May 21, 1963 J. H. METTERSHEIMER, JR 3,090,322

OIL PUMP

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FIG. 1

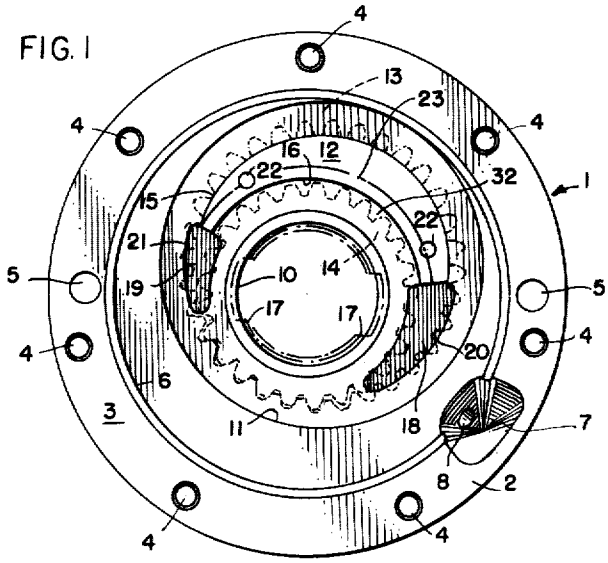

FIG. 2

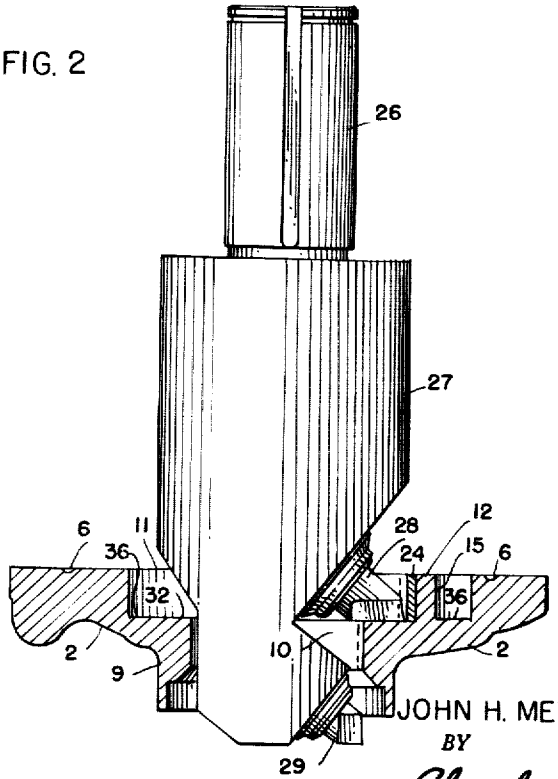

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FIG. 3

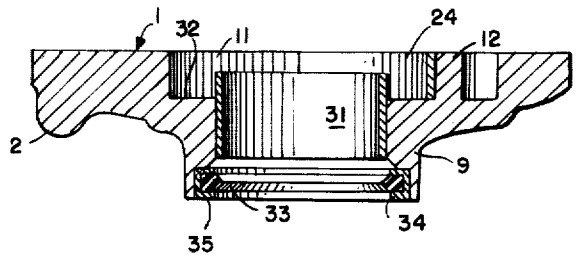


FIG. 4

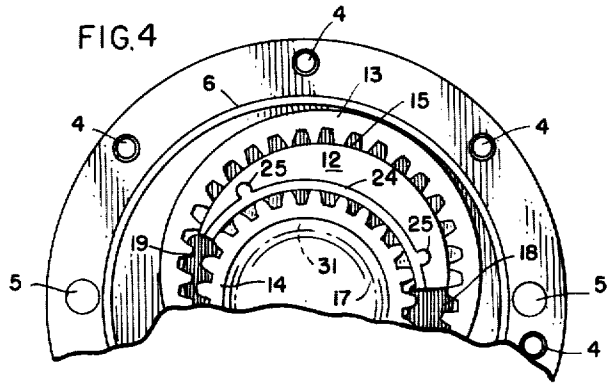


FIG. 5

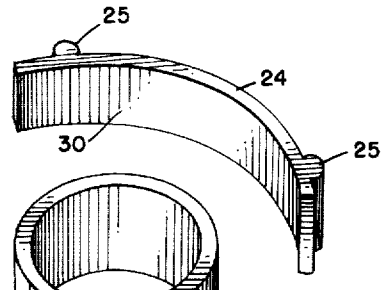
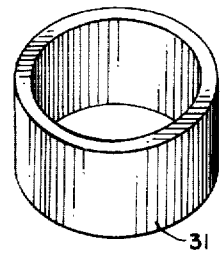


FIG. 6



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OIL PUMP

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6 Claims. (Cl. 103—126)

This invention, in general, relates to fluid gear pumps and, more particularly, to the rebuilding of worn fluid gear pumps, in particular, gear pumps with a worn crescent.

Gear pumps are used, among many different uses, to pump oil for the hydraulic transmissions of automobiles. One type of gear pump to which the present invention is particularly suited is a pump having a central, driven pinion gear which drives an internal ring gear of larger internal diameter than the outside diameter of the pinion gear. A crescent-shaped piece, known as a crescent, is provided in the pump chamber in the space between gears. The teeth of the pinion gear are in close clearance with one side of the crescent, and the teeth of the ring gear are in close clearance with the other side of the crescent. The crescent, in effect, divides the space between gears into two spaced zones whereby oil may be drawn into one zone, carried by the spaces between gear teeth across the crescent, and discharged at a higher pressure from the other zone.

In order to pump oil effectively, the space between the curved sides of the crescent and the gear teeth must be at a close tolerance. Pumps of this type develop over a period of time, however, worn areas on surfaces adjacent the pinion gear. It has been observed that wear on one end of the curved face of the crescent and/or wear on the gear pocket face of the pump housing occurs when the journal bearing of the pump housing for the pinion gear drive shaft becomes worn due to gravity effect of the shaft on the bearing or to misalignment. Eventually, the wear by the pinion gear on the housing becomes substantial enough that the pump provides insufficient pressure to operate the hydraulic transmission.

With such worn gear pumps, it had been the practice up to the time of my invention to replace the worn pump with a new pump. This invention provides a process for rebuilding worn gear pump housings by the machining of the housing, in which process there is mounted in the pump housing a curved insert liner in the worn area of the crescent. This insert liner is then machined to provide a curved face corresponding to the face of the original crescent prior to the development of wear on said face. The mounting of the insert liner and machining of the pump housing are relatively simple mechanical steps, and the combined cost of parts and labor in the rebuilding of the pump housing is considerably less than the cost of replacement of the pump housing.

It is an object of the invention to provide a process for the rebuilding of worn gear pump housings by simple machining operations.

A further object of the invention is to provide a process for rebuilding of gear pump housings which have a worn face on a crescent in said housing.

Still another object of the invention is to provide a machining process used in the rebuilding of pump housings for gear pumps to restore the tolerances in the pump to its design specifications.

A further object of the invention is to provide, as an article of manufacture, a rebuilt gear pump housing with a properly machined, crescent replacement face.

These and other objects of the invention, which will be suggested to those of ordinary skill in the art in the following description of the invention and the embodiment illustrated in the drawings, are attained by practice of the principles of the invention herein described. Other embodiments of the invention utilizing the same or equivalent principles may be used without departing from the true spirit and principles of the invention.

In the drawings:

FIG. 1 represents a front elevation of a gear pump housing adapted to be mounted on an automotive hydraulic, automatic transmission with the gears (shown in phantom) set in place in said housing.

FIG. 2 represents a diametric cross-section in side elevation of the pump housing of FIG. 1 with a cutting tool in the position at the end of the machining of the pump housing in the practice of the invention.

FIG. 3 is a diametric cross-section in side elevation of the rebuilt pump housing.

FIG. 4 is a fragmentary front elevation of the gear pump housing and gears shown in FIG. 1 after the insert for the crescent has been mounted in the housing and the housing has been machined.

FIGS. 5 and 6 are perspective views, respectively, of the snap-in insert crescent liner and the journal bearing bushing for journalling the drive shaft in the pump housing, which parts are inserted in the rebuilt pump housings of the invention.

The pump housing and gears shown in FIG. 1 depict a heavy, metal housing **1** having a peripheral flange portion **2**. The flange portion **2** has a flat, machined face **3**. Tapped holes **4** extend from the face **3** into or through the flange portion **2**, and studs **5** project from the face **3**. These are used in the positioning and attachment of the housing **1** on the transmission housing.

There is an annular weep groove **6** which is interrupted by a drain well **7**. Seepage oil is conducted by the weep groove and also by the passage **8** between the well and the hub **9** to the drain well **7** and is returned to the oil reservoir of the transmission.

The central hub **9** of the housing **1** has an axial hole **10** therethrough. In an off-center position with respect to the hole **10**, the housing has a cylindrical recess **11** opening at the face **3**. The recess **11** is divided on one side by a crescent-shaped member **12**, hereinafter called the crescent. The recess **11** is the race for a close-fitting internal ring gear **13**.

The internal ring gear **13** revolves in the recess **11** with the gear teeth of the gear **13** in close proximity to the curved, outer face **15** of the crescent **12**, carrying oil trapped between the teeth and the face **15** from one end of the crescent to the other end.

The ring gear **13** is driven by the pinion gear **14** whose teeth mesh with gear teeth of the ring gear on one side of the ring gear orbit. The pinion gear teeth revolve in close proximity to the curved, inner face **16** of the crescent **12**, similarly carrying oil trapped between the teeth and the face **16** from one end of the crescent **12** to the other end. The curvature of the inner face **16** is concentric with respect to the hole **10**, and the curvature of the outer face **15** is concentric with respect to the recess **11**.

The pinion gear **14** is driven by a drive shaft connected to the gear **14** by an eared connection **17**. As viewed in FIG. 1, when the gears **13** and **14** are rotated counterclockwise, the chamber **18** between the gears is the feed chamber of the pump, and the chamber **19** at the other end of crescent **12** between the gears is the discharge chamber of the gear pump. The pump housing **1** has small wells or recesses **20** and **21** in its surface opposite the chambers **18** and **19**, respectively. The chambers **18** and **19** are aligned with ports in the face of the hydraulic transmission housing (not shown) on which the pump housing **1** is mounted.

The drive shaft for the gear **14** is journalled in a

journal bushing mounted in the hole **10** of the housing **1**. With misalignment of the drive shaft or the development of wear on the journal bushing, the shaft pressure on the gear **14** causes it to run out of alignment—developing wear on one end of the face **16** of the crescent **12** by the pinion gear teeth and/or causing wear on the face **32** of the inner gear race. As wear persists, the original close tolerances between the revolving gears and the adjacent parts of the pump housing are lost, especially at the face **16** or the face **32**, and the pressure differential between chambers **18** and **19** drops to a point where the pump efficiency is so low that the pump output is too low to operate the hydraulic transmission.

Pumps which have developed this kind of wear have heretofore been scrapped and replaced by new pumps. This invention proposes a process for rebuilding these worn pumps at a cost for parts and labor which is substantially less than the cost of a new pump. In this process, the face **3** is machined in a flat, smooth plane so that it will have a fluid-tight fit when mounted on the transmission housing. The crescent **12** is drilled to provide at least two holes **22** spaced inwardly from and parallel to the face **16**. The worn face **16** is then machined on a rotary cutting machine, e.g., a lathe or a vertical boring mill, to cut away the worn face to a depth whereby the cutting intercepts the sides of the holes **22** toward the cutting tool. The depth of cut is shown by the curved phantom line **23** on the crescent **12** in FIG. 1. The depth of cut into the holes **22** by the cutting of the new curved faec is less than one-half the hole diameter.

The pump housing is now ready for placement of the insert liner **24** in the housing. The insert liner **24** is a die-cast, curved plate conforming in dimensions and curvature with the freshly cut face of the crescent. It may be made of any suitable metal or even a moldable thermo-setting resin capable of withstanding temperatures in the order of 300° F. or more. It has on its outer surface keys or ribs **25** having a rounded shape and spacing corresponding to the unremoved portions of the drilled holes **22**. The ribs or keys **25** extend transversely across the curved plate **24** and may be cast integrally with or attached to the plate **24**. They have a slight taper, e.g., about 1°, so that they may be press-fitted into the holes **22**. The thickness of the plate **24** is greater than the depth of cut into the face **16**—the plate having an oversized condition so that it can be machined to design tolerance. The crescent at this stage is now ready for the next machining operation.

In the next machining step, the pump housing is machined on a rotary cutting machine, e.g., a lathe or vertical boring mill. The cutting tool is shown in FIG. 2 and comprises a shank **26** and a body portion **27** with a pair of cutting bits **28** and **29**. The bits **28** and **29** are positioned on the body portion **27** to perform two or three machining operations in one movement of the tool into working contact with the workpiece. First, the bit **29** rebores the axial hole **10** to a predetermined diameter to realign the hole. The bit **28** machines the inner face **30** of the oversized insert **24** to a predetermined radius so that the machined, inner face of the insert **24** has a close fit with the teeth of the spur gear **14**. When the face **3** has been, or will be, machined in the rebuilding process, the bit **28** is moved far enough into the housing **1** to machine off from the face **32** of the pinion gear race a cut equal in depth to the depth of material removed from the face **3**. This maintains the distance between faces **3** and **32** at the design specification. Furthermore, the machining of the face **32** restores worn areas to a planar surface.

The final machining step on the gear pump housing is one of removal of stock in the outer gear pocket at the face **36** adjacent the side wall of the recess **11**. This is conveniently done by a trepanning operation on a vertical mill having a pair of cutting bits mounted in a rotary head. The trepanning removes stock from the face **36** in an anular area which is as wide as the distance between the side wall of the recess **11** and the outer wall **15** of the crescent **12**. The depth of cut on the face **36** is equal to the depth of cut by the tool bit **28** on the face **32** so that the machined faces **32** and **36** are coplanar.

After the boring operations, a tubular bearing sleeve **31** is fitted into the machined hole **10**. The sleeve **31** is a bushing which has the proper inner diameter for the drive shaft for the gear **14**. The bushing may be one which extends into the recess **11** as shown in FIG. 3, or it may be approximately flush with the surface **32**. A rubber oil-seal O-ring **33**, positioned in an annular mounting ring **34**, is mounted in the cylindrical bore **35** of the hub **9** to prevent oil leakage from the drive shaft journal. The gears **13** and **14** are put into place, and the rebuilt gear pump is ready for use (FIG. 4).

It will thus be seen from the foregoing description, considered in conjunction with the accompanying drawing, that this invention provides new concepts in the rebuilding of worn, positive displacement, gear pumps and has novel features, advantages, and characteristics, and accomplishes its intended objectives, including those hereinbefore pointed out and others which are inherent in the invention.

The invention is hereby claimed as follows:

1. In a process for rebuilding gear pumps having a metal pump housing with a drive shaft journal in a central hub of said housing, the axial hole of said drive shaft journal communicating with an off-center recess in the face of said housing, in which recess rotates a pinion gear and an internal ring gear driven by said pinion gear, a crescent-shaped member in said recess between said gears, and said pinion gear rotates in close proximity to the inner curved face of said crescent-shaped member and said ring gear rotates in close proximity to the outer, curved face of said crescent-shaped member, said inner face being worn, the steps comprising machining off of said inner face a predetermined amount of said crescent, securing an arcuate liner to said machined inner face to bring the crescent-shaped member plus liner to an oversized condition, machining said liner to a radius of curvature corresponding to the radius of curvature of the inner face of the original crescent-shaped member, reboring the axial hole in said hub, and mounting a cylindrical bushing in said rebored axial hole.

2. The process as claimed in claim 1 wherein said crescent is drilled to provide axially-directed drill holes spaced inwardly from said inner face, said inner face of said crescent is machined to a depth to intercept one side of said drill holes, said liner is provided with axially-positioned, rounded, slightly tapered keys of a diameter substantially equal to the diameter of the drilled holes, and said keys are press-fitted in said holes to mount said liner on the machined crescent.

3. In a process for rebuilding gear pumps having a metal pump housing with a drive shaft journal in a central hub of said housing, the axial hole of said drive shaft journal communicating with an off-center recess in the face of said housing, in which recess rotates a pinion gear and an internal ring gear driven by said pinion gear, a crescent-shaped member in said recess between said gears, and said pinion gear rotates in close proximity to the inner curved face of said crescent-shaped member and said ring gear rotates in close proximity to the outer, curved face of said crescent-shaped member, said inner face being worn, the steps comprising machining said face of said housing in a flat plane, machining in a flat plane parallel to said first-mentioned flat plane the annular surface of said housing surrounding said axial hole against which the side of said pinion gear travels at a depth of material removal equal to the depth of material removal at said face of said housing, machining off of said inner face a predetermined amount of said crescent, securing an arcuate liner to said machined inner face to bring the crescent-shaped member plus liner to an over-

sized condition, machining said liner to a radius of curvature corresponding to the radius of curvature of the inner face of the original crescent-shaped member, reboring the axial hole in said hub, and mounting a cylindrical bushing in said rebored axial hole.

4. The process of claim 3 wherein said machining of said annular surface and said inner face is done by a single cutting tool in a single passage of said cutting tool into said housing.

5. A rebuilt gear pump comprising a metal pump housing having a central hub on one side thereof, a rebored aligned, axial hole extending through said hub, a cylindrical bushing mounted in said hole, a planar face on the opposite side of said housing with a cylindrical recess in said face, said recess communicating with said axial hole and being off-center with respect thereto, an internal ring gear in said recess, a pinion gear drivingly engaged with said ring gear, a crescent-shaped member in said recess with the curved, outer face of said crescent in close proximity to the teeth of the ring gear, and a curved plate insert liner mounted on the inner face of said crescent and forming a rebuilt inner face of said crescent with the curved inner face of said liner in close proximity to the teeth of said pinion gear.

6. A rebuilt gear pump housing comprising a metal pump housing having a central hub on one side thereof, a rebored aligned, axial hole extending through said hub, a cylindrical bushing mounted in said hole, a planar face on the opposite side of said housing with a cylindrical recess in said face, said recess communicating with said axial hole and being off-center with respect thereto, a crescent-shaped member in said recess, and a curved plate insert liner mounted on the inner face of said crescent.

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