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[54] ROTARY-PISTON MOTOR WITH IMPROVED CYLINDER CHAMBER MOVING SEALS

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[51] **Int. Cl.** **F03c 3/00,** F01c 21/04
[58] **Field of Search** 418/266, 267, 268, 178, 418/235; 308/241

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[57] **ABSTRACT**

A rotary variable chamber motor, such as a hydraulic pressure operated motor, having a plurality of chambers each having variable volume as a function of the angular position of a rotary piston assembly. A plurality of radially slideable "working blades" each reciprocating in a corresponding rotary piston slot, serve to separate the plural chambers. Spring means tends to keep each working blade extended radially against the shaped inner wall of a housing in which the piston assembly is rotatably mounted. Each working blade has a relatively large number of small recesses or indentations along a portion of each blade face which is in close frictional contact with a corresponding slot face during operation.

6 Claims, 2 Drawing Figures

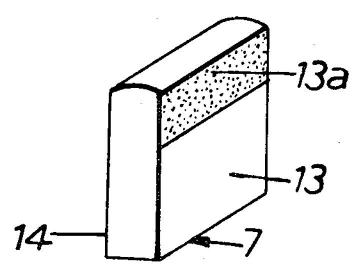

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FIG.1.

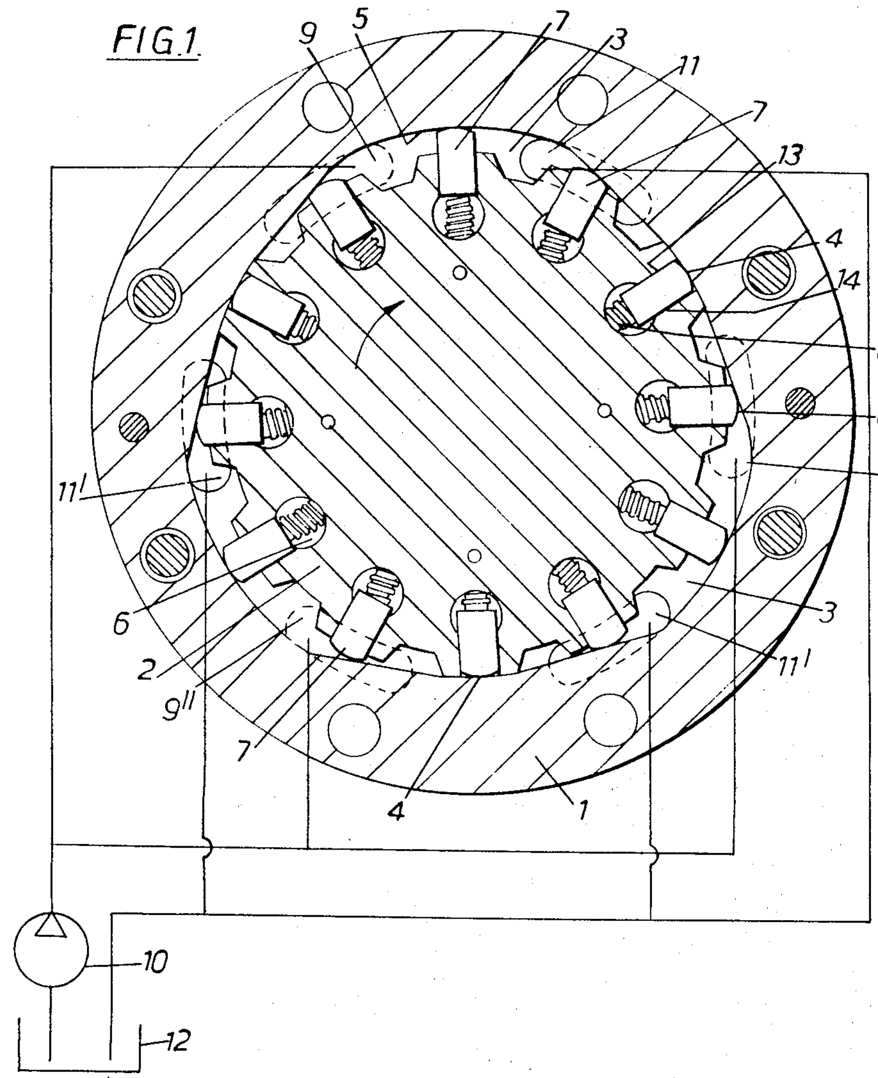
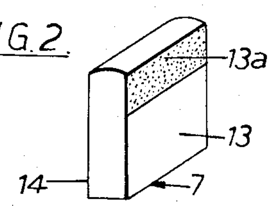


FIG.2.



ROTARY-PISTON MOTOR WITH IMPROVED CYLINDER CHAMBER MOVING SEALS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to rotary variable chamber fluid operated motors, and more particularly to means for reducing friction between "working blades" which reciprocate in corresponding slots of a rotor assembly to act as variable chamber seals against an inner housing surface.

2. Description of the Prior Art

Rotary motors of the type to which the present invention is applicable are well known per se. The invention is particularly applicable to the slow-running rotary-piston motor having a plurality of working blades radially movable within the slots of a cylindrical rotary piston pivoted in a housing, wherein the working blades are sealingly guided in a manner suggestive of a cam follower, along the inner housing wall surrounding the rotary piston and forming crescent-shaped working chambers.

In rotary-piston engines of the above character, the working chambers spaced on the periphery of the rotary piston are separated from each other by the working blades sliding along the inner housing wall. Therefore, reliable and satisfactory operation of the engines largely depends on whether the working blades tightly abut the inner housing wall to be able to efficiently separate the individual working chambers. To achieve this, well-known rotary-piston engines provide for the working blades to be forced against the inner housing wall with the aid of springs acting on their bottom surfaces or by means of hydraulic pressure applied thereto. However, these prior art measures have proved to be insufficient in a large number of cases wherein, in specific working ranges, e.g., at low rotational speeds, the working blades lifted or were not adequately against the inner housing wall and started self-motivated movements, the result being "hydraulic short circuits" (in the case of a hydraulic motor). The reason for this lies in the very high static-friction forces between the working blades and the rotary piston (into which they are slideably fit). That phenomenon is most significant at low rotational speeds and at high hydraulic working pressures when the hydraulic fluid film between the working blades and the rotary piston is interrupted. This problem occurs very frequently in rotary-piston motors when the engines are started from a standstill with maximum load or if sudden load reversals occur.

The manner in which the present invention deals with these prior art problems will be evident as this description proceeds.

SUMMARY

It is the general object of the present invention to provide a rotary-piston engine of the initially described general type, wherein the described malfunctions are eliminated by achieving improved abutment of the working blades against the inner housing wall in all engine working ranges. According to the invention, this is achieved in that the upper portion of the lateral face of the working blades is provided with a plurality of small recesses or holes. These recesses improve the adhesive strength of a fluid film at the upper end of the working blade when the latter is in its retracted position, so that, when the working blade is again moving out of the slot of the rotary piston (rotor), the static-friction forces will be greatly reduced, thus enabling free conformal movement of the working blade against substantially only liquid friction.

To adapt the rotary-piston engine for use in two directions of rotation and to avoid improper mounting of the working blades during assembly, the present invention provides for these recesses to be disposed along the upper portions of lateral face of the working blades. Furthermore, it has been found that excessive wear can be avoided by locating these recesses along the radially outer edge of the working blade surfaces for distance approximating ½ to ⅓ of the working-blade stroke.

The recesses in the lateral face of the working blade preferable have a depth on the order of 1/1000 mm to 4/1000 mm (0.00004 in. and 0.00016 in., approx.) and a diameter between 10/1000 mm and 20/1000 mm (0.0004 in. and 0.0008 in., approx.). The number of recesses is preferably between 300 and 500 per square millimeter.

According to another aspect of the invention, it is possible to produce the recesses either chemically (by etching or corroding) or mechanically by eroding, stamping, hammering or boring. The recesses may also be conveniently produced by sandblasting or ball-blasting. After use of one of these blasting processes, however, the roughness of the blade surface should be reduced to reduce wear. Such a process step may be accomplished through use of an oil stone for smoothing the overall surface portion of the working blade containing the recesses.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view of a rotary-piston engine.

FIG. 2 shows a working blade of the rotary-piston engine of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The illustrated rotary-piston engine (FIG. 1) comprises a cylindrical housing 1 wherein is rotationally mounted a rotary piston assembly 2 also of cylindrical shape. Between the housing 1 and the rotary piston 2 there are provided a plurality of crescent-shaped working chambers, typically 3, separated from each other by points 4 at which the inner wall 5 of the housing 1 abuts a portion of the outer circumference of the rotary piston 2. The rotary piston 2 is provided with radial slots 6 containing radially movable working blades 7. The front or outer ends of the working blades 7 are urged against the inner wall 5 of the housing 1 by means of springs 8 supported by the bottom of the slots 6 and acting upon the bottom surfaces of the working blades 7.

In the lateral boundary surfaces of the working chambers 3 established by the housing 1, there are provided a plurality of generally kidney-shaped connector openings 9, 9′, 9′′ and 11, 11′, 11′′, the former three communicating with a pressure-medium source 10 and the latter three with a reservoir 12. The working blades projecting into the working chambers and resting against the inner wall 5 provide for separation of those portions of the working chambers 3 communicating with the pressure-medium source 10 via the openings 9, 9′, 9′′ from those portions connecting with the reservoir 12 via the openings 11, 11′, 11′′. The pressure difference thereby applied to the working blades 7 generates an engine torque causing the rotary piston **2** to move clockwise as shown in the embodiment of the drawing.

Radial movement of the working blades **7** is determined by the outline of the inner wall **5** of the housing **1.** Within the region of the disconnecting points **4,** the working blades **7** are almost completely retracted into the slots **6** of the rotary piston **2,** whereas in the middle of the working chambers **3** they project out of the slots **6** by the greatest amount. The working-blade stroke is determined by those two extreme positions.

On their way from a disconnecting point **4** to the middle of a working chamber **3,** radial outward movement of the working blades **7** is effected by springs **8** which have to overcome mainly the friction forces acting on the working blades. If the friction forces occasioned are too high, the springs **8** are not in a position to keep the working blades **7** in abutment with the inner wall **5** which may result in the openings **9, 9',** and **9''** to directly communicate with **11, 11'** and **11'',** i.e., a "short circuit" on the pressure source would be produced, this preventing proper engine operation.

To avoid this, the upper portion **13***a* (FIG. 2) of the lateral face **13** of the working blades **7** orthogonal and opposite the direction of rotation of the rotary piston is provided with a plurality of small recesses as can be clearly seen in FIG. **2.** Said recesses cause a pressure-medium film to be maintained between the lateral face **13** of the working blades **7** and the adjacent slot surface in the rotary piston within that period of time in which the working blades **7** are in their retracted positions when overriding the disconnecting points **4.** This expedient prevents mixed or static friction so that the springs **8,** after overriding the disconnecting points **4,** have only the low friction forces resulting from fluid friction to overcome, in order to extend the working blades **7.** It is not necessary to also provide recesses on the lateral face **14** of the working blades **7** facing in the direction of rotation as the working blades engage said lateral face **14** in frictional contact only during retraction into the slots **6.** During that phase of the cycle of working blade operation there is obviously no problem of inadequate blade abutment against the housing inner surface. A large inwardly directed radial force is automatically produced by the outline of the inner wall **5** of the housing **1,** against the force of the springs **8** so that abutment of the working blades **7** against the inner wall **5** will be always ensured in the contracting blade portion of the cycle.

In a rotary-piston engine is adapted for operation in two directions of rotation, it is advisable to provide recesses also along the other portion (i.e. the lateral face **14**) of the working blades **7** in order to stabilize the fluid film for both directions of rotation.

The term recesses as used herein is intended to describe the plural holes, indentations, or other surface depressions produced in the blade face in a band as illustrated, by any of the chemical or mechanical processes referred to hereinbefore. These recesses are very small in size and will have regular surface perimeters if produced by drilling or stamping or some other comparable process, but will have irregular individual recess shapes and depths if effected by etching on some other comparable chemical method. The actual process to be used is substantially a matter of choice in view of costs and other manufacturing considerations. Other methods of forming the recesses and other variations and modifications of the illustrated and described structure will suggest themselves to those skilled in this art. Accordingly, it is not intended that the scope of the invention should be considered limited by the drawings or this description, these being typical and illustrative only.

What is claimed is:

1. In rotary-piston motor having a housing with a shaped inner circumferential surface and a rotor assembly mounted to rotate within said housing, the combination comprising:

a plurality of blades and a corresponding plurality of slots in said rotor assembly, said slots supporting said blades in substantially radial alignment with radially sliding freedom in a fluid medium, said blades having a maximum radial stroke from their most radially outward position to their radially innermost position

means for exerting a resilient force radially outward tending to produce abutment of an outer edge of each of said blades against said shaped inner housing surface;

and means comprising a plurality of recesses of relatively small depth and diameter along a lateral face of each of said blades in sliding contact with a corresponding inside slot face for retaining a film of said fluid between said slot and blade faces forming a band on the outward extremity of said blade faces, the balance of said blade faces being relatively smooth, whereby when said blades are in their radially innermost positions said outward bands are in sliding contact with their corresponding inside slot faces and when said blades are in their most radially outward positions said outward bands are in substantially full contact with said fluid medium radially outwardly of the rotor shafts.

2. Apparatus according to claim **1** in which said band containing said recesses is defined as approximately ⅓ of said stroke in radially measured dimension.

3. Apparatus according to claim **1** in which said band containing said recesses is defined as having a radially measured dimension along said blade surface of ½ to ⅓ of said stroke.

4. Apparatus according to claim **1** in which said motor is defined as being of a type operated by a hydraulic fluid supplied thereto under pressure, and said hydraulic fluid is said fluid medium providing a fluid film whereby said stroke of each of said blades is effected primarily against fluid friction provided by said fluid film, said recesses acting to enhance the effectiveness of said film.

5. Apparatus according to claim **4** in which said individual recesses are defined as having a depth not exceeding 0.004 millimeters and a diameter not exceeding 0.020 millimeters.

6. Apparatus according to claim **4** in which said individual recesses have depths substantially between 0.001 and 0.004 millimeters and diameters substantially between 0.010 and 0.020 millimeters.

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