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(54) Variable output internal pump.

(57) A variable output pump is of the gerotor type with a multi-lobed rotor meshed internally of an annulus with one extra lobe, the rotor comprising two parts axially arranged end-to-end and one of which is arranged to be phase shifted by relative rotation. After a 180 degree shift (Figure 5) the chambers formed between the rotors and annulus will comprise one axial part between rotor 10 and annulus 16 which is at maximum volume whilst the adjacent and communicating part between rotor 12 and the annulus will be at minimum volume and hence the pump will be in zero output condition. When both rotor parts are phase synchronised the pump is in maximum output condition ; it can be turned to any intermediate position.

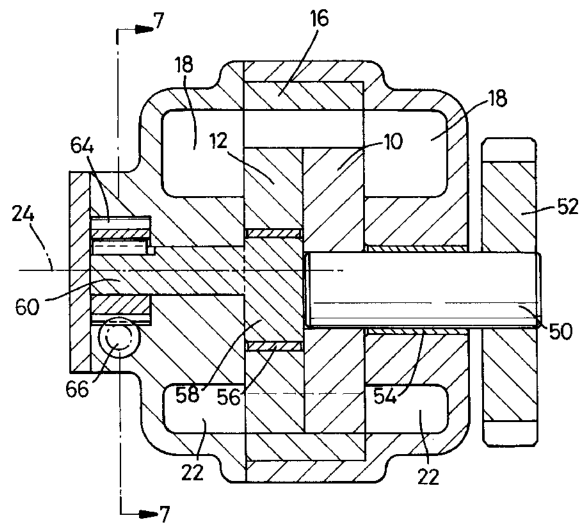

Fig. 6

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This invention relates to pumps of the kind comprising a gerotor set of rotor with n lobes meshed internally of an annulus with n+1 lobes. This creates a set of chambers each defined between successive crests of the rotor lobes. When one rotor lobe is fully meshed with the interlobe space of the annulus, the chambers immediately next to that rotor lobe will be of minimum volume, whereas those more or less diametrically opposed will be of maximum volume. In use, both rotor and annulus turn, albeit at different speeds, and about parallel axes, and each chamber moves about the axes increasing in volume and then decreasing in volume Inlet and outlet ports are located at one or both axial ends of the chambers, and as the chambers move over the inlet port they increase in volume and suck, and as they move over the outlet port they decrease in volume and expel. This is responsible for the pumping action.

With a simple form of pump as herein described, the output volume is directly related to drive speed.

A known type of this kind of pump has the annulus duplicated so that it forms two end-to-end and relatively angularly movable portions. Each annulus lies in an eccentric ring, arranged to be turned to vary the eccentricity of the corresponding annulus relative to the rotor. When both are synchronised in the normal position where a plane containing the axes of rotation of both annulus and rotor lies generally between the inlet and outlet ports, maximum output is delivered, but by turning the two rings in opposite directions output is reduced. This may be considered to be because the chambers formed between the rotor and annuli will not be at minimum volume when they first register with the inlet port and in one case will be reducing in volume for a first part of their orbit, and will not have reached maximum volume when they move out of register with the inlet port: in the other case the chambers will be increasing in volume when they first register with the inlet but will reach and pass maximum volume and hence either not fill completely or will expel some fluid into the inlet port before leaving the inlet port. So the total output is reduced. Such a pump may be used in situations where relatively large volume is needed at low speeds but relatively lower volumes at higher speeds, for example.

EPA 0 076 033 shows a pump of the kind described in the preceding paragraph, but one which has been found difficult to operate. EPA 0 174 734 shows an improved version of the same pump using needle roller bearings in an attempt to overcome the difficulties and EPA 0 284 226 shows a more refined version of the pump in a form which has been commercially successful, but which is expensive to manufacture.

The object of the present invention is to provide similar results but to simplify design and manufacture and hence enable less expensive pumps to be made.

According to the invention, a gerotor pump has a single annulus, and two axially adjacent rotors which are arranged to be relatively angularly adjusted.

Preferably one of the rotors is angularly fixed in relation to a drive shaft, and the other is movable between two extreme positions in which it is respectively synchronised or wholly in phase with the first rotor, and 180 degree shifted to be wholly out of phase with the first. This would give outputs from the complete pump varying between zero and maximum, but in alternative designs variation would be between minimum and maximum, i.e. not down to zero.

The invention is now more particularly described with reference to the accompanying drawings wherein:

Figures 1-5 are diagrammatic representations showing a five lobe rotor engaged in a six lobe annulus and illustrating five different relative angular positions between the two rotor parts

Figure 6 is a sectional elevation of a presently preferred embodiment of the invention; and

Figure 7 is a section taken on the line 7-7 of Figure 6.

Turning first to Figures 1 to 5, the rotor consists of two axially arranged, i.e. end-to-end five lobed rotors 10 12. They are located within an annulus 16 having six lobes. These figures also show the inlet port 18 formed in body 20 and the outlet port 22 also formed in the body. The two ports are generally symmetrical of the plane PP which contains the axis 14 of the rotor 10 and the axis 24 of the annulus.

Figure 1 shows the zero position in which the two rotor parts are phase synchronised: both rotate about axis 14. The rotor lobe which is symmetrically arranged relative to the plane PP is fully engaged with an annulus interlobe space and the maximum diameter chamber is diametrically opposite, i.e. as indicated by the reference numeral 28. Assuming rotation in the direction of the arrow A in Figure 1, the smallest chamber 30 overlaps one end of the inlet port 16 and the next largest chamber 32 overlaps the other end of the inlet port. Similarly chambers 34 36 which are generally opposite to chambers 32 30 overlap the outlet port.

Figure 2 shows the situation when the two rotor parts have been shifted so as to be 45 degrees out of phase. Rotor 10 is still on axis 14 but rotor 12 is on axis 40 which is now spaced from axis 14 and also from axis 24 which is that of the annulus. Each chamber may now be considered to be divided into two axially arranged i.e. end-to-end portions (which necessarily communicate with one another) but the portion composed of the space radially located between rotor 10 and annulus 16 is as in Figure 1, but that between rotor 12 and the annulus is phase shifted so that effectively over the area of the inlet port it is smaller, but over the area of the outlet port is larger.

Figure 3 shows the phase shift carried on so that the axis of the rotor part 12 is now shown by the reference 40 and is 90 degree removed from the plane

PP about the point 24. In this position, the minimum volume chamber for rotor 12 has shifted to be wholly located within the inlet port whereas two equal large volume chambers are both substantially aligned with the outlet port. Figure 4 shows 135 degree phase shift and Figure 5 shows 180 degree phase shift. In the latter case, the maximum volume chamber for the rotor 10 is angularly aligned with the minimum volume chambers for the rotor 12 and the total effect is a zero pumping action.

In short, Figure 1 shows the pump set for maximum pumping activity, Figure 5 shows the pump set for minimum or zero pumping activity, and Figures 2-4 show intermediate stages between these two extremes.

Turning now to Figure 6 which shows the rotors phase aligned, the same reference numbers are used as with Figures 1-5. Rotor 10 is fast with shaft 50 which is also fixed to drive gear 52, and the shaft is bushed at 54 in the pump body. Rotor 12 is bushed at 56 on eccentric 58 carried on shaft 60. In both cases the bushes are merely preferable. Shaft 60 is on axis 62, which is concentric with the annulus. Shaft 60 is also fast with pinion 64.

The pinion is meshed with a rack 66 which conveniently is mounted on piston rod 68 carried by piston 70 and slidable in a cylinder diagrammatically illustrated by the reference numeral 72. The cylinder may be supplied with fluid at either end via shuttle valve 74.

The shuttle valve may be connected to pump output or for example the main lubricant gallery of an I.C. engine being supplied by the pump, so that pressure is communicated via the pipe 76 and can act upon the spool 78 resisted by the spring 80. In the illustrated position fluid flows through the spool, through radial ports in the spool and via the passage 82. It can act upon the piston 70 to displace the rack and turn the pinion.

When the pressure is sufficient to displace the spool against the spring, line 82 is placed in communication with waist 84 on the spool and what was the return line 86 is placed in communication with the line 76 so as to reverse the direction of movement of the piston 70. By selection of the spring relative to the oil pressure involved the pump can be automatically turned between minimum and maximum positions and adjusted to required positions therebetween

It will be appreciated that rotor 12 is driven indirectly by rotor 10 via the annulus. That is to say the shaft 50 turns the rotor 10 which turns the annulus, and the annulus turns the rotor 12.

In another embodiment not illustrated, rotor 12 is journalled on an eccentric bush carried on an extension of the shaft 50.

In a further embodiment also not shown, the annulus is driven, and the two rotors are journalled on respective eccentric bushes each provided with straight tooth spur pinion gears carried on a common axis which is co-axial to the annulus. These pinions are located outside the rotors, i.e. at opposite axial ends of the pump, and arranged to be driven through equal and opposite amounts by a gear drive system for example operated by pump hydraulic pressure acting in a piston and cylinder to drive a rack turning the gears. Hence the axis of each rotor can be shifted through for example 90 degrees, and always in opposite directions, which amounts to 180 degree phase shift possibility with like results as in the first mentioned embodiment. This gives a particularly neat and simple construction.

The simplicity of the present invention, particularly in the version illustrated in Figures 6 and 7, will be appreciated by those skilled in the art especially by comparison with the mentioned prior art.

Claims

1. A gerotor pump having a single annulus and two axially adjacent rotors which are relatively angularly adjustable.

2. A pump as claimed in Claim 1 wherein one of the rotors is angularly fixed in relation to a drive shaft and the other of the rotors is movable between extreme positions relative to said one rotor.

3. A pump as claimed in Claim 1 or Claim 2 wherein the second rotor is journalled on an extension of the shaft which carries the first rotor.

4. A pump as claimed in any preceding claim wherein the other of the rotors is journalled on an eccentric carried by a shaft which is journalled on the annulus axis and arranged to be turned so as to shift the phase of the said other rotor relative to the said one rotor.

5. A pump as claimed in Claim 4 wherein the said drive shaft and the shaft co-axial with the annulus are located end-to-end.

6. A pump as claimed in Claim 4 or Claim 5 wherein said other shaft carries a pinion engaged with a rack.

7. A pump as claimed in any preceding claim wherein the pump body is provided with inlet ports at opposite axial ends and also with outlet ports at opposite axial ends.

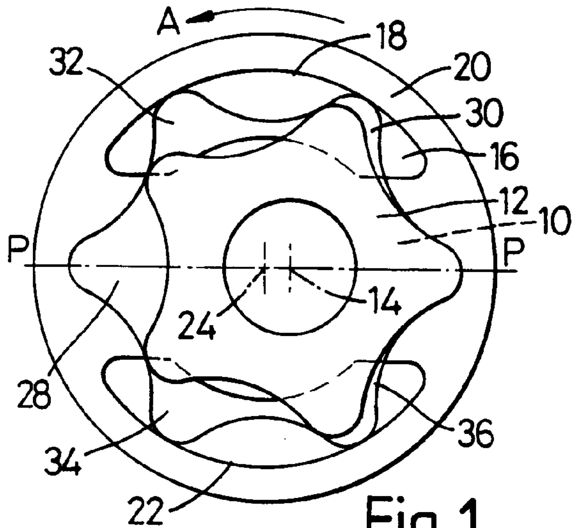

Fig. 1

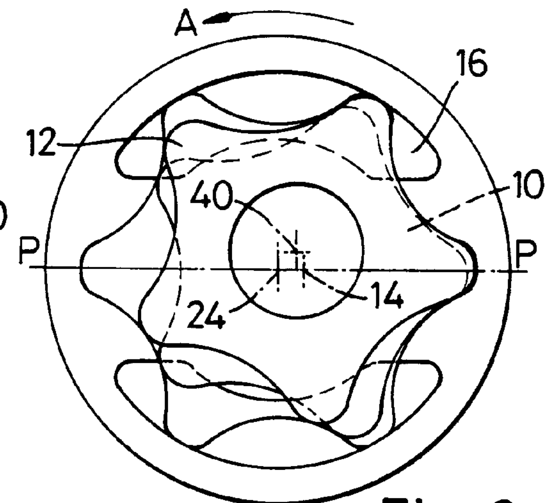

Fig. 2

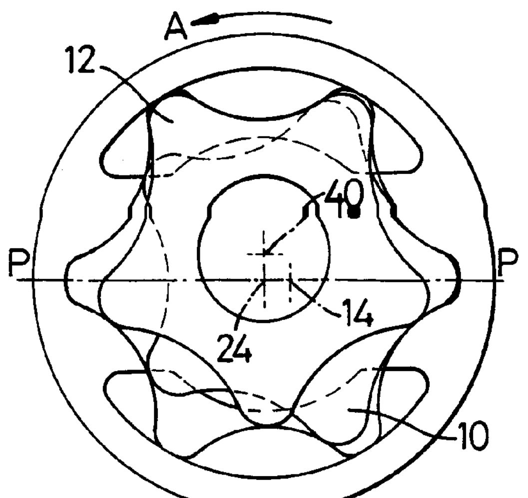

Fig. 3

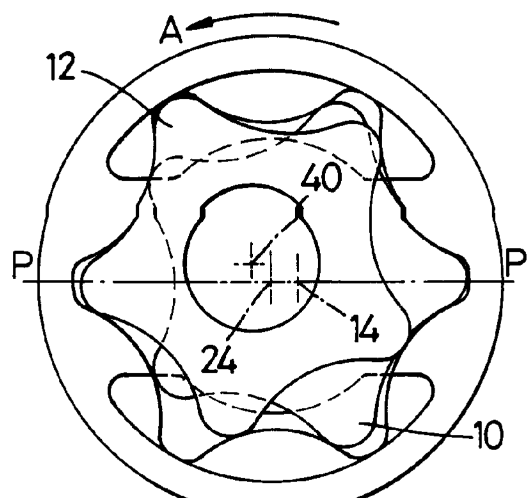

Fig. 4

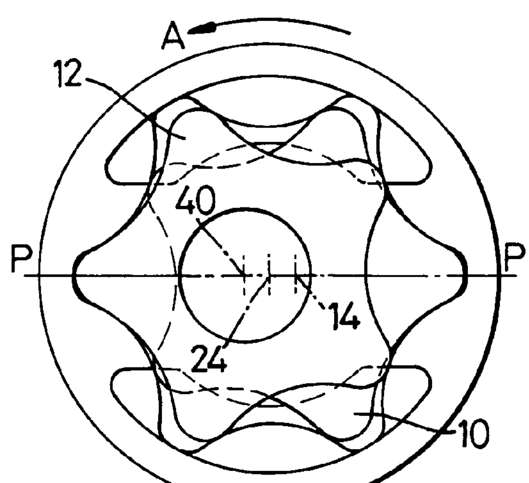

Fig. 5

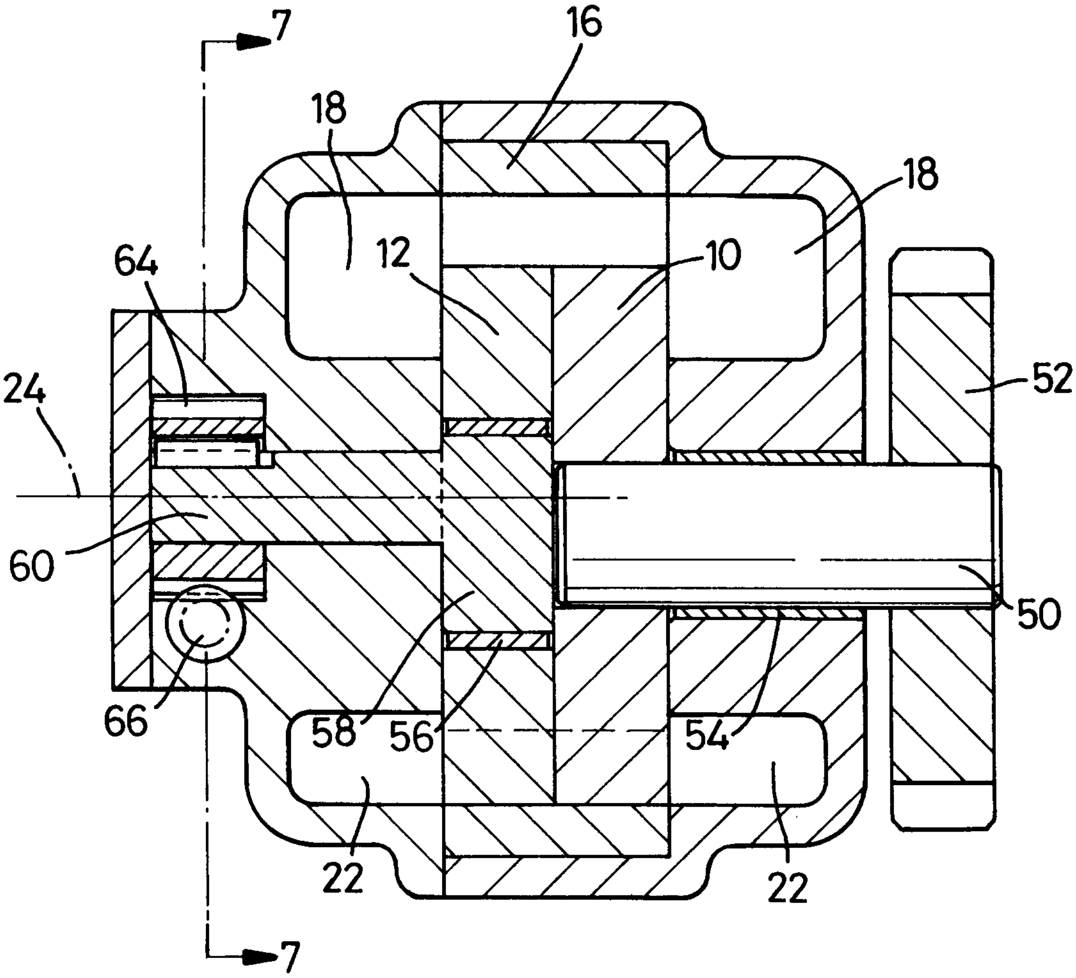

Fig. 6

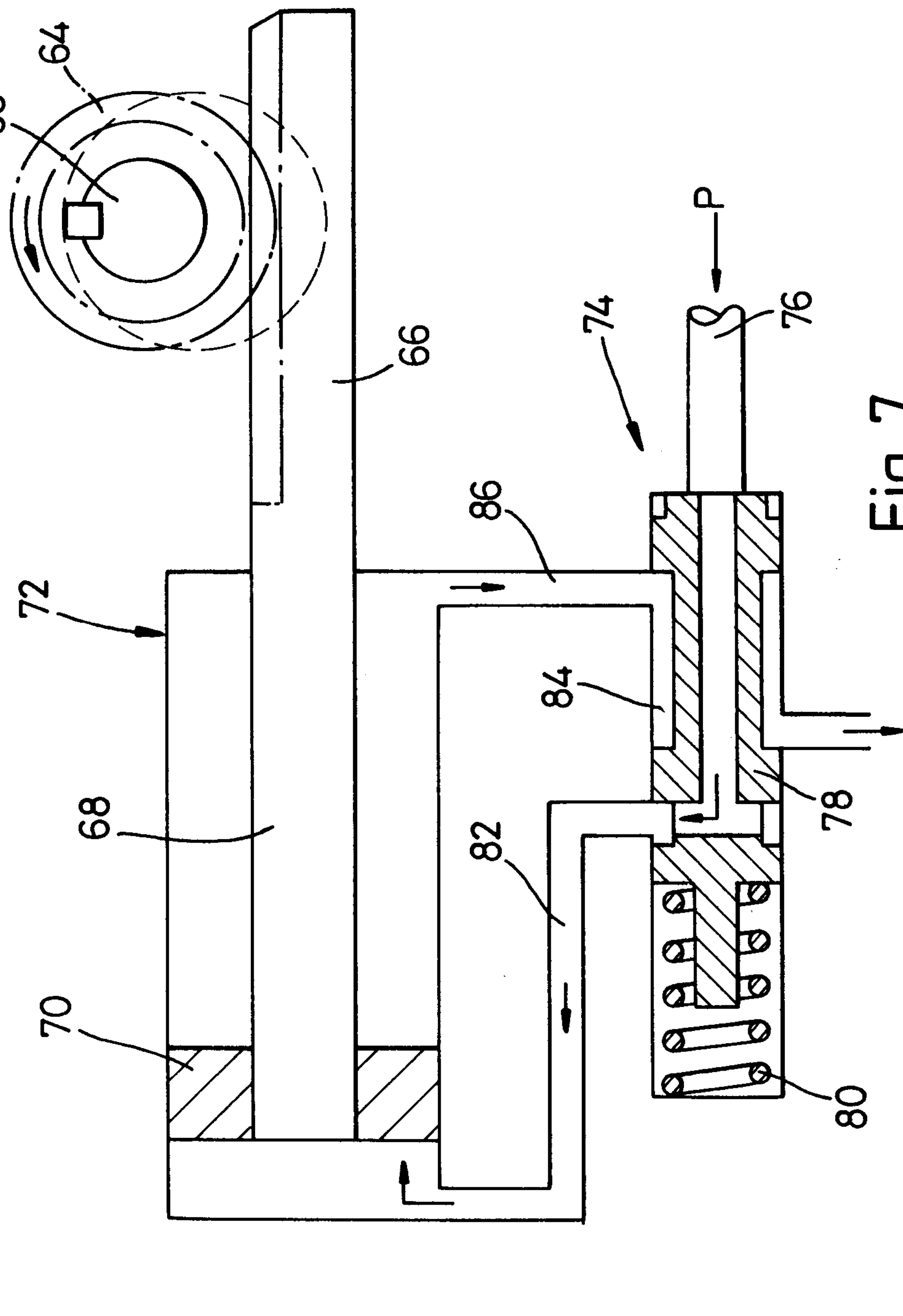

Fig. 7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 93 30 2689

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.5)
A	GB-A-2 120 324 (NEPTUNE SYSTEMS LTD.) * the whole document * -----	1	F04C15/04 F04C2/10
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			F04C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	24 JUNE 1993	DIMITROULAS P.

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
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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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