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Internal gear pump.

A gerotor pump has an inner rotor (10) with lobes (15) on its outer periphery and an outer rotor (13) with lobes (16) on its inner periphery. The outer rotor (13) is arranged to rotate about an axis which is excentric relative to the axis of rotation of the inner rotor (10) whereby the lobes (15,16) define a series of pumping chambers. The pump further includes an inlet port (21) and an outlet port (22) with sealing lands (23,24) forming seals therebetween. One of the sealing lands (24) includes a groove (26) which extends generally circumferentially across the land from the outlet port (22) but terminates distant from the inlet port (21). The groove (26) acts to enable a gradual equalization of pressures in the outlet port and pumping chambers during operation thereby reducing noise and vibration.

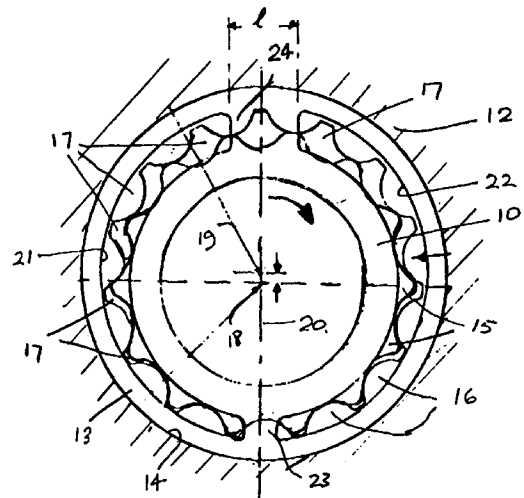


FIG. 1

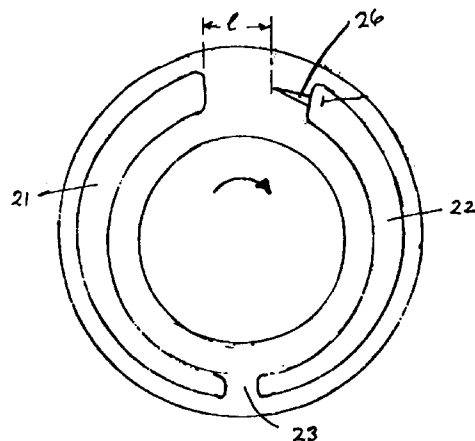


FIG. 2

This invention relates to pumps and is more particularly concerned with gerotor pumps, sometimes known as N(N-1) type pumps.

Gerotor pumps are in common use as engine lubricating pumps, the inner rotor being driven by a shaft geared to the crankshaft or being driven directly from the crankshaft. They are positive displacement pumps in which discrete volumes of oil contained in the pumping chambers pass between suction and pressure ports in the end plates. In consequence the output flow fluctuates due to geometric effects and due to the compression of the low pressure oil as it becomes exposed to the high pressure in the output port. This compression effect becomes more marked if the oil in the sump becomes aerated significantly due to the operation of the engine.

The effect of output flow fluctuation is to cause a pressure variation at a frequency which is a multiple of the number of teeth on the driven rotor and the rotational speed, and under certain circumstances this cyclic pressure variation can cause excitation of the engine structure or associated systems sufficiently to emit undesirable noise.

The purpose of the present invention is to reduce the severity of volume fluctuation, particularly where aerated oil is present. One benefit of this is to reduce undesirable noise in sensitive installations.

According to this invention there is provided a gerotor pump comprising a housing, an inner rotor having a lobed outer periphery and mounted for rotation in the housing, an outer rotor encircling the inner rotor and having a lobed inner periphery, the outer rotor being mounted in the housing for rotation about an axis which is eccentric relative to the axis of rotation of the inner rotor, the lobes of the two rotors interengaging to define a series of pumping chambers, and means defining radial surfaces in sealing engagement with the two rotors at opposite axial sides thereof, at least one of which surfaces has therein a circumferentially extending inlet port, a circumferentially extending outlet port and sealing lands forming seals between the inlet and outlet ports, the sealing land disposed at or adjacent the location at which the pumping chambers have their maximum volume having in its face a groove extending circumferentially from the outlet port towards but terminating short of the inlet port.

In preferred constructions according to the invention, the sealing land having said groove therein has a circumferential length greater than the circumferential distance between successive points of sealing contact between the two rotors at the location of the said sealing land. The circumferential length of the said sealing land may, for example, be $1\frac{1}{2}$ to 2 times the circumferential distance between said successive points of contact.

The invention will now be described in more detail with reference by way of example to the accompany-

ing diagrammatic drawings in which:

Figure 1 illustrates the general arrangement of a gerotor pump having a conventional porting arrangement, and

Figure 2 shows the porting arrangement of a pump according to the invention.

Referring first to Figure 1 of the drawings, the pump comprises an inner rotor 10 mounted on a drive shaft 11 carried in a bearing in the pump housing 12, and an outer rotor 13 rotatably mounted eccentrically with respect to the inner rotor in a cylindrical recess 14 in the housing. The recess is closed off by an end plate (not shown) which forms a seal with the axially outer end faces of the two rotors. The inner rotor has lobes 15 on its outer periphery and the outer rotor has lobes 16 on its inner periphery, the number of lobes on the outer rotor being greater by one than the number of lobes on the inner rotor, so that a series of pumping chambers 17 are defined between the two sets of lobes and have minimum and maximum volumes at opposite sides of the two axes of rotation 18, 19 on extensions 20 of a line joining the two axes. The inner end wall of the recess in the housing forms a seal with the adjacent ends of the two rotors and is formed with a circumferentially extending inlet port 21 and a circumferentially extending outlet port 22. The ports 21, 22 are shown in full lines in Figure 1 for convenience, but are behind the rotors 10, 13. Where the lobes of the two rotors are in deepest interengagement, the end wall of the recess has a first sealing land 23 separating the two ports, and where the lobes are in least deep interengagement a second sealing land 24 separates the two ports. The rotor 10 is driven in the direction of the arrow, so that as each pumping chamber 17 passes the first sealing land 23 its volume is a minimum but increases with continuing rotation, drawing working fluid into the chamber from the inlet port 21. As each pumping chamber reaches the second sealing land 24 its volume is a maximum and is sealed by that land, the circumferential length of the land being substantially equal to the circumferential distance l between the sealing points between the four lobes defining the chamber 17 at that point. As the chamber moves past the land 24 and continues round, its volume reduces progressively discharging its charge of oil to the outer port. In some constructions the sealing land 24 is displaced a few degrees round in the direction of rotation of the rotors to provide more time for the pumping chambers to fill, but the principle of operation is unchanged.

Referring now to Figure 2, the porting arrangement in a pump according to the invention is shown. In this arrangement, the length of the second sealing land 24 is increased, reducing the circumferential length of the outlet port 22 but leaving the inlet port 21 unchanged. The length of the land 24 in this construction is typically up to 2 times the circumferential length l of the pumping chambers as they pass that

land. A groove 26 extends generally circumferentially along the land from the outlet port 22 towards but terminates well short of the inlet port 21. The groove has its greatest cross-section at its end opening to the outlet port and the cross-section reduces progressively to zero at a position spaced from the opposite end of the land by a distance l equal to the distance between the seals of the adjacent pumping chambers.

In operation of the pump described with relation to Figure 2, used as a lubricating pump for an internal combustion engine, the oil which is contained in a pumping chamber is abruptly exposed to the outlet port oil pressure as the pumping chamber moves beyond the downstream end of the sealing land in the arrangement of Figure 1 and this results in a degree of unwanted noise. If the oil has not become aerated the lengthening of land 24 in itself would result in compression of the oil in the pumping chamber owing to the fact that the volume of the pumping chamber has begun to reduce during its past movement the sealing land 24. The effect can be severe if the oil in the pumping chambers is not aerated. On the other hand, if the oil in the pumping chambers is aerated, the compression may be insufficient to raise the pressure in the chamber to the value existing in the outlet port. The presence of the groove 26 operates to permit more gradual equalization of the pressures in the outlet port and the pumping chambers. When the oil is not aerated oil can flow from the pumping chamber along the groove to the outlet port reducing the pressure in the pumping chamber gradually. When the oil is aerated, oil can flow along the groove from the outlet port to the pumping chamber to raise the pressure in the pumping chamber. The progressive nature of this transfer of oil prevents sudden volume changes and hence sudden pressure changes as the pumping chambers come into communication with the outlet port, and thus reduces noise and vibrations which may occur in some installations.

The maximum length of the groove is such as to prevent significant direct leakage past land 24 from the outlet to the inlet port, and for this reason the groove will commence not normally nearer to the inlet port than a distance equal to l .

Claims

1. A gerotor pump comprising a housing, an inner rotor having a lobed outer periphery and mounted for rotation in the housing, an outer rotor encircling the inner rotor and having a lobed inner periphery, the outer rotor being mounted in the housing for rotation about an axis which is eccentric relative to the axis of rotation of the inner rotor, the lobes of the two rotors interengaging to define a series of pumping chambers, and means defin-

ing radial surfaces in sealing engagement with the two rotors at opposite axial sides thereof, at least one of which surfaces has therein a circumferentially extending inlet port, a circumferentially extending outlet port and sealing lands forming seals between the inlet and outlet ports, the sealing land disposed at or adjacent the location at which the pumping chambers have their maximum volume having in its face a groove extending circumferentially from the outlet port towards but terminating short of the inlet port.

- 2. A pump as claimed in claim 1, wherein the sealing land having said groove therein has a circumferential length greater than the circumferential distance l between successive points of sealing contact between the two rotors at the location of the said sealing land.
- 3. A pump as claimed in claim 2, wherein the circumferential length of the said sealing land is between 1 and 2 times the circumferential distance between said successive points of contact.
- 4. A pump as claimed in claim 2 or claim 3, wherein the groove has a cross-sectional area which increases progressively in a direction towards the outlet port and commences substantially at said circumferential distance l from the upstream end of said sealing land.

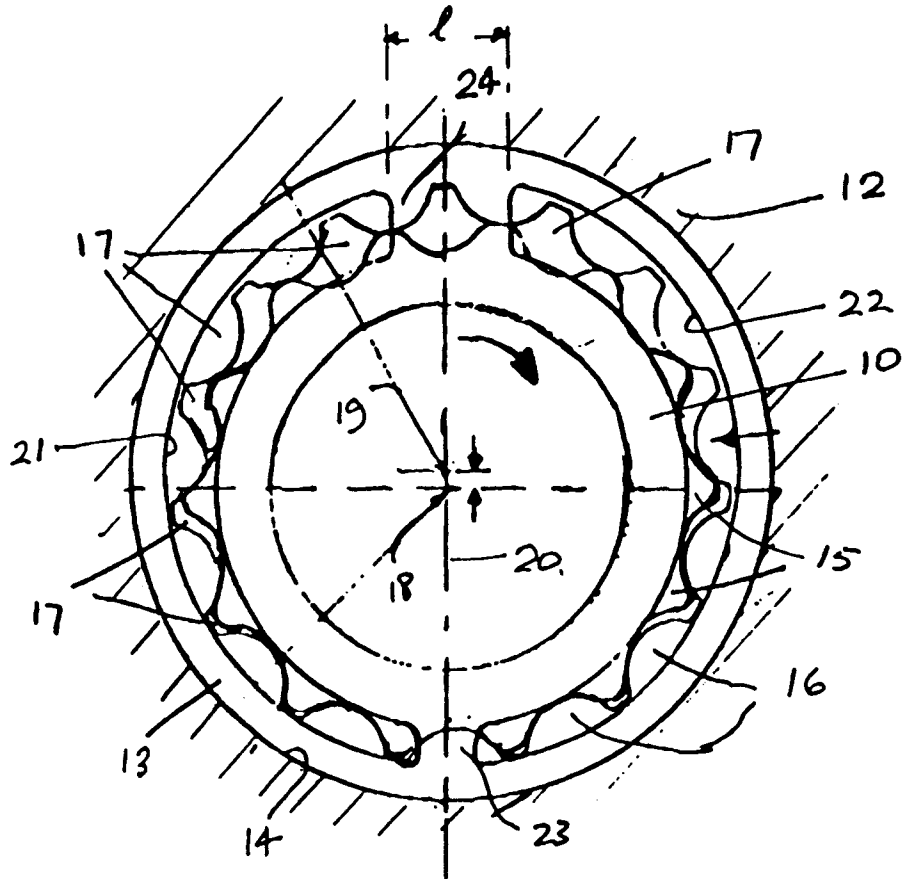


FIG. 1

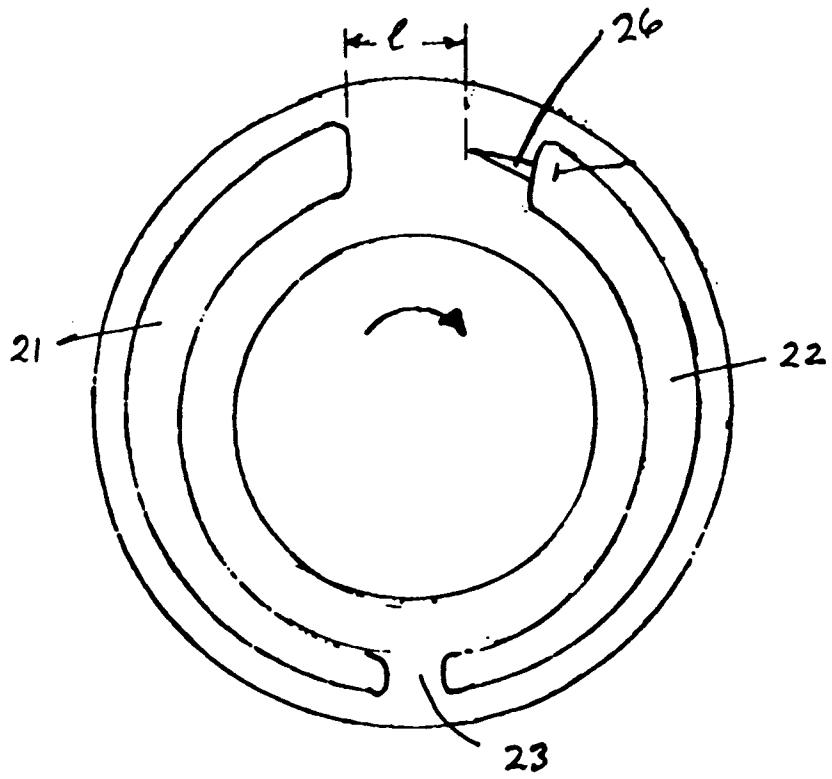


FIG. 2



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 30 0338

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	US-A-4 767 296 (ATSUSHI SATOMOTO) * column 3, line 4 - column 4, line 19; figures 1-6 *	1-4	F04C15/02
X	CH-A-493 740 (DANFOSS) * column 1, line 36 - column 3, line 5 * * column 3, line 47 - line 59; figures * * column 4, line 8 - line 34 *	1,2	
A	GB-A-894 669 (HOBOURN-EATON) * page 2, line 34 - line 89; figures 2,3 * * page 4, line 62 - line 85; figures 5,6 *	1,4	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			F04C
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		11 May 1995	Kapoulas, T
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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