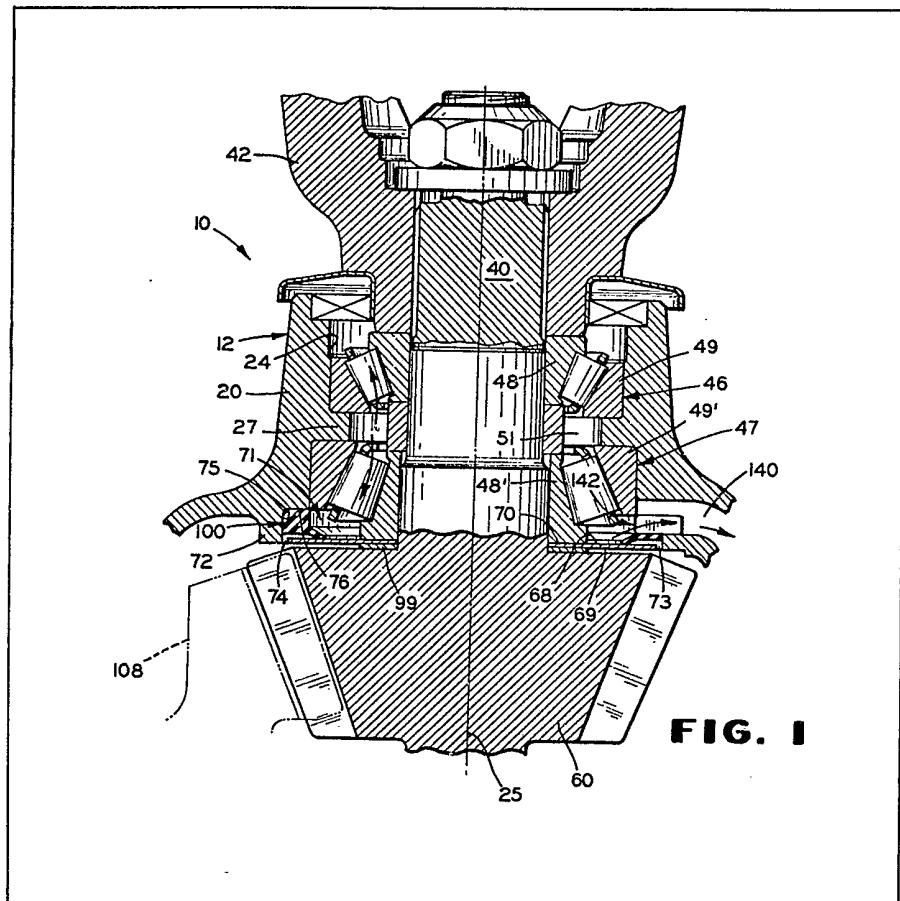


- (21) Application No 8020779
- (22) Date of filing 25 Jun 1980
- (30) Priority data
- (31) 55420
- (32) 6 Jul 1979
- (33) United States of America (US)
- (43) Application published 8 Apr 1981
- (51) INT CL³
F16C 33/66 33/78
- (52) Domestic classification
F2A 210 221 260 5C8
5CR 9P D20 D24
- (56) Documents cited
GB 1487815
GB 1346066
GB 1339920
GB 1248903
GB 1183826
GB 1006327
GB 768240
- (58) Field of search
F1C
F2A
- (71) Applicants
Dana Corporation, 4500
Dorr Street, Toledo, Ohio,
United States of America
- (72) Inventor
Robert J. Ostrander
- (74) Agents
Haseltine Lake & Co.,
Hazlitt House, 28,
Southampton Buildings,
Chancery Lane, London,
WC2A 1AT, England

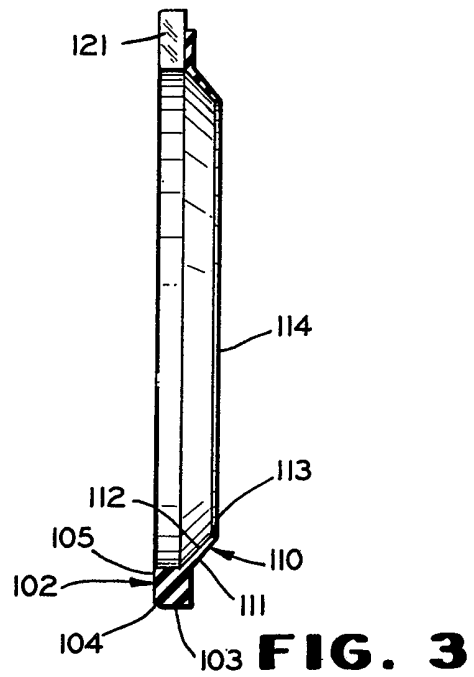
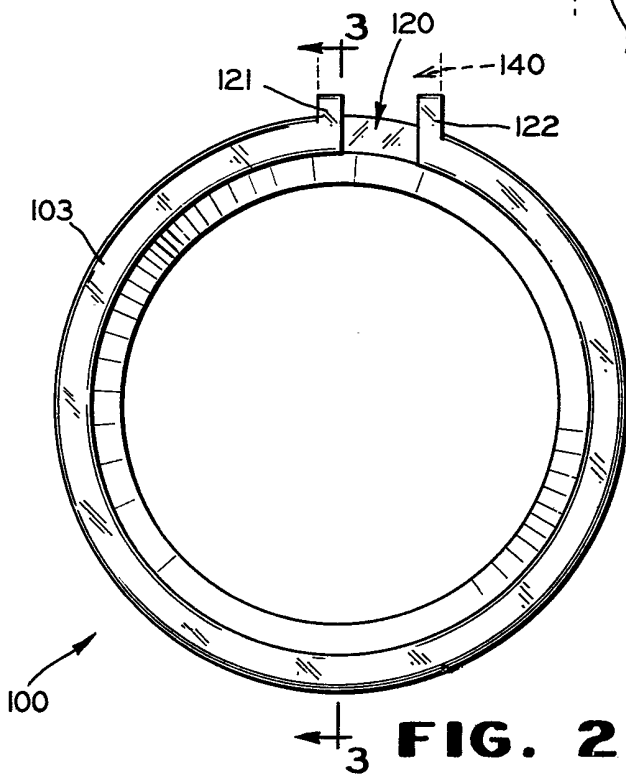
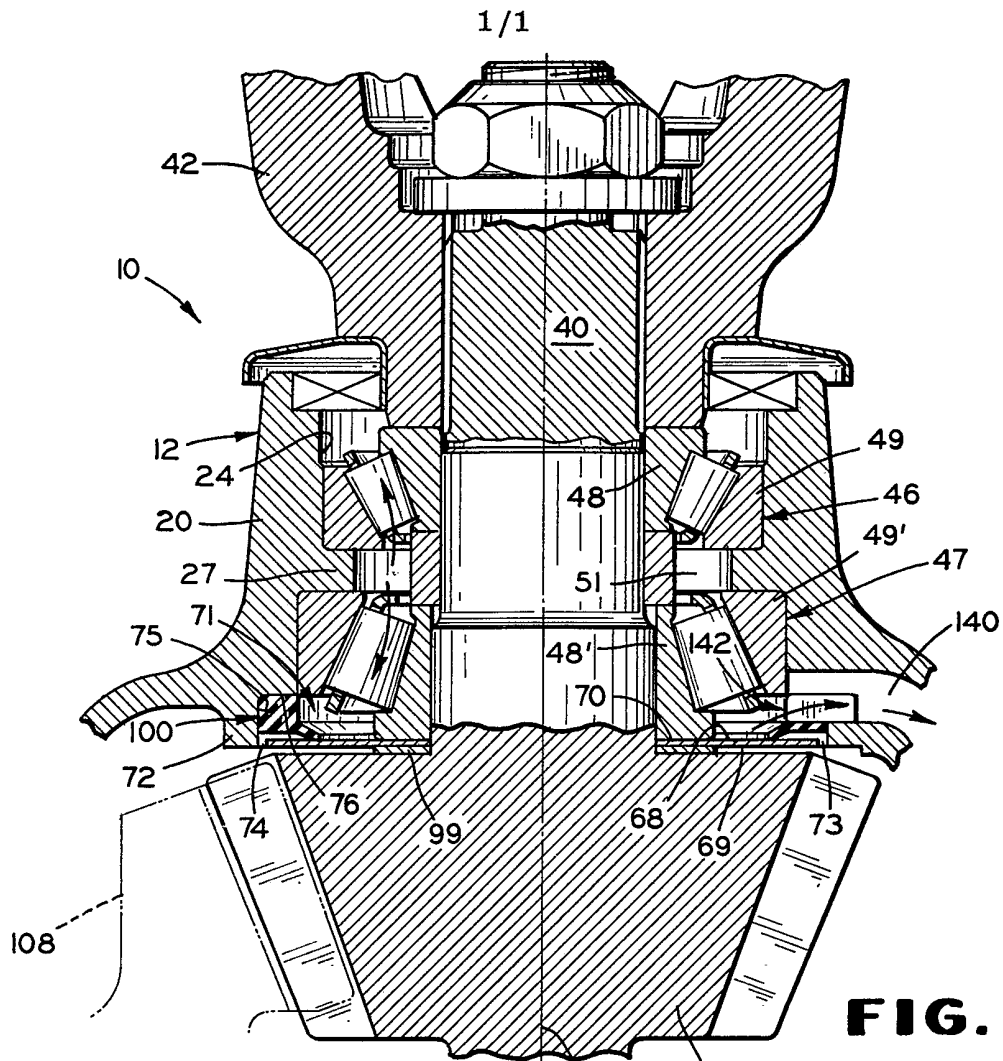
(54) Lubricating shaft assemblies

(57) A rotary assembly, such as an axle shaft (40), is mounted for rotation in a bore (2). A lubrication chamber (71) is bounded by surfaces (75, 76) of the bore, a baffle (69), and a bearing assembly (47). The baffle (69)

rotates with the shaft (40) and acts to pump lubricant from the chamber (71) through an outlet (140) by centrifugal action. A seal (100), having a rib (102, Figures 2 and 3) and a lip (110, Figures 2 and 3), prevents leakage of lubricant through a gap (73) between the baffle (69) and the surface (75).



GB 2 058 240 A



SPECIFICATION

Lubricant flow in a rotary assembly

This invention relates to lubrication systems, for example in drive units.

5 Many types of drive units for transmitting power are well known and are widely used in industrial applications, such as in power take-off units, and in vehicular applications, such as axles. Lubricant flow over the drive unit components lubricates and helps to dissipate heat. For example, lubricant flowing rapidly across the bearings and gears of an axle can absorb heat therefrom and transfer it to the housing, which often has fins or other heat dissipating devices rendering it more capable of such heat dissipation.

10 With the ever-increasing size of drive units used in industrial and vehicular applications, as for example heavy duty truck axles, lubricant circulation becomes increasingly difficult.

20 Increasing speed and load carrying requirements of modern vehicular and industrial drive units have increased the stresses to which these drive units are exposed and have magnified the lubrication problems.

25 A lubricant circulation system disclosed in U.S. Patent Application No. 831,588 and British Patent Application No. 32561/78 assigned to or in the name of the present applicants, the disclosures of which are incorporated herein by reference, has significantly advanced the state of the art by providing a pressurized system for forcing lubricant to critical drive unit components. Unfortunately, previously known seals have not been entirely satisfactory in such a pressurized system.

35 According to the present invention there is provided a rotary assembly comprising a rotary member which is rotatable in a bore and includes a radially extending surface adjacent the bore, an annular lubricant chamber being bounded at least partly by the bore and the radially extending surface, a seal being provided in the chamber and comprising an annular rib which engages the bore and a lip which extends from the rib and engages the radially extending surface.

For a better understanding of the present invention and to show how it may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

50 Figure 1 is a sectional view of part of a drive unit;

Figure 2 is a plan view of a seal of the drive unit shown in Figure 1; and

55 Figure 3 is a sectional view taken along the line 3—3 in Figure 2.

Figure 1 shows the input portion of a drive unit 10 such as a heavy duty truck axle. The drive unit 10 comprises a housing 12 which defines a lubricant reservoir (not shown).

60 The housing 12 includes a boss 20 through which extends a stepped bore 24 defining an input opening and having an axis 25. The bore 24 has an annular ridge 27 for supporting bearing assemblies as will be described later in this

65 description. The bore 24 further comprises an annular and generally axially extending ridge 72 having an annular axially extending surface 75 which terminates at an annular radially extending surface 76. The surfaces 75 and 76 partially define a lubrication chamber.

70 An input shaft 40, having a yoke 42, is rotatable about the axis 25 and extends through the input opening into the bore 24. The input shaft 40 includes an axially inner portion on which a drive pinion 60 is provided. A ring gear 108 meshes with the pinion 60 to drive the axle as is well known in the art.

80 Inner and outer pinion bearing assemblies 47 and 46, respectively, are positioned within the bore 24 on opposite sides of the ridge 27 for rotatably supporting the input shaft 40. A lubricant collection area 51 exists between the bearing assemblies 46 and 47. The pinion bearing assemblies 46 and 47 each comprise an inner race 48 and 48', respectively, rotatable with the input shaft 40 and an outer race 49 and 49', respectively, supported by the surface of the bore 24 and abutting the ridge 27. The bearing assemblies 46 and 47 each include a plurality of circumferentially distributed tapered roller elements, the elements tapering in the direction towards the other bearing assembly (i.e., the smallest diameter portion of each element is exposed to the collection area 51 between the bearing assemblies 46 and 47). The outer pinion bearing assembly 46 is secured within the bore 24 by the yoke 42 which abuts and rotates with the inner race 48. The inner bearing assembly 47 ultimately is held in position by the drive pinion 60. The axially innermost portion of the input shaft is rotatably secured within the housing 12 by a nose bearing assembly (not shown).

90 An annular metal baffle 70 is affixed to the axially inner portion of the rotatable input shaft 40. The baffle 70 has an inside diameter approximately equal to the diameter of the input shaft 40. The baffle 70 is generally flat, having two parallel and radially extending faces 68 and 69 and an annular radially outer surface 74. An annular shim 99 is positioned between the baffle 70 and the pinion 60 to provide proper alignment between the pinion gear teeth and the ring gear teeth. Alternatively, the baffle 70 may axially abut the drive pinion 60 and act itself as a shim for positioning the pinion relative to the ring gear. The thickness of the baffle may then be varied as required.

105 In an alternative construction, the baffle may be an integral part of the input shaft 40 or of the pinion 60. In this specification, including the appended claims, the baffle 70 and the pinion gear 60 may be considered a part of the shaft 40. Therefore, the radially extending surface 68 may be considered as a surface of the shaft 40.

125 The outside diameter of the baffle 70 is smaller than the inside diameter of the ridge 72 to prevent the annular baffle surface 74 from rubbing against the radially inner annular ridge surface 75. An annular gap 73 between the baffle 70 and the

ridge 72 is provided because of the manufacturing tolerances required to press fit the baffle 70 over the inner portion of the input shaft 40. In the presently preferred embodiment, the gap 73 has a maximum width of about .125 inches (3.175 mm).

An annular lubricant pressurization and pump chamber 71 is formed between the ridge 72, the flat, radially extending surface 68 of the baffle 70 and the inner pinion bearing assembly 47. A lubricant passageway 140 integrally formed within the housing 12 extends generally from an axially inward position of the bore 24 to differential and planetary gears of the drive unit (not shown). The passageway 140 has a generally rectangular cross-section with an average depth of about .5 inches (1.27 cm), as seen in Figure 1, and an average width of about 1.25 inches (3.175 cm). The passageway 140 includes an inlet 142 axially positioned between the baffle 70 and the inner roller bearing assembly 47 and an outlet (not shown) adjacent the drive unit gears.

The axle housing is provided with a lubricant return path (not shown) leading from the lubricant reservoir to the lubricant collection area 51 between the bearing assemblies 46 and 47. The tapered roller bearing assemblies 46 and 47 pump lubricant entering the collection area 51 in the direction of the lubricant entering the collection area 51 in the direction of the arrows. A typical heavy duty axle operates at speeds in the range 2800 to 3200 rpm, but the tapered roller elements rotate at a much higher speed, for example at about 10,000 rpm, thereby creating significant pumping forces.

The inner pinion bearing assembly 47 pulls lubricant from the collection area 51 and directs it into the annular pump chamber 71 and against the flat annular baffle 70 which rotates with the input shaft 40 and the pinion 60. The baffle 70 rapidly circulates lubricant within the chamber 71, producing a fluid pressure head therein.

The chamber 71 opens at the inlet 142 of the passageway 140, which can also be considered as the lubrication chamber outlet. The centrifugal forces and the fluid pressure head created by the baffle force lubricant out of the chamber 71 and into the passageway 140. The fluid pressure head is maintained within the lubricant passageway 140 because of its relatively small cross-sectional area. Lubricant is therefore forced through the passageway 140 to its outlet and into the drive unit gears.

As previously noted, the outer surface 74 of the baffle 70 rotates adjacent the surface 75 to prevent excessive lubricant leakage through the gap 73. However, in some applications, the gap may cause excessive leakage of lubricant, thereby decreasing the lubricant pressure head within the pump chamber 71 and the pumping capabilities of the baffle 70.

To avoid this, an integrally molded elastomeric seal 100 is positioned within the lubricant chamber 71. The seal may be molded from any common seal elastomer, such as nitrile.

Positioning the seal 100 within the lubricant chamber provides the significant advantage that the pinion 60 and shaft 40 can be removed from the bore 24 without removing the seal, unlike seals which are located outside the lubricant chamber.

Referring to Figures 2 and 3, the seal 100 includes an annular outer rib 102 which abuts the bore 24. The rib 102 has an annular outer axially extending surface 103 which abuts the surface 75 and an annular radially extending surface 105 which abuts the surface 76. The rib has a rounded edge 104 which conforms to the radius between the surfaces 75 and 76.

A frustoconical elastomeric lip 110 extends from a corner of the rib 102. The lip has an inner surface 112, an outer surface 111 and an annular axially extending surface 113 extending between the surfaces 112 and 111. A sealing edge 114 is formed between the surfaces 111 and 113. The sealing edge 114 is in sliding and sealing contact with the radially extending surface 68. The lip 110 is relatively thin and sufficiently flexible to allow the use of spacers or shims such as 99, which are required for proper gear positioning as previously mentioned, without affecting the seal performance.

The seal 100 has generally radial protuberances or tangs 121 and 122 which extend from the lubricant chamber 71 into the lubricant passageway 140 (shown in phantom in Figure 2). These tangs, along with the frictional contact between the rib 102 and the bore 24, prevent rotation of the seal within the chamber 71. Additional tangs may be added around the seal's circumference in some applications where there are large seal drag forces. The seal rib 102 is partially interrupted by an opening or channel 120 which allows communication between the lubricant chamber 71 and the lubricant passageway 140.

In summary, lubricant entering the chamber 71 is rapidly circulated by the baffle 70, thereby creating a pressure head. Lubricant pressure in the chamber 71 acts against the seal lip surface 112, thereby forcing the lip against the baffle, preventing lubricant from escaping from the lubricant chamber through the gap 73. Centrifugal force urges the lubricant radially outwardly toward the bore 24. The seal lip 110 deflects lubricant away from the baffle to a location where it can readily pass into the lubrication passageway 140.

Although the foregoing structure has been described for the purpose of illustrating a presently preferred embodiment of the invention, it should be understood that many modifications or alterations may be made without departing from the spirit and scope of the invention as set forth in the appended claims.

125 CLAIMS

1. A rotary assembly comprising a rotary member which is rotatable in a bore and includes a radially extending surface adjacent the bore, an annular lubricant chamber being bounded at least

- partly by the bore and the radially extending surface, a seal being provided in the chamber and comprising an annular rib which engages the bore and a lip which extends from the rib and engages the radially extending surface.
- 5 2. A rotary assembly as claimed in claim 1, in which retaining means are provided for preventing rotation of the seal relative to the bore.
- 10 3. A rotary assembly as claimed in claim 2, in which a lubricant outlet extends from the lubricant chamber, and in which the retaining means comprises at least one projection on the seal which extends into the lubricant outlet.
- 15 4. A rotary assembly as claimed in any one of the preceding claims, in which a lubricant outlet extends from the lubricant chamber, and in which an opening is provided in the rib, this opening
- 20 being aligned with the lubricant outlet.
- 25 5. A rotary assembly as claimed in any one of the preceding claims, in which the rotary member includes a baffle on which the radially extending surface is provided.
- 30 6. A rotary assembly as claimed in any one of the preceding claims, in which the rotary member is supported in the bore by a bearing assembly which partially bounds the lubricant chamber.
7. A rotary assembly as claimed in any one of the preceding claims, which is part of a drive unit.
8. A rotary assembly as claimed in claim 7, in which the rotary member comprises a shaft provided with a pinion.
9. A rotary assembly substantially as described herein with reference to and as shown in the accompanying drawings.