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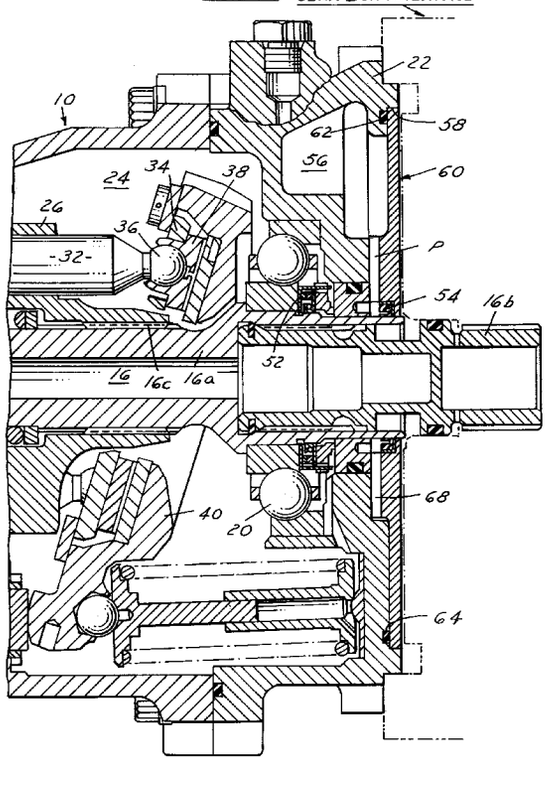
(54) Rotary fluid pressure energy translating device with shaft seal.

(57) A fluid pressure energy translating device having housing (10), a drive shaft (16) rotatably supported in the housing, and a rotating pump assembly in the housing in driving engagement with the shaft. An inboard seal (52) engages on the shaft (16). The shaft (16) has a section (16b) extending beyond the housing (10). A baffle (60) is mounted on an end member (22) of the pump and the baffle and the end member define at least one chamber (56). A passage (P) extends between the seal (52) and the chamber (56) such that fluid leaking past the inboard seal (52) passes to the chamber (56).

FIG. 2 GEAR BOX INTERFACE



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The present invention is directed to rotary fluid pressure energy translating device with shaft seal, and more particularly to an improved shaft seal construction that finds particular utility in rotary hydraulic devices such as hydraulic pumps and motors.

Background of the Invention

Rotary hydraulic machines such as motors and pumps conventionally include a housing, a rotatable shaft that extends from the housing for coupling to an external device, and a shaft seal within the housing surrounding the shaft for preventing leakage of hydraulic fluid along the shaft into or out of the housing. The seal conventionally includes an annular resilient sealing ring. In the event of leakage, the fluid may leak along the shaft past the seal into or out of the housing, causing loss of fluid and potential contamination. If the pump is mounted on a transmission housing gear box, the pump fluid could leak into the transmission, or the transmission fluid could leak into the pump.

In United States Patent No. 5,199,718 a pair of annular resilient sealing rings (with garter springs) are spaced from each other lengthwise on the shaft. The pair of sealing rings provide double protection against fluid leakage along the shaft. A fluid passage extends from between the seals to externally of the housing, and a pressure plug is disposed at the outer end of this passage to prevent entry of dirt. When the pressure of fluid that leaks past the first seal reaches the retention pressure of the passage plug, which may be on the order of 1 to 3 p.s.i., the plug is upset and fluid drips from the housing for observation by a user to indicate a need for seal repair.

In United States Patent No. 5,201,647, a rotary machine includes a housing, a shaft carried for rotation and extending from the housing, and a shaft seal carried by the housing in sealing engagement with the shaft to prevent leakage of fluid along the shaft. The shaft seal comprises an annular shell adapted for mounting within the housing surrounding the shaft and radially spaced therefrom. At least one, and preferably two, annular resilient sealing rings are carried by the shell and extend radially inwardly therefrom into rotary sealing engagement with the shaft. A pressure relief valve includes at least one opening that extends radially through the shell and a resilient band surrounding the shell externally of such opening. Pressure of fluid urges the band away from the shell to permit flow of fluid through the shell opening externally of the shell and band, while the band prevents entry of dirt or debris through the opening into the shell.

The problem of leakage has special concern in aircraft where leakage can result in a need to shut down the aircraft engines.

The fluid used in the hydraulic system on aircraft is incompatible with the fluid used in the gearbox which drives the hydraulic pump. Since the pump and gearbox are directly connected, they form a cavity into which the leakage past the shaft seals of both devices drain into and mix. This cavity typically has a common overboard drain to allow the fluids to be evacuated to avoid filling this cavity with fluid.

However, when mixed at high temperatures (which are typical on aircraft where these devices are installed) these fluids form solids which obstruct the overboard drain system. Once the drain system is blocked, fluid collects in the cavity. As the level of the fluid reaches the gearbox shaft seal, fluid leaks into the gearbox. This is due to the fact that the gearbox shaft seal will only hold pressure in one direction. When enough fluid leaks into the gearbox, a fluid level indicator will detect a high level. As part of the safety systems on the aircraft, the engine (which drives the gearbox) will automatically be shut down.

The root cause of this potential problem is that both the pump and gearbox shaft seals leak. This is an industry wide problem and is usually considered a "weak link" in all rotary devices. Since the technology available for shaft seal design cannot guarantee zero leakage, the next best design is to separate the fluids. The idea to use the same fluid in the gearbox as is used in the hydraulic system has also been mentioned. However, the hydraulic fluid would be a poor gearbox fluid and vice versa. In accordance with the present invention, a baffle is installed on the end member of the pump to form separate cavities between the pump and the gearbox. This prevents the two fluids from mixing when the shaft seals leak. Each cavity also has its own overboard drain to insure the fluids do not mix before exiting the overboard drain system. This will insure that no in-flight engine shut-downs will occur due to a high fluid level in the gearbox as a result of the pump and gearbox shaft seal leakages.

This assurance is especially valuable for twin engine aircraft which try to obtain Extended Twin Engine Operations (E.T.O.P.) rating from the Federal Aviation Administration. This is because it eliminates a failure mode which causes inflight engine shut downs. In-flight engine shut downs are more critical for aircraft with only two engines as opposed to aircraft with three or four engines. This rating allows the aircraft much greater range during normal operations. Pilots must plan their routes to maintain a certain flying time from a viable airport at all times during a flight in case of an emergency. An E.T.O.P.'s rating increases the required time. The baffle design will help twin engine aircraft obtain this rating.

Summary of the Invention

Accordingly, among the objectives of the present invention are to provide a shaft seal system between

the pump and gear box which precludes mixing of the fluids and stopping-up of the drains whereby avoiding in-flight engine shut down.

In accordance with one embodiment of the invention, the shaft seal system comprises a baffle provided on a pump end member adjacent to the gear box and functioning to define a fluid chamber to which leakage through the pump seal passes by passages between the baffle and the end member. The baffle interfaces with a seal contained in the pump end member. The baffle preferably supports the outer annular seal which engages the rotary pump shaft.

Description of the Drawings

Fig. 1 is a longitudinal sectional view through a rotary pump embodying the invention.

Fig. 2 is a fragmentary view on an enlarged scale of a portion of the pump shown in Fig. 1 with the gear box interface shown.

Fig. 3 is a rear plan view of the baffle utilized in the pump.

Fig. 4 is an end view of the end member of the pump taken from the right as viewed in Fig. 2 with the baffle removed.

FIG. 5 is a fragmentary view of a modified form of rotary pump.

Description of the Preferred Embodiment

Referring to Figs. 1 and 2, the invention relates to a rotary pump, herein shown as a variable displacement pump.

Referring now to Fig. 1, an axial piston pump has a housing 10, a valve plate 14 which includes an inlet port and an outlet port.

A drive shaft 16 is rotatably supported in housing 10 by a bearing 18 in one end of the housing 10 and bearing 20 in an end member (mounting flange) 22. The housing 10 has an inner cavity 24 which receives a rotating pump assembly including cylinder barrel 26 rotatably mounted therein. Cylinder barrel 26 is drivingly connected to the drive shaft 16 by a drive spline 16c.

The cylinder barrel 26 has a plurality of bores 30 open at one end to receive pistons 32. Each piston 32 is held in place by a shoe plate 34.

Each shoe 38 bears against an angularly adjustable yoke 40 so that as the barrel 26 is rotated by drive shaft 16, piston shoes 38 follow the yoke 40 causing the pistons 32 to reciprocate within the bores 30.

Each bore 30 has a port opposite its open end which communicates fluid between valve plate 14 and the bore 30. Both an inlet port (not shown) and an outlet port (not shown) are formed within the valve plate 14.

The inlet and outlet ports are arranged in the valve plate 14 so that the pistons 32 pass the inlet port as they are being pulled away from the valve plate 14 and are forced back in toward the valve plate 14 as they pass outlet port. Such a fixed displacement pump is shown, for example, in United States Patent No. 5,230,274, and a variable displacement pump in United States patent 3,643,550, incorporated herein by reference.

As further shown in Fig. 1, the pump includes a rotary impeller 50 which functions to boost the inlet pressure to the piston 32 as it is pulled back from valve plate 14, thus filling bore 30 with fluid.

The pump shaft 16 is formed in two sections shaft 16a, 16b with an inboard seal 52 as well as an outboard seal 54. As shown in FIG. 2 an inboard seal 52 and an outboard seal 54 engage the section 16a while the outer section 16b extends axially outwardly for engagement with the drive spline of a gear box.

In accordance with the invention, the flange end member 22 of the pump (FIG. 2) is formed with arcuate chambers 56 and has an annular shoulder 58 for receiving a baffle 60 in the form of a plate that is held in position by screws (not shown). The baffle 60 engages a seal 62 (FIG. 2) provided in a groove 64 in the end member 22 of the pump (Fig. 4). The baffle 60 (FIG. 3) has a plurality of radial grooves 68 in a planar surface thereof that form passages P (FIG. 2) when installed into end member 22. The baffle 60 further supports the outermost seal 54 (FIG. 1). Any leakage past the inner seal 52 passes through the passages P formed by the grooves to the annular chamber 56. Fluid collected in chamber 56 is drained overboard via the aircrafts drip drain system. This precludes the mixing of the incompatible fluids which leak past the pump and gear box seals.

In the modified form shown in FIG. 5, the outboard seal 54 is omitted. The baffle 60a is modified so that there is no recess for an outboard seal. In this form, the baffle 60a functions substantially the same except that a small amount of leakage may occur between the cavities of the pump and the gear box. Thus, the fluids may be mixed. In instances where the fluids are comparable, this form provides a viable alternative.

Although the invention has been shown as applicable to a pump having a rotating assembly of the axial piston type, the invention is also applicable to other types of pumps such as vane pumps as shown, for example, in United States Patent 3,451,346 and 4,505,654, incorporated herein by reference.

It can thus be seen that there has been provided a shaft seal system between the pump and the gear box which precludes mixing of the fluid and stopping-up of the drains whereby avoiding in-flight engine shut down.

Claims

1. A fluid pressure energy translating device comprising
   a housing,
   a drive shaft rotatably supported in said housing,
   a rotating pump assembly in said housing in driving engagement with said shaft,
   an inboard seal engaging on said shaft,
   said shaft having a section extending beyond said housing.
   a baffle mounted on an end member,
   said baffle and said end member defining at least one chamber,
   said baffle and end member defining passage means extending between said seal and said chamber such that fluid leaking past said inboard seal passes to said chamber.

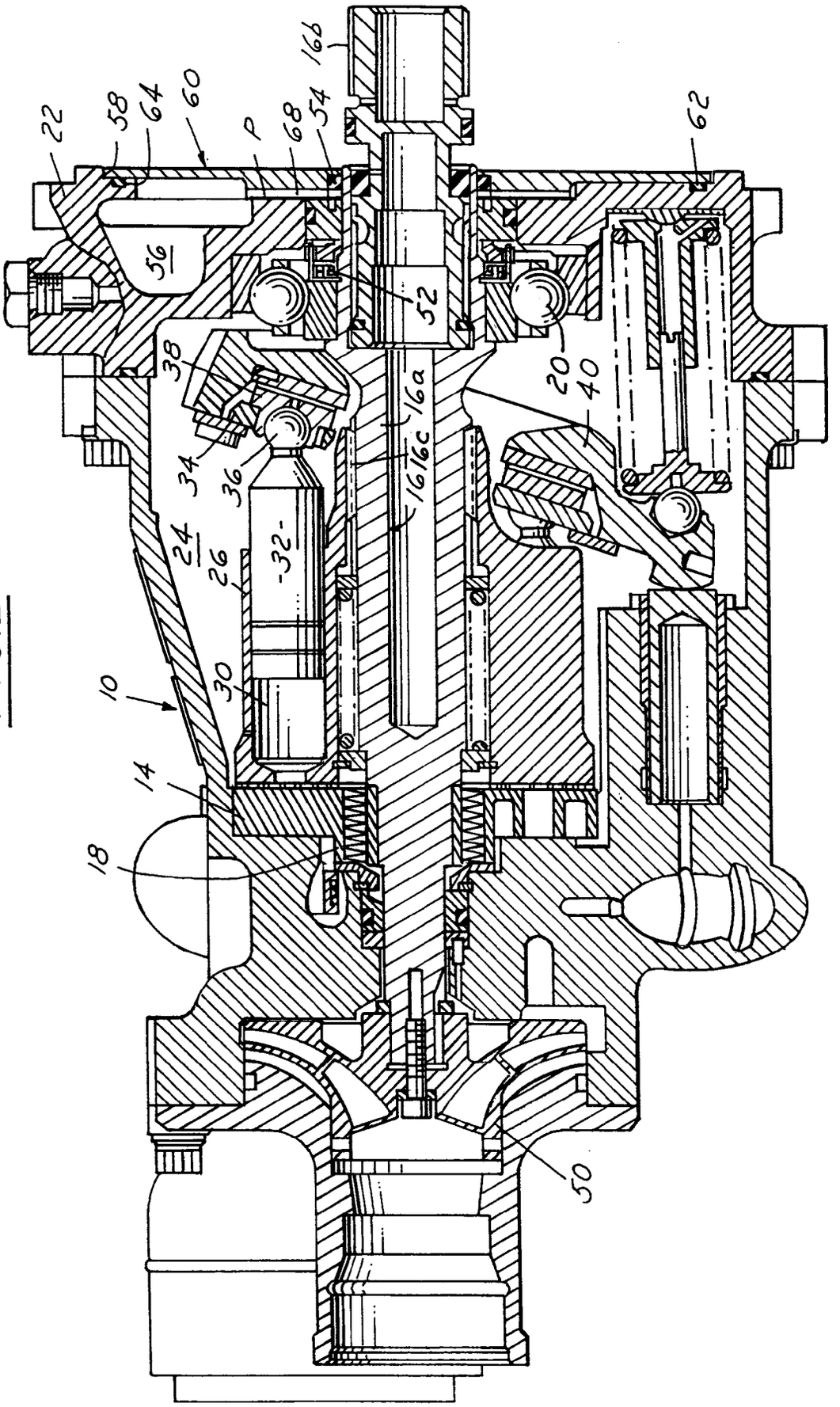
2. The fluid pressure energy translating device set forth in claim 1 wherein said baffle has a generally planar surface, said passage means comprising a generally radial groove therein which cooperates with said end member to define said passage means.

3. The fluid pressure energy translating device set forth in claim 1 or 2 whereinsaid baffle and said end member define a plurality of circumferentially spaced chambers.

4. The fluid pressure energy translating device set forth in claim 3 wherein said baffle has a generally planar surface, said passage means comprising a plurality of cirucumferentially spaced generally radial grooves which cooperate with said end member to define said passage means.

5. The fluid pressure energy translating device set forth in any one of claims 1-4 including an outboard seal, said baffle supporting said outboard seal.

6. The fluid pressure energy translating device set forth in claim 5 wherein said rotating pump assembly is of the axial piston type.


16b
22
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64
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P
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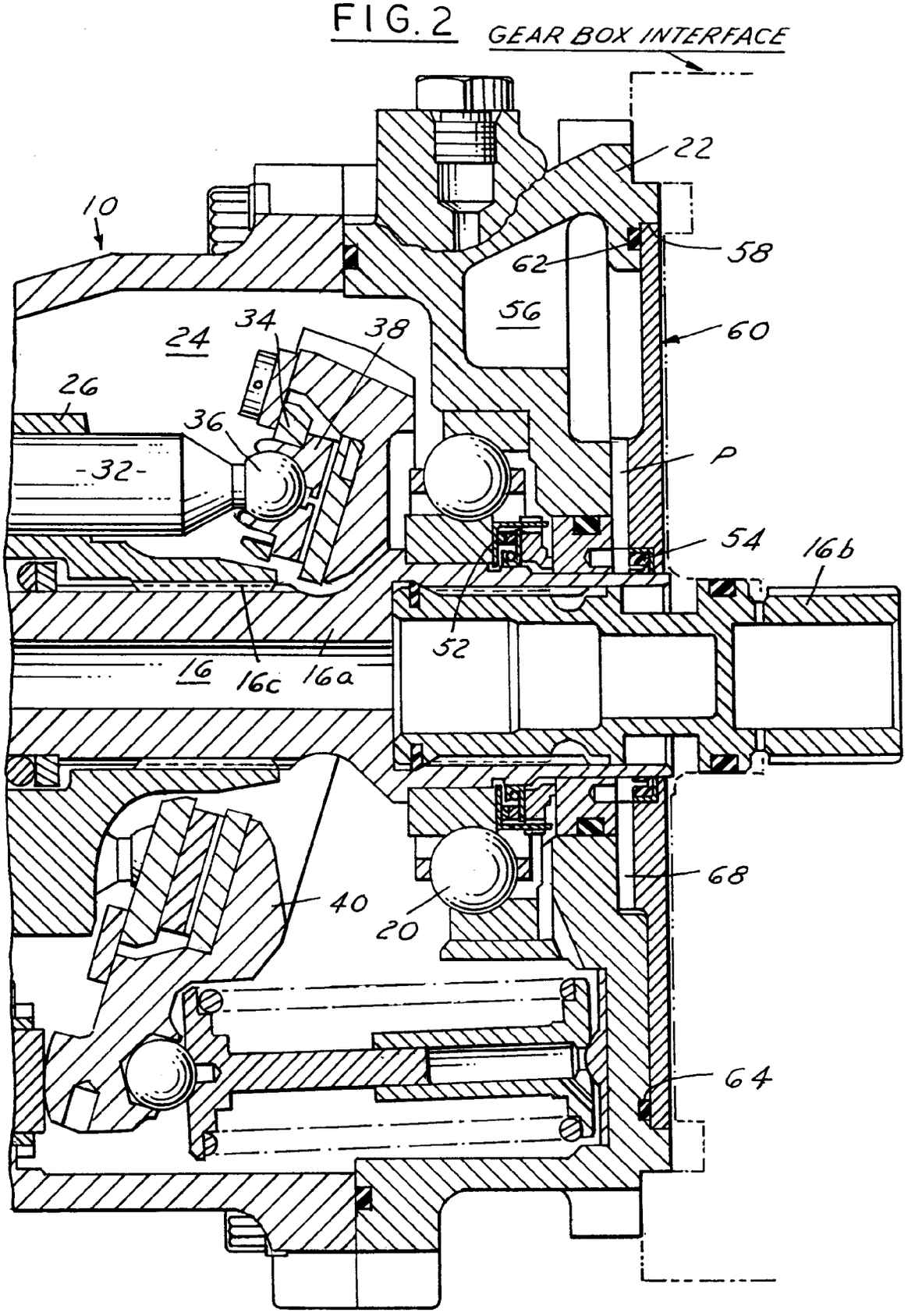
FIG.1

FIG. 2


GEAR BOX INTERFACE
22
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16b
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16c
16a
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FIG.3

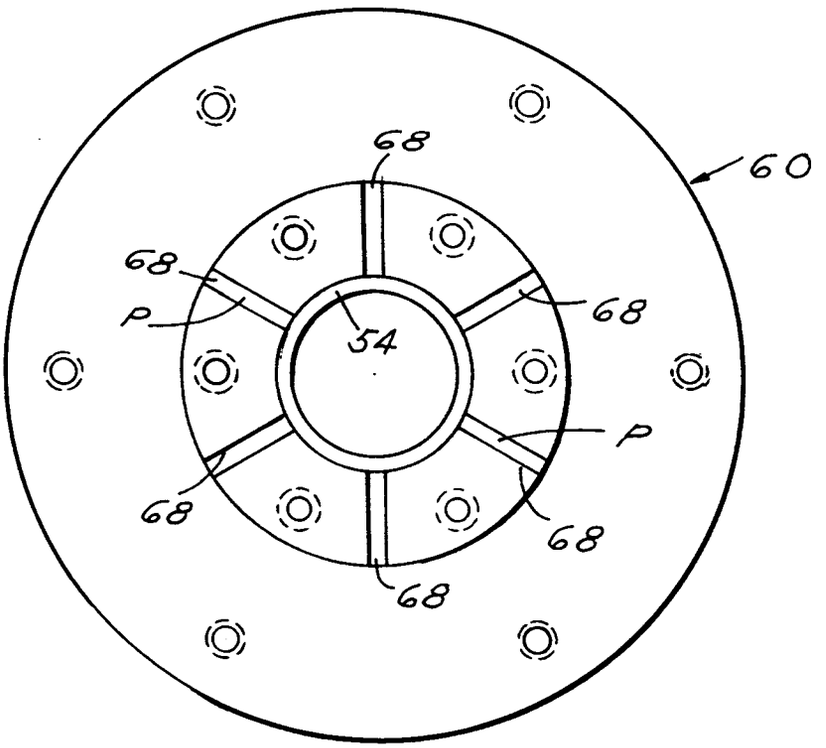


FIG.4

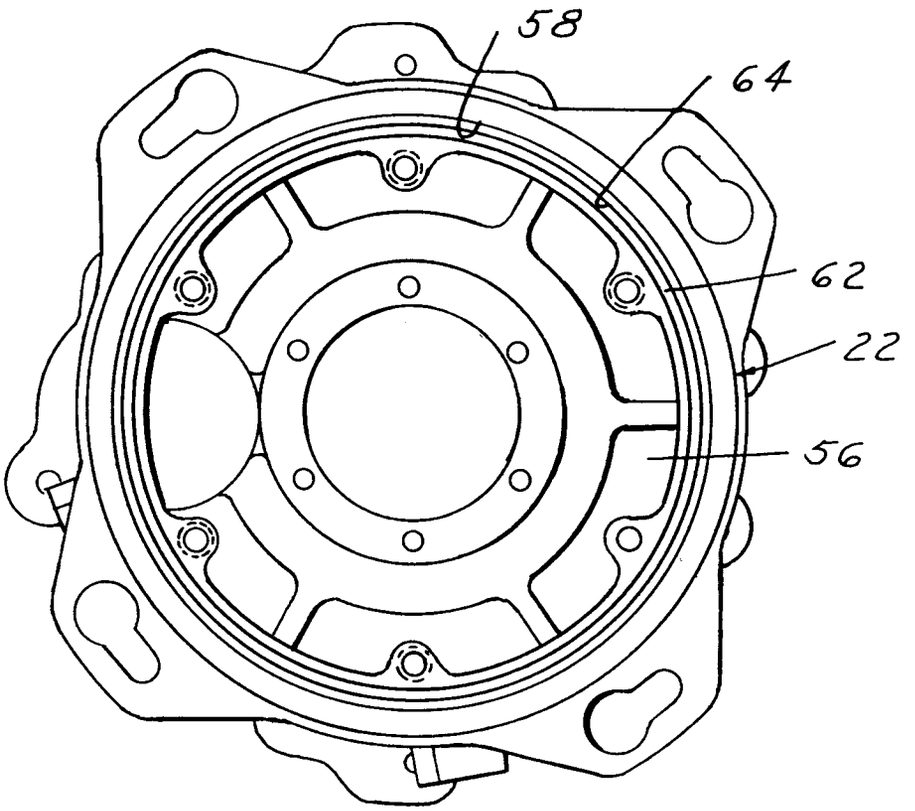
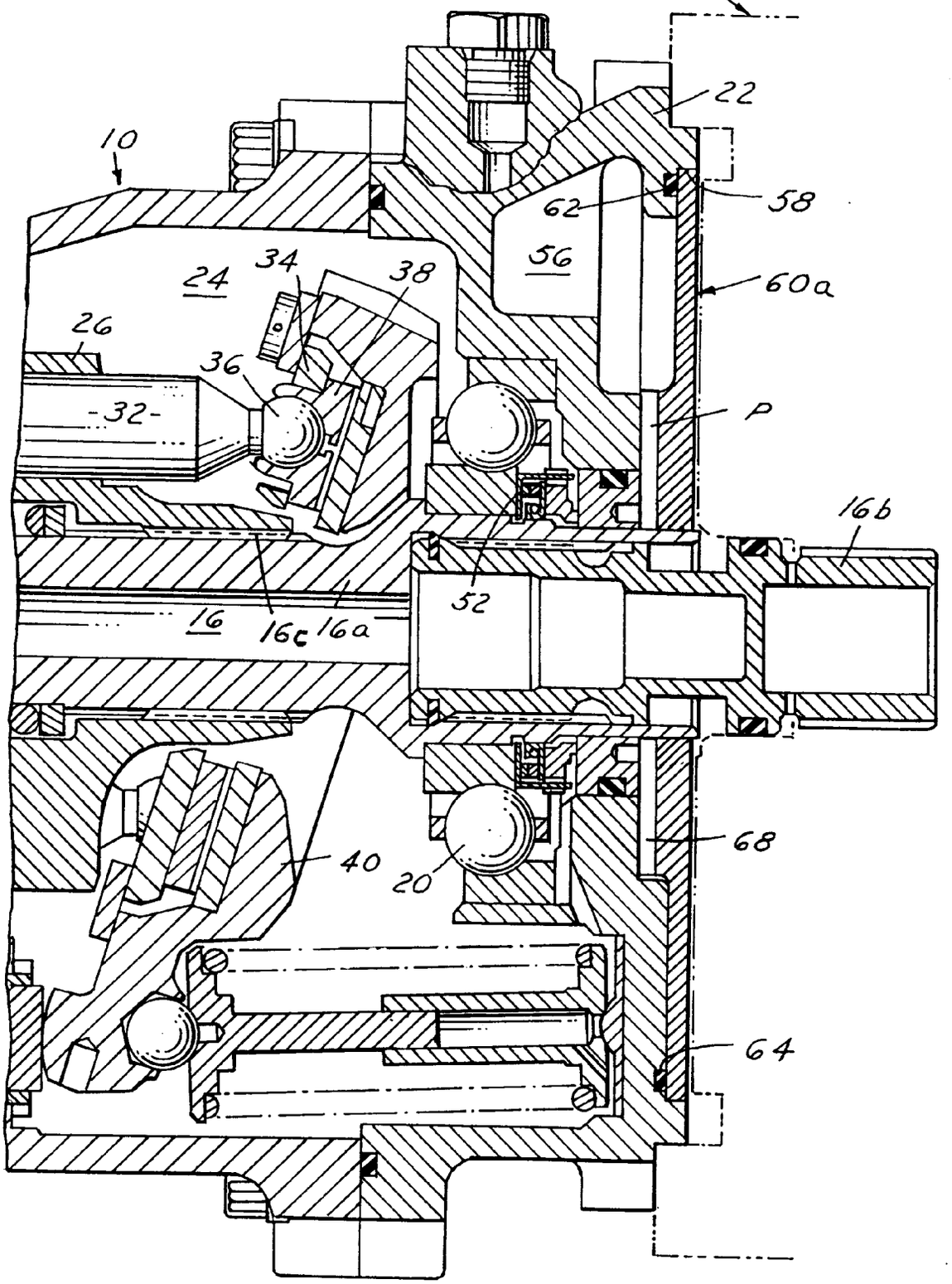


FIG. 5 GEAR BOX INTERFACE



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EUROPEAN SEARCH REPORT

Application Number
EP 94 30 9037

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	WO-A-91 09240 (INGERSOLL-RAND COMP.) * the whole document * ---	1,2,5	F04B1/04 F04B1/20 F04B53/04
A	US-A-4 896 890 (MAUNEY) * the whole document * ---	1,2	
A	US-A-5 035 155 (ROBLEDO) * the whole document * -----	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

F04B
F04C
F16J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	19 April 1995	Von Arx, H

CATEGORY OF CITED DOCUMENTS

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