therein and the remaining number of said holes are empty and define vent passages. Each pin may be press-fitted into its respective hole, and conveniently the holes and pins are disposed to provide an axial clearance space between the pins and the distal end of the shaft means.

The connecting means may include an axially extending bolt threadedly engaging the distal end of the shaft means, the thrust bearing being disposed on the bolt.

The lack of reaction forces applied to the second housing portions means that it need not be formed as a structural member and conveniently it is made of plastics material. The first housing portion may comprise a cover member connected to the shaft means and including passages therein communicating with the valving passages in the shaft means, and inlet and outlet connections, and the second housing portion may be generally cup-shaped and surround the cylinder barrel, the cover member defining a closure for the cup-shaped second housing portion.

One embodiment of an axial piston pump assembly in accordance with the present invention will now be described by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a cross-sectional view of a preferred embodiment of the subject inventive concept;

Figure 2 is a cross-sectional view showing a prior art construction, and

Figure 3 is a cross-sectional view taken substantially along line 3—3 of Figure 2.

Referring first to Figures 2 and 3, there is disclosed generally at 20 an axial piston pump assembly constructed in accordance with the prior art teachings. The axial piston pump assembly 10 includes a housing means including a first cup-shaped closing portion 12 and a second housing portion 14 defining a cover or closure plate. The first and second housing portions 12 and 14 are interconnected by bolts 16. The cup-shaped housing 12 defines a tank for hydraulic fluid and surrounds a cylinder barrel 18. The cylinder barrel 18 includes a plurality of piston cavities 20 in which are reciprocally supported a plurality of pistons 22. The cover plate or housing portion 14 supports a cam 24 which reacts with the pistons 22 for causing reciprocating movement of the pistons as the cylinder barrel 18 rotates. The cylinder barrel 18 is rotatably supported on a spicket shaft 26 which is, in turn, rigidly secured to the closure or cover plate 14. A shaft portion 28 is rotatably supported in the cup-shaped housing 12 and extends from and is integral with the cylinder barrel 18. Springs 30 are disposed in the piston cavities 20 between the ends of the pistons 22 and the ends of the piston cavities 20 for urging the pistons 22 against the cam 24.

The spicket shaft 26 includes a fluid inlet port 32 and a fluid outlet port 34. The ports 32 and 34 are in communication with fluid passages 36 and 38 which, in turn, are in communication with fluid passages in the cover plate or closure member 14 which lead to fluid connections for the pump assembly. A fluid port 40 extends from each piston cavity 20 to the spicket shaft 26 for fluid communication with the ports 32 and 34 during rotation of the cylinder barrel 18 for directing fluid flow to and from the piston cavities 20. In order to machine and form the fluid passages or ports 40, the cylinder barrel 18 must be drilled from the exterior thereof radially inwardly through each piston cavity 20 and thereafter the exterior portion of the holes must be plugged with the threaded plugs 42.

As the cylinder barrel 18 rotates and the pistons 22 react with the cam 24 for pressurizing fluid in the piston cavities 20 a reaction force results between the pistons 22 and the cylinder barrel 18 to urge the cylinder barrel 18 to the left, as viewed in Figure 2, against a thrust bearing 44. Such a reaction force places the cup-shaped housing portion 12 in tension along its side walls, therefore requiring that the housing portion 12 be a structural member.

Referring now to Figure 1, an axial piston pump assembly constructed in accordance

with the instant invention is generally shown at 50. The pump assembly 50 comprises a housing means including first and second interconnected housing portions. The first housing portion is defined by a closure or cover portion 52 and the second housing portion is defined by the cup-shaped portion 54. A seal 56 is disposed between the first and second housing portions 52 and 54. The first and second housing portions 52 and 54 may be secured together in any convenient manner such as by gluing bolts, fasteners, or a snap-in ridge and groove as generally indicated at 58.

A cylinder barrel generally indicated at 60 is supported in the housing means. A plurality of pistons 62 are reciprocatively supported in a plurality of piston cavities 64 in the cylinder barrel 60 for reciprocating movement parallel to an axis of rotation. A cam means generally indicated at 66 reacts with the pistons 62 for causing the reciprocating movement thereof. The cylinder barrel 60 and the cam means 66 are supported in the housing means for rotation relative to one another about the axis of rotation for effecting the reciprocating movement of the pistons 62. Such is accomplished because the cylinder barrel 60 is rotatably supported in the housing means, as will be described more specifically hereinafter.

The assembly 50 also includes a restraining means generally shown at 68 for transferring all of the reaction forces resulting from the reciprocating movement of the pistons 62 by the cam means 66 solely to the first housing portion 52. The restraining means 68 includes a spicket shaft means 70 which is connected to and extends from the first housing portion 52 and into a cavity or bore in the cylinder barrel 60. The spicket shaft 70 is coaxial or disposed on the axis of rotation of the cylinder barrel 60. The restraining means 68 also includes a connecting means generally shown at 72 interconnecting the spicket shaft 70 and the cylinder barrel 60. The cylinder barrel 60 is rotatably supported on the spicket shaft 70 and is also rotatably supported by the second portion 54 of the housing means at 74 as the cylinder barrel 60 includes a shaft portion 76 formed integrally therewith and extending exteriorly of the housing portion 54 and rotatably supported therein at 74. The shaft 76 is normally connected to a steering wheel in a marine craft for rotating the cylinder barrel 60 in either direction depending upon the desired direction of the marine craft.

The connecting means 72 includes a thrust bearing means 78 for transmitting the reaction forces from the cylinder barrel 60 to the spicket shaft 70. The spicket shaft 70 extends to a distal end 80 within the cylinder barrel 60 and the cylinder barrel 60 defines a cavity 82 adjacent the distal end 80 of the spicket shaft. The connecting means 72 also includes an axially extending bolt 84 threadedly engaging the distal end 80 of the spicket shaft 70 and the thrust bearing 78 is disposed upon and retained by the bolt 84.

The spicket shaft 70 includes valving passages, one of which is shown at 86, for successively communicating with fluid ports 88 during rotation of the cylinder barrel 60 for directing fluid to and from the piston cavities 64. The fluid ports 88 extend between each of the piston cavities 64 and the spicket shaft 70.

The cylinder barrel 60 includes a plurality of holes 90 and 90^1 which extend therethrough from the exterior thereof to the cavity 82 therein.

The connection means 68 further includes the projection means comprising the pins 92 which engage the thrust bearing 78 on the side thereof facing the distal end 80 of the spicket shaft 70. Each of the pins 92 is secured in one of the holes 90 by being press-fitted thereinto and engages the thrust bearing 78. Each of the holes 90 and 90^1 is axially aligned with one of the fluid ports 88 whereby the holes 90 and 90^1 may be machined or drilled and extended to drill or machine the fluid ports 88 thereby eliminating the requirement for plugs in the exterior wall of the cylinder barrel 60 extending from each piston cavity to the exterior surface of the cylinder barrel. In other words, each of the holes 90 and 90^1 is aligned with one of the fluid ports 88 disposed on the diametrically opposite side of the spicket shaft 70. Further, each of the holes 90 and 90^1 and the corresponding aligned fluid ports 88 are disposed on axes which are, in turn, disposed in an imaginary cone so that the axes of the holes and the fluid ports intersect the axis of rotation of the cylinder barrel 60 which is, in turn, the longitudinal axis of the spicket shaft 70.

In the embodiment shown, there are preferably six piston cavities 64 and, consequently, six pistons, thereby requiring six fluid ports 88. There are, therefore, six holes 90 and 90^1, however, half or three of the holes 90^1 are empty or absent of a pin 92 so as to define a vent passage from the cavity 82 in the cylinder barrel to the exterior of the cylinder barrel 60 to communicate with the reservoir of fluid surrounding the cylinder barrel 60 thereby preventing any fluid pressure build-up in the cavity 82. It will be appreciated that the pump assembly may include an odd number of pistons 62 in which case approximately one-half of the holes 90 and 90^1 will be either empty or include pins 92.

As illustrated, the second housing portion 54 is generally cup-shaped and surrounds the cylinder barrel 60 to define a fluid reservoir and the first housing portion 52 defines

a closure or cap member for closing the cup-shaped housing portion 54. The first housing portion 52 has fluid passages therein in fluid communication with the valving passages 86 in the shaft 70 and in fluid communication with the fluid connections 94 and 96 which may have threaded connections for connection to fluid lines extending to an actuator, or the like. The shaft 70 has passages similar to the passages 36 and 38 as in the shaft 26. A filler cap 98 threadedly engages the cup-shaped housing portion 54 and may be removed for filling the reservoir defined by the housing portion 54 with hydraulic fluid.

It will be noted that the holes 90 and 90^1 are disposed to provide an axial clearance space between the pins 92 and the distal end of the spicket shaft 70. When the pump assembly is assembled, the bolt 84 is secured to the spicket shaft 70, as shown, with the thrust bearing 78 in position. Thereafter, the spicket shaft 70 is inserted into cylinder barrel 60 and forwardly sufficiently that the pins 92 may be driven into the holes 90 and clear the thrust bearing 78 because of the clearance provided between the thrust bearing 78 and the distal end of the spicket shaft 70. Once the pins 92 are in position, the spicket shaft 70 is bolted or otherwise tightened to the closure housing portion 52 and drawn rearwardly thereagainst so that the thrust bearing 78 is urged against the pins 92. Since the pins define a cone or disk-shaped surface, the thrust bearing 78 bears against the pins forming a dish to arrange or align itself to a natural position perpendicular to the axis of rotation. In other words, the disposition of the pins 92 are such as to provide a self-aligning function of the thrust bearing 78 during assembly.

As will be appreciated, during rotation of the cylinder barrel 60, the pistons 62 are reciprocated and the resultant forces created by the pressure in the piston cavities 64 and transferred to the cylinder barrel 60 are, in turn, transmitted through the pins 92 to the thrust bearing 78 and then to the spicket shaft 70 and to the housing portion 52. This eliminates any transmission of the reaction forces to the cup-shaped housing portion 54 and, therefore, the cup-shaped housing portion 54 may be made of nonstructural materials or low cost materials such as plastics.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

WHAT WE CLAIM IS:—

1. An axial piston pump assembly comprising: housing means including first and second interconnected housing portions, a cylinder barrel rotatably supported in the housing means, the cylinder barrel including a drive shaft extending therefrom and through and exteriorly of the second housing portion, a plurality of pistons reciprocatively supported in a plurality of piston cavities in the cylinder barrel for reciprocating movement parallel to an axis of rotation, cam means disposed between the pistons and the first housing portion for reacting with the pistons for causing the reciprocating movement thereof upon rotation of the cylinder barrel, shaft means extending from the first housing portion into the cylinder barrel for rotatably supporting the cylinder barrel, the cylinder barrel including fluid ports extending between each of the piston cavities and the shaft means, the shaft means including valving passages for successively communicating with the fluid ports during rotation of the cylinder barrel for directing fluid to and from the piston cavities, connecting means interconnecting the cylinder barrel and the distal end of the shaft means for transferring reaction forces resulting from the reciprocating movement of the pistons caused by the cam means through the shaft means to the first housing portion while freely allowing rotation of the cylinder barrel on the shaft means, the cylinder barrel defining a cavity adjacent the distal end of the shaft means, the cylinder barrel including a plurality of holes extending therethrough from the exterior thereof to the cavity therein, the connecting means including a thrust bearing supported at the distal end of the shaft means and a plurality of pins secured in at least some of the holes and engaging the thrust bearing on the side thereof facing the distal end of the shaft means.

2. An assembly as claimed in claim 1 wherein each of said holes is aligned with a respective one of the fluid ports.

3. An assembly as claimed in claim 2 wherein each of said holes is aligned with a respective one of the fluid ports disposed on the diametrically opposite side of the shaft means.

4. An assembly as claimed in claim 2 or claim 3 wherein the axes defined by the aligned holes and fluid ports are disposed in an imaginary cone.

5. An assembly as claimed in any one of claims 2 to 4 wherein the axes defined by the aligned holes and fluid ports intersect the axis of rotation.

6. An assembly as claimed in any one of the preceding claims wherein at least one of said holes is empty and defines a vent passage from the cavity to the exterior of the cylinder barrel.

7. An assembly as claimed in claim 6 wherein approximately one-half of said holes

have pins disposed therein and the remaining number of said holes are empty and define vent passages.

8. An assembly as claimed in any one of the preceding claims wherein each of the pins is press-fitted into its respective hole.

9. An assembly as claimed in any one of the preceding claims wherein the holes and pins are disposed to provide an axial clearance space between the pins and the distal end of the shaft means.

10. An assembly as claimed in any one of the preceding claims wherein the connecting means includes an axially extending bolt threadedly engaging the distal end of the shaft means, the thrust bearing being disposed on the bolt.

11. An assembly as claimed in any one of the preceding claims wherein the second housing portion is made of plastics material.

12. An assembly as claimed in any one of the preceding claims wherein the first housing portion comprises a cover member connected to the shaft means and including passages therein communicating with the valving passages in the shaft means, and inlet and outlet connections.

13. An assembly as claimed in claim 12 wherein the second housing portion is generally cup-shaped and surrounds the cylinder barrel, the cover member defining a closure for the cup-shaped second housing portion.

14. An axial piston pump assembly substantially as herein described with reference to Figure 1 of the accompanying drawings.

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1575628 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

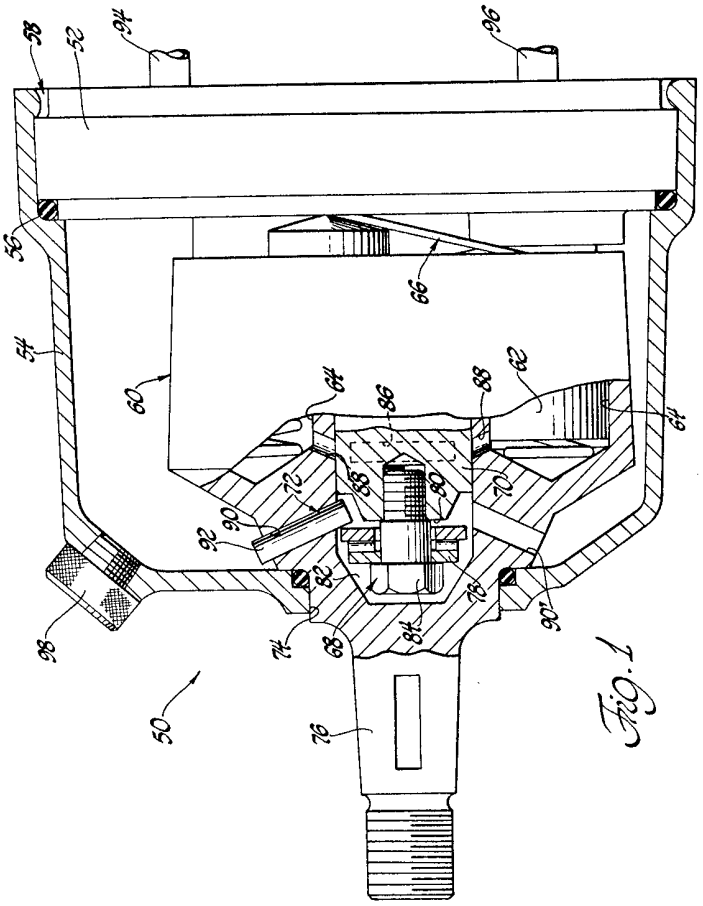
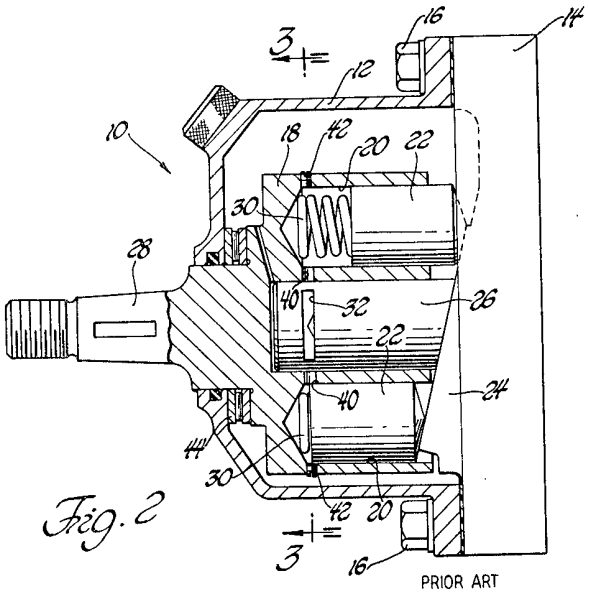


Fig. 1

1575628 COMPLETE SPECIFICATION

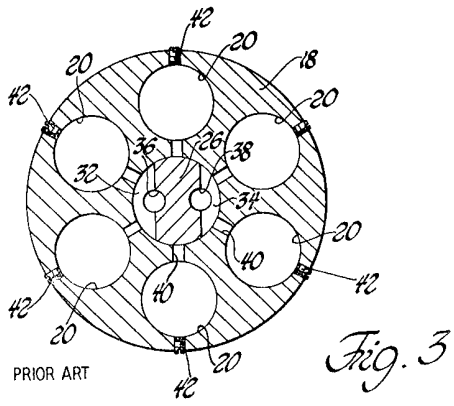
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Sheet 2



PRIOR ART

Fig. 2



PRIOR ART

Fig. 3