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ROTARY MOTOR WITH VANED STATOR

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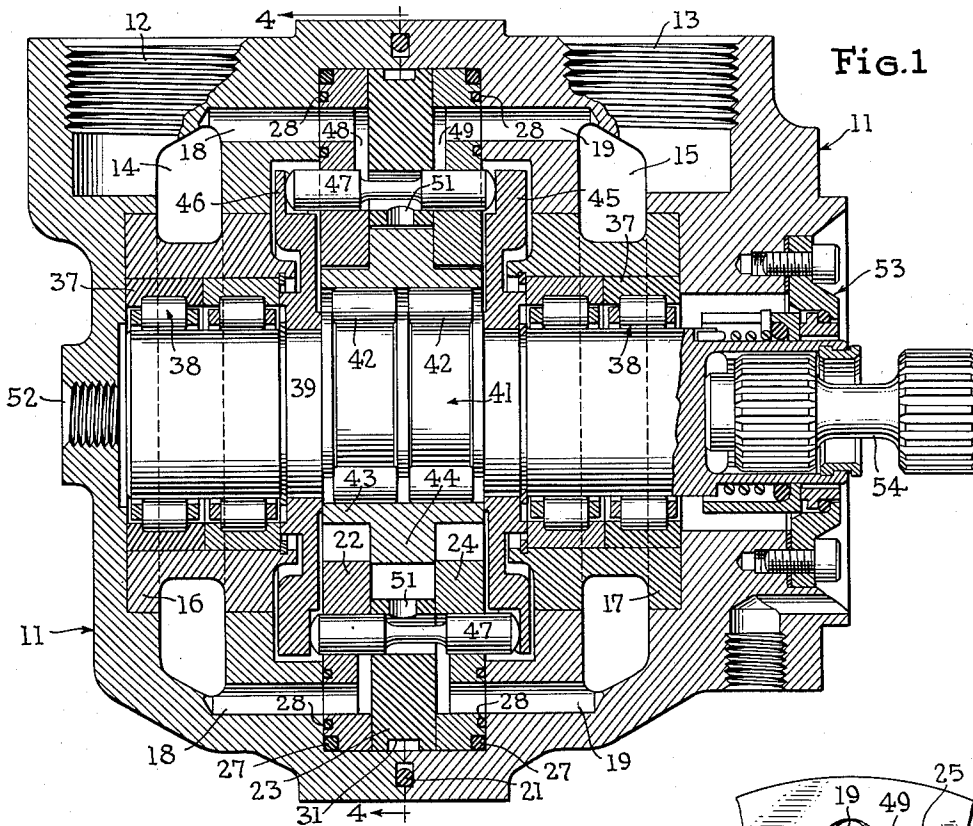


Fig. 1

Fig. 2

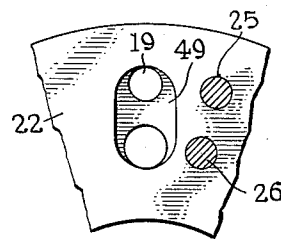
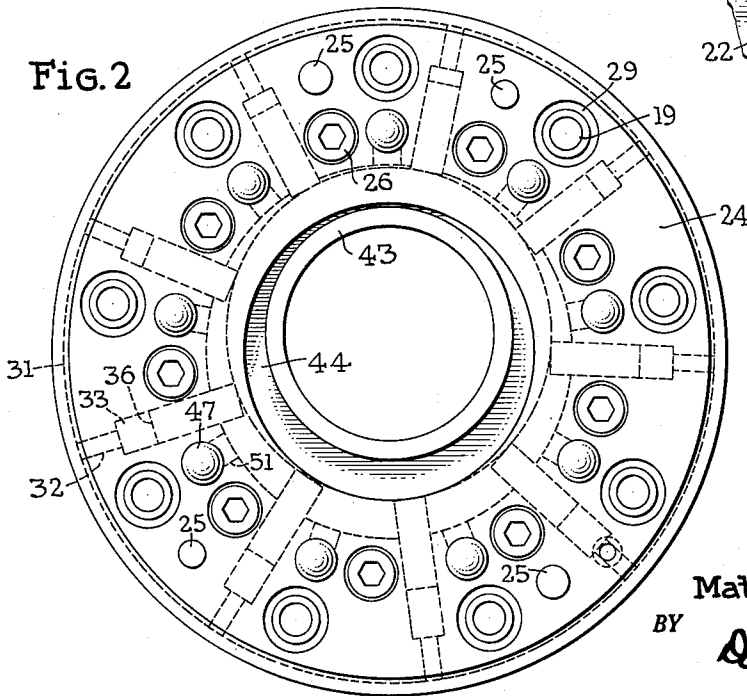


Fig. 3

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FIG. 4

The graph shows a smooth, downward-opening curve on a coordinate plane. The x-axis is labeled from 1 to 9 with tick marks at every integer. The curve starts at (1, 0), rises to a peak at (5, 0.8), and then falls back to (9, 0). The area under the curve is shaded in light blue.

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ROTARY MOTOR WITH VANED STATOR

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8 Claims. (Cl. 103—130)

This invention relates to rotary engines of the positive displacement (sometimes called expansible chamber) type and will be disclosed as embodied in a hydraulic motor. The invention, in its broader aspects is adaptable for use in liquid pumps.

The invention makes use of a rotor disc which is eccentrically mounted so as to rotate freely on a rotary shaft. This disc rolls around in a cylindrical chamber coaxial with the shaft, and seals between plane surfaced face plates, the effect being to define a revolving crescent shaped space which is subdivided into working spaces by vanes which are projected inward from radial guide slots formed in the cylindrical wall of the chamber.

The vanes divide the crescent shaped space into a plurality of working spaces which change in volume as the shaft rotates. Distribution of working fluid (ordinarily oil) is effected by balanced piston valves, one for each working space. The axes of the valves are parallel with the axis of the shaft and the valves are positively reciprocated by a pair of sinusoidal disc cams which turn with the shaft and engage opposite ends of the valves.

The engine may be manufactured with great precision at moderate cost because nearly all working surfaces are either planes or right circular cylinders. Even the sinusoidal surfaces of the cams can be generated with comparative ease, and in such manner as to afford desired valve motion characteristics.

A practical embodiment of the invention has been built and is illustrated in the accompanying drawings, in which:

Fig. 1 is an axial section, the shaft and its journals being shown chiefly in elevation.

Fig. 2 is an end view of the assembly comprising the side plates, rim ring, rotor and valves. The outlines of the crescent shaped space and the vanes are shown in broken lines.

Fig. 3 is a fragmentary view of a portion of the inner surface of a face plate adjacent one of the valve seats, and showing how ports are formed.

Fig. 4 is a section through the assembly shown in Fig. 2, the location of the plane of section being indicated by the line 4—4 of Fig. 1.

Fig. 5 is a development of one practicable cam surface, i. e. one which affords simple harmonic motion. Other forms to give special effects such as accelerated port opening may readily be developed.

Fig. 6 is a section of the double port and check valve arrangement used in reversible engines to subject the outer end of the vanes to the dominant pressure, and so assure their projection into contact with the rotor, regardless of the direction of rotation.

The body 11 of the pump is generally cylindrical in form and is divided on the plane 4—4 into two sections having respectively the connections 12 and 13 which in a reversible motor serve alternatively as inlet and outlet. These connections lead to corresponding ring manifolds 14 and 15 formed partly in the corresponding body sections and partly in the bearing-supporting inserts 16 and 17. From each of the manifolds 14 and 15 branch pas-

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sages 18 and 19 lead to the distributing valves for respective working spaces.

The joint between the two sections of body 11 is sealed by a gasket 21, and the two sections are counterbored from the plane of division to receive and confine an assembly made up of the center ring 23 and the two side rings 22 and 24. The three rings have the same outside diameter, but the inner diameter of ring 23 is greater than that of the two rings 22 and 24, so that the assembly of rings defines an internal channel which is rectangular in cross-section. The rings are held in strict register by dowels 25 and are held together by socket-screws 26 whose heads are countersunk in ring 24 as shown in Fig. 2. The assembly is sealed at its peripheral corners by O-ring gaskets 27 set in corner grooves as best shown in Fig. 1. The ports 18, 19 are sealed by small O-ring gaskets 28 set in ring grooves formed in rings 22 and 24. Such grooves are indicated at 29 in Fig. 2.

The center ring 23 is formed with an encircling groove 31 from which lead a plurality of passages 32 each extending to the outer end of a radial vane slot 33. These slots are formed wholly in ring 23 and are rectangular in form (see Fig. 4). The groove 31 must be fed with pressure fluid from whichever of the connections 12 or 13 is the high pressure connection.

In Figs. 6 and 2 there is shown automatic means for selecting the high pressure connection where the engine is reversible. Reversal requires merely reversal of the supply and discharge connections to 12 and 13. Hence, as shown in Fig. 6, channel 31 is connected to both manifolds 14 and 16, but each connection is controlled by a check valve, 34 and 35 respectively each arranged to permit flow toward channel 31 and close against reverse flow. As a consequence the vanes 36 are forced inward by the highest fluid pressure in the system and so maintain sealing contact with the periphery of the rotor.

Held in the members 16 and 17 by snap rings, as shown, are the outer races 37 of pairs of annular roller bearings generally indicated at 38. These sustain a main shaft 39 having an eccentric portion 41 on which are roller bearings generally indicated at 42. These carry the rotor comprising in one piece a sleeve 43 and an outward extending flange disc 44, which makes a working fit with the rings 22 and 24 between which it extends (see Figs. 1, 2 and 3). The construction is such that the rotor and the assembly made up of rings 22, 23, 24 enclose a crescent shaped space subdivided by vanes 36 into distinct working spaces equal in number with the vanes.

Fixed on shaft 39, between the eccentric portion 41 and the adjacent main shaft bearings are two similar disc cams 45 and 46 which react on opposite ends of the piston valves 47 and impart to the valves one double reciprocation per turn of the main shaft. The motion may be harmonic and Fig. 5 is a diagram showing simultaneous positions of the nine valves indicated in Fig. 2.

The piston valves 47 are ordinary balanced inside cut-off valves. They control extensions 48, 49 of passages 18 and 19 (see Fig. 3) and connect these alternately with a port 51 leading to the corresponding working space. Obviously there are extensions 48 and 49 and a port 51 for each working space. The valve should be designed without positive lap. At moderate speeds zero lap is theoretically practicable, but a small negative lap will commonly be used. One desirable thing about the construction is that the valves may be designed for any desired lap and the cams may be designed to give such characteristics as lead, rapid closing or opening or both. The latitude in cam design is greater where a single direction of rotation is contemplated because if reversal is contemplated asymmetric cams are impossible, though they can be used if the direction of rotation is not reversed.

As shown in Fig. 1, the bearing is blind at the left end of the shaft 39. A drain connection 52 is provided for leakage. At the righthand end of shaft 39 there is a running seal 53 of ordinary form. The member 54 is simply a self-aligning coupling through which the shaft 39 is driven.

The invention provides a rotary device having a plurality of working spaces (nine in the illustrated example) in which the cycles recur in overlapping relation. The construction is adapted for simple and inexpensive manufacture, and can have sufficient mechanical strength to withstand high hydraulic pressures.

What is claimed is:

1. The combination of a body having two fluid connections; shaft bearings mounted in said body; a shaft mounted in said bearings and having an eccentric journal; a disc-like rotor rotatably mounted on said journal, the periphery of the disc being circular and concentric with the journal and the sides of the disc being spaced plane surfaces normal to the axis of the journal; an annular housing fixed in said body and encircling said disc, the housing defining an annular channel bounded by a generally cylindrical peripheral wall coaxial with the shaft and by plane side surfaces normal to the shaft axis and spaced to afford a running fit with the side surfaces of the rotor, whereby a crescent shaped space is enclosed by the housing and rotor; a plurality of vanes reciprocable radially in slots in the periphery of said annular channel, and subdividing said crescent shaped space into a corresponding number of distinct working spaces; means serving to urge said vanes into contact with the periphery of said rotor; a plurality of balanced piston distributing valves, one for each said working space, located outwardly of the working spaces and each reciprocable in a path parallel with the shaft axis to control admission to and exhaust from the corresponding space from and to respective fluid connections; and disc cams fixed on said shaft and engaging said valves to reciprocate the valves.

2. The combination defined in claim 1 in which the means serving to urge the vanes into contact with the rotor comprises a manifold connected with the inlet fluid connection and having branches leading to the slots behind the various vanes.

3. The combination defined in claim 1 in which reversal of rotation of the rotor may be effected by interchanging said two fluid connections as between supply and discharge, and the means serving to urge the vanes into contact with the rotor comprises a manifold connected with the slots behind the vanes, and having one-way flow connections, one with each fluid connection of the body, so arranged as to permit flow toward the manifold and prevent reverse flow.

4. The combination defined in claim 1 in which the body comprises a divided shell in which the bearings are mounted, and between the parts of which is clamped the annular housing composed of three ported rings, namely a middle ring which defines the periphery of the channel

and contains the vane slots, and two side rings which are seated against opposite faces of the middle ring and define the sides of the channel.

5. The combination defined in claim 1 in which the body comprises a divided shell in which the bearings are mounted, and between the parts of which is clamped the annular housing composed of three ported rings, namely a middle ring which defines the periphery of the channel and contains the vane slots, and two side rings which are seated against opposite faces of the middle ring and define the sides of the channel; and dowel pins and threaded connectors arranged to hold said rings in close face contact with their ports in register independently of the confining action of said body.

6. The combination defined in claim 1 in which the eccentric journal on the shaft is interposed between two main shaft bearings, and each of the disc cams is fixed to the shaft between said eccentric journal and a corresponding one of said two main shaft bearings.

7. The combination defined in claim 1 in which the eccentric journal on the shaft is interposed between two main shaft bearings, and each of the disc cams is fixed to the shaft between said eccentric journal and a corresponding one of said two main shaft bearings; the valves are guided solely in ways formed in the annular housing and said housing is clamped between portions of the body in an annular area encircling the area occupied by said valves.

8. The combination defined in claim 1 in which the body comprises a divided shell in which the bearings are mounted, and between the parts of which is clamped the annular housing composed of three ported rings, namely a middle ring which defines the periphery of the channel and contains the vane slots, and two side rings which are seated against opposite faces of the middle ring and define the sides of the channel; the eccentric journal on the shaft is interposed between the two main shaft bearings and each of the disc cams is fixed to the shaft between said eccentric journal and a corresponding one of said two main shaft bearings, the valves are guided solely in ways formed in the annular housing and said housing is clamped between portions of the body solely in an area encircling the area occupied by said valves.

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