COOLING AND LUBRICATION SYSTEM FOR ROTARY MECHANISMS

Filed May 27, 1960 5 Sheets-Sheet 1

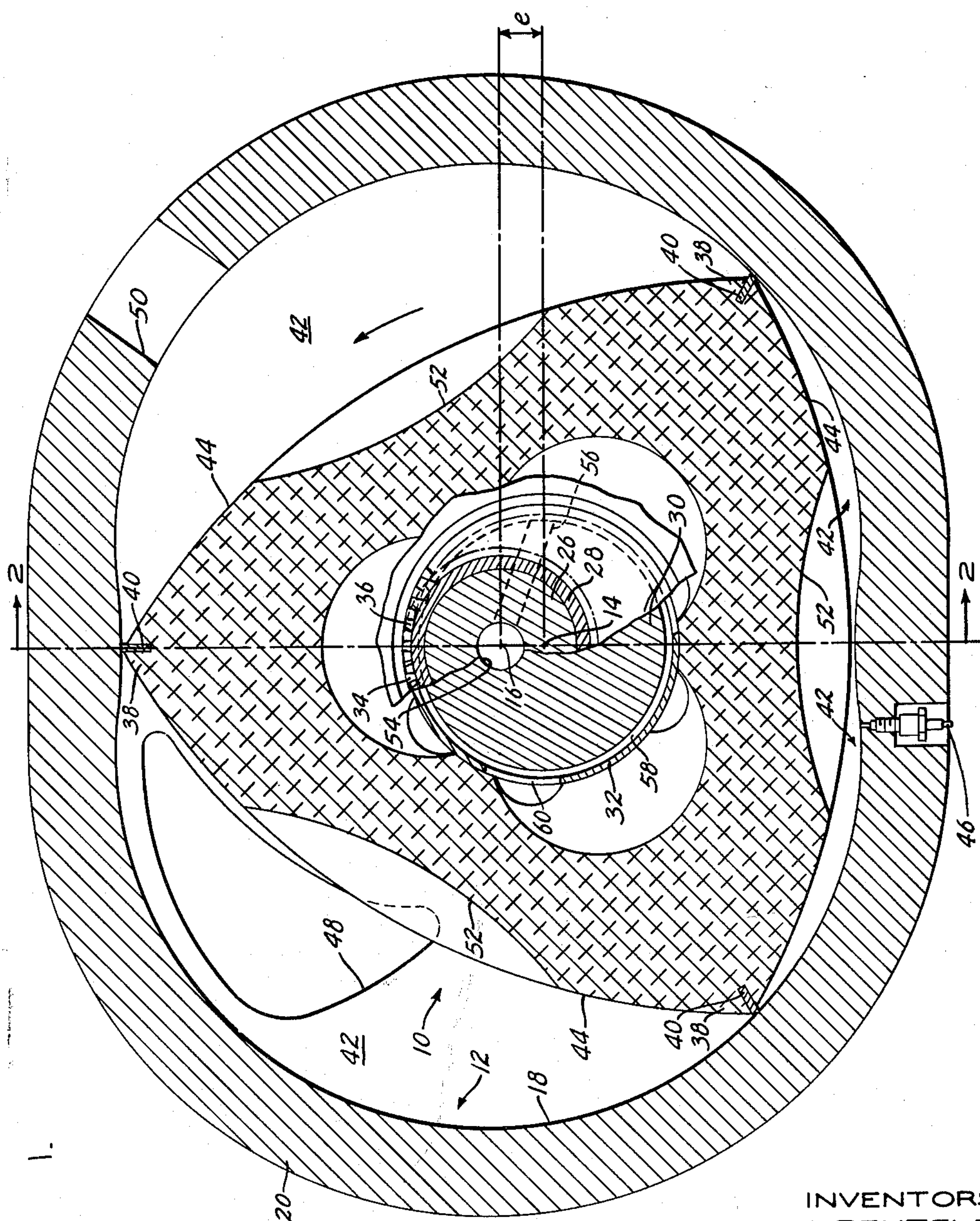


FIG. 1.

INVENTORS
MAX BENTELE
CHARLES JONES
ALEXANDER H. RAYE
BY
Morgan, Finnegan, Durham & Pine
ATTORNEYS

COOLING AND LUBRICATION SYSTEM FOR ROTARY MECHANISMS

Filed May 27, 1960

FIG. 2.

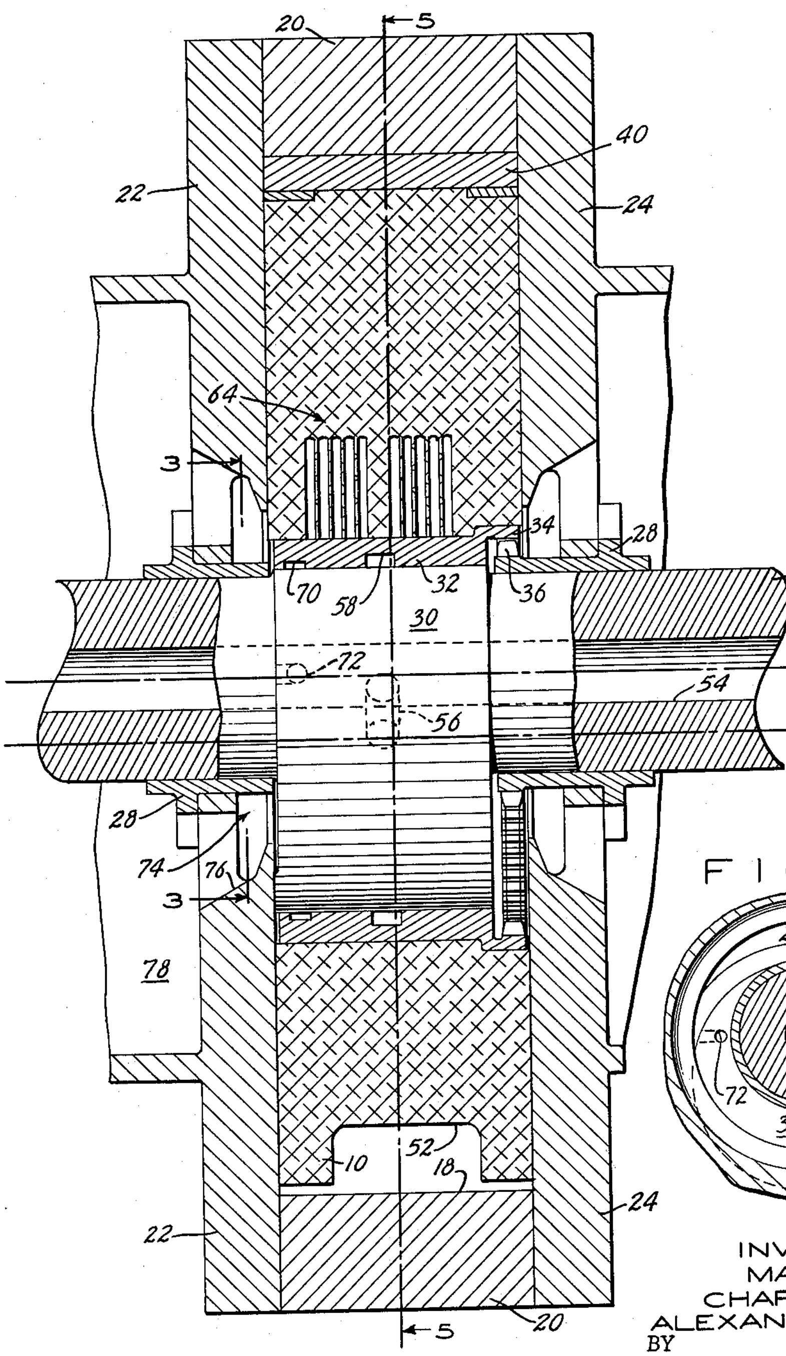
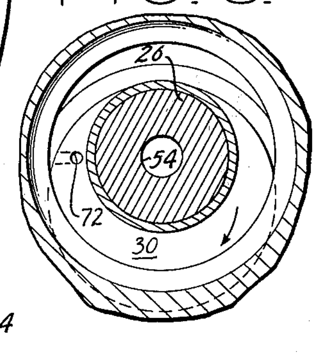


FIG. 3.



INVENTORS
MAX BENTELE
CHARLES JONES
ALEXANDER H. RAYE
BY
Morgan, Finnegan, Durham & Pine
ATTORNEYS

July 23, 1963 M. BENTELE ET AL 3,098,605

COOLING AND LUBRICATION SYSTEM FOR ROTARY MECHANISMS

Filed May 27, 1960 5 Sheets-Sheet 3

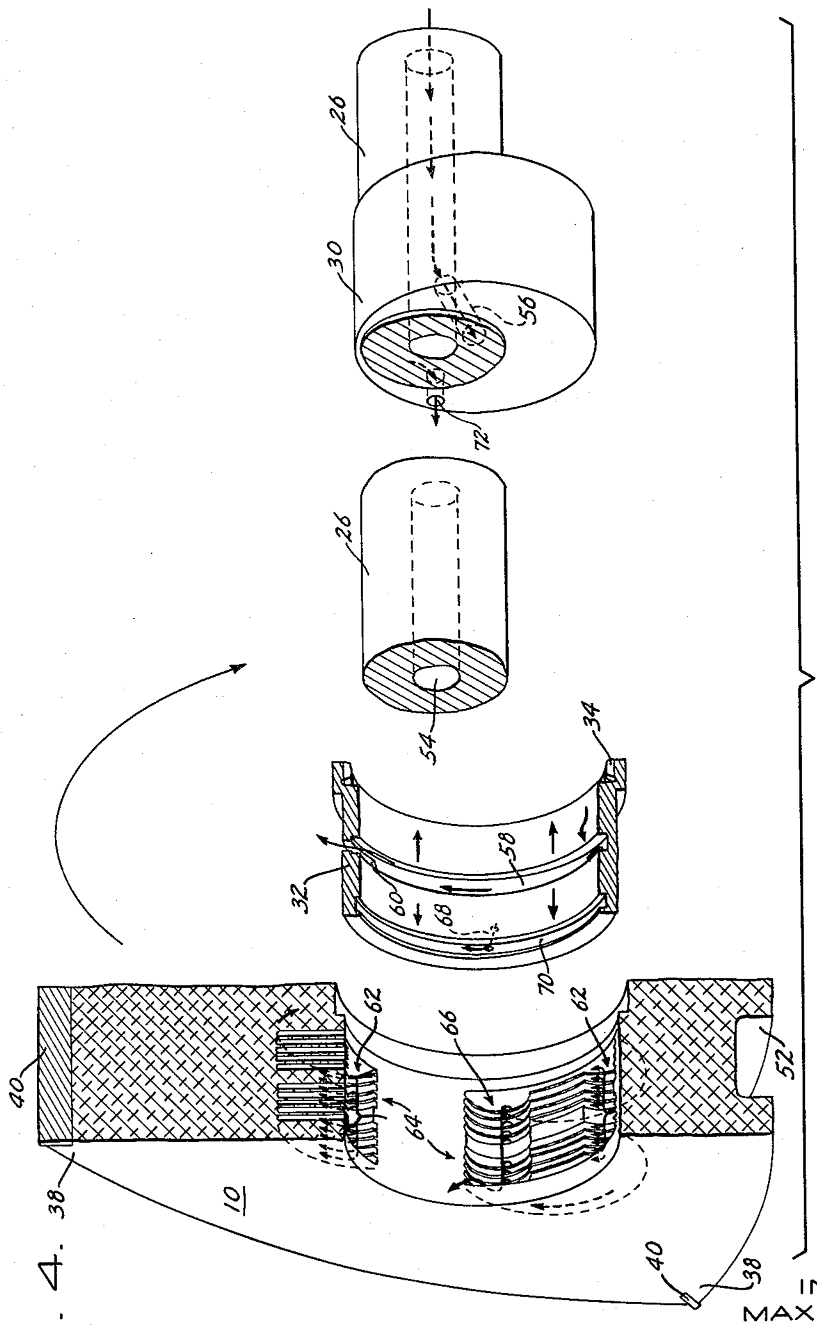


FIG. 4.

INVENTORS
MAX BENTELE
CHARLES JONES
ALEXANDER H. RAYE
BY
Morgan, Finnegan, Durham & Pine
ATTORNEYS

COOLING AND LUBRICATION SYSTEM FOR ROTARY MECHANISMS

Filed May 27, 1960 5 Sheets-Sheet 4

FIG. 5.

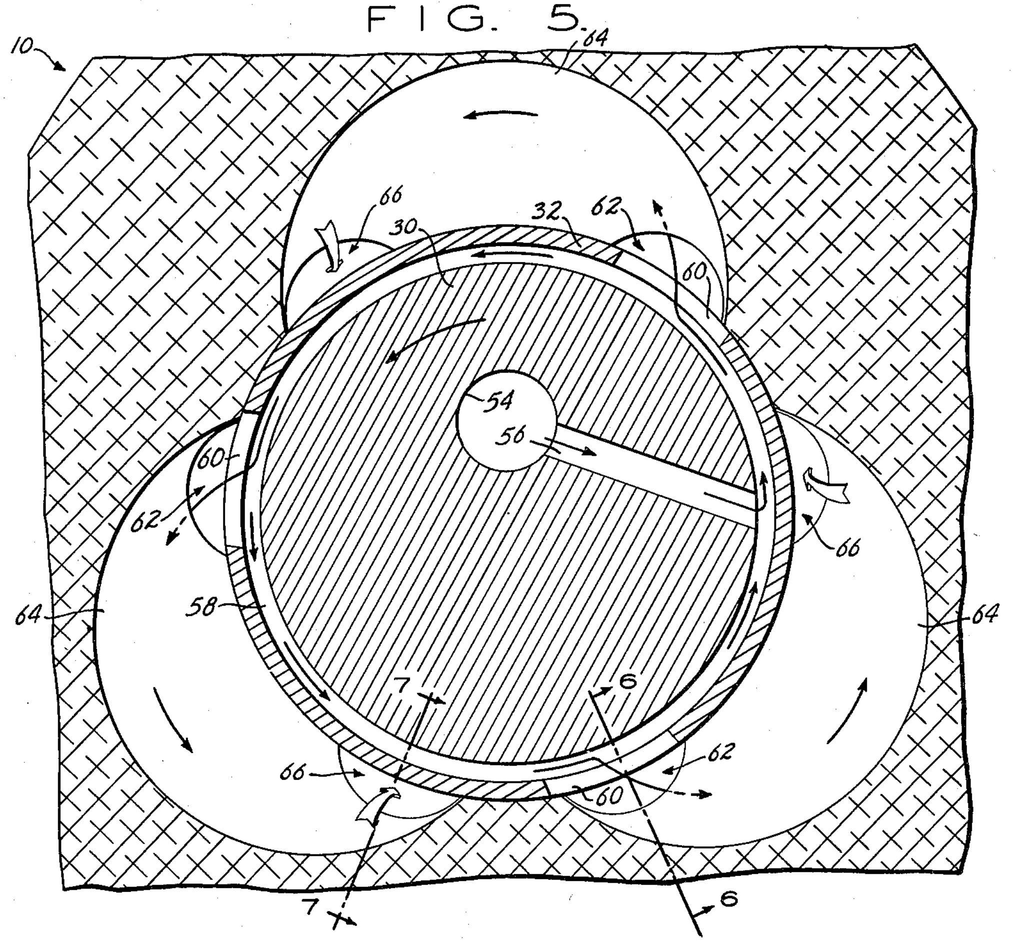


FIG. 7.

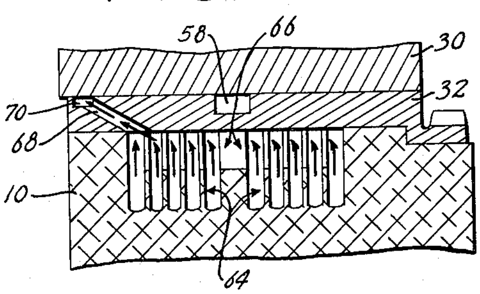
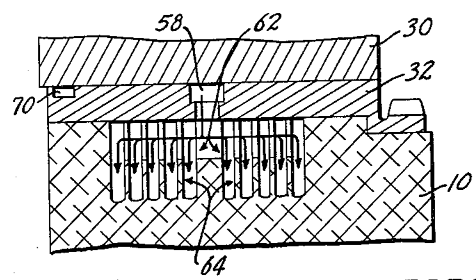


FIG. 6.



INVENTORS
MAX BENTELE
CHARLES JONES
ALEXANDER H. RAYE
BY
Morgan, Finnegan, Durham & Pine
ATTORNEYS

COOLING AND LUBRICATION SYSTEM FOR ROTARY MECHANISMS

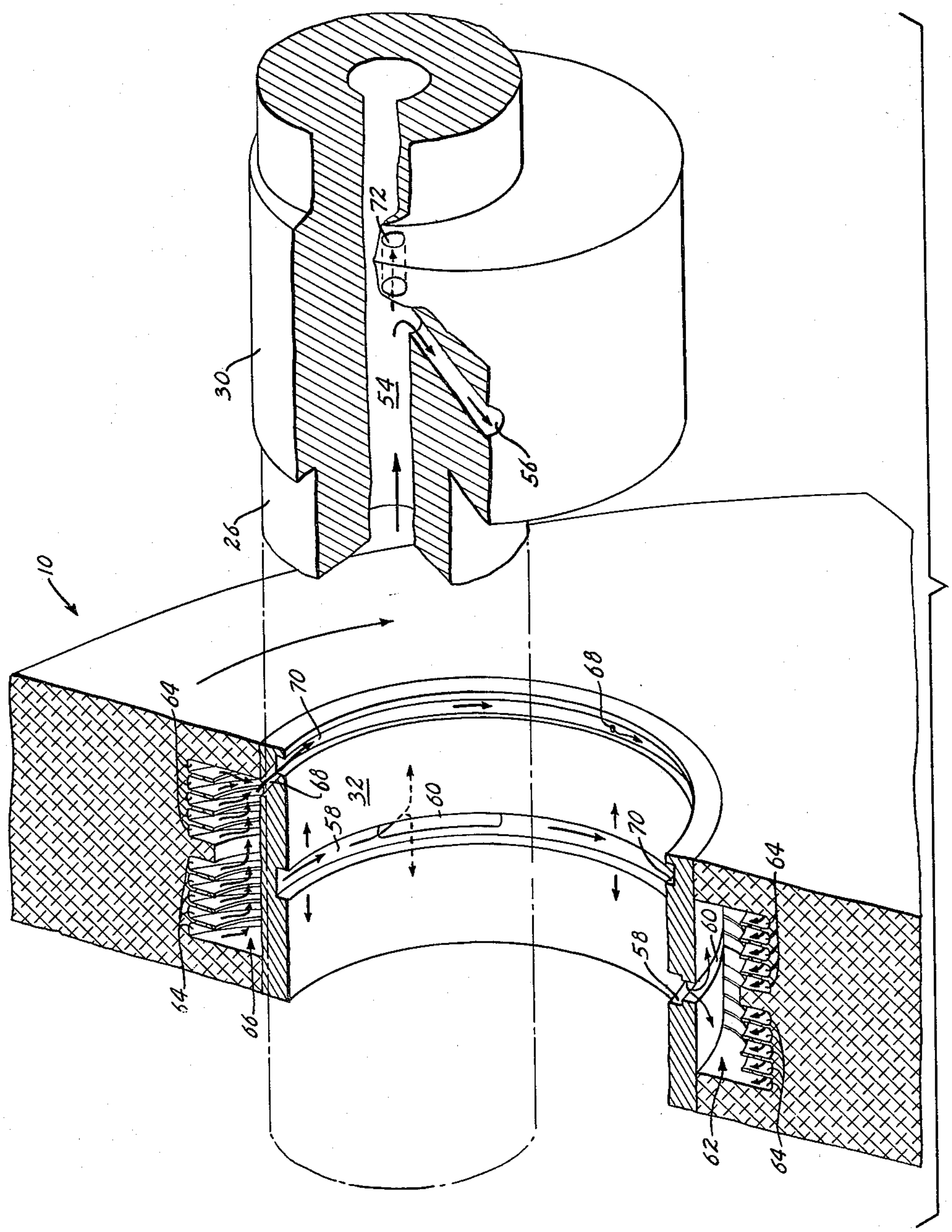


FIG. 8.

INVENTORS
MAX BENTELE
CHARLES JONES
ALEXANDER H. RAYE
BY
Morgan, Finnegan, Durham & Pine
ATTORNEYS

United States Patent Office

3,098,605
Patented July 23, 1963

1

3,098,605

COOLING AND LUBRICATION SYSTEM FOR ROTARY MECHANISMS

Max Bentele, Ridgewood, and Charles Jones and Alexander H. Raye, Paramus, N.J., assignors to Curtiss-Wright Corporation, a corporation of Delaware

Filed May 27, 1960, Ser. No. 32,413
22 Claims. (Cl. 230—210)

The present invention relates to means for cooling rotary mechanisms, and more particularly to a fluid cooling system for the inner body or rotor of such mechanisms.

Although this invention is applicable to and useful in almose any type of rotary mechanism which presents a cooling requirement, such as combustion engines, fluid motors, fluid pumps, compressors, and the like, it is particularly useful in rotating combustion engines. To simplify and clarify the explanation of the invention, the description which follows will, for the most part, be restricted to the use of the invention in a rotating combustion engine. It will be apparent from the description, however, that with slight modifications which would be obvious to a person skilled in the art, the invention is equally applicable to other types of rotary mechanisms.

The present invention is particularly useful in rotary mechanisms of the type which comprise an outer body having an axis, axially-spaced end walls, and a peripheral wall interconnecting the end walls. In such rotary mechanisms the inner surfaces of the peripheral wall and end walls form a cavity, and the mechanism also includes an inner body or rotor which is mounted within the cavity between its end walls.

The axis of the inner body or rotor is eccentric from and parallel to the axis of the cavity of the outer body, and the rotor has axially-spaced end faces disposed adjacent to the end walls of the outer body, and a plurality of circumferentially-spaced apex portions. The rotor is rotatable relative to the outer body, and its apex portions substantially continuously engage the inner surface of the outer body to form a plurality of working chambers which vary in volume during engine operation, as a result of relative rotation between the rotor and outer body.

The inner surface of the peripheral wall of the outer body has a multi-lobed profile which is preferably an epitrochoid and the number of lobes of this epitrochoid is one less than the number of apex portions of the inner body or rotor.

By suitable arrangement of ports, such rotary mechanisms may be used as fluid motors, compressors, fluid pumps, or internal combustion engines. The invention is of particular importance when employed with a rotary mechanism which is designed for use as a rotating combustion engine, and, accordingly, will be described in combination with such an engine. As the description proceeds, however, it will be apparent that the invention is not limited to this specific application.

When the rotary mechanism is designed for use as a rotating combustion engine, such engines also include an intake passage means for administering a fuel-air mixture to the variable volume working chambers, an exhaust passage means communicating with the working chambers, and suitable ignition means so that during engine operation the working chambers of the engine undergo a

2

cycle of operation which includes the four phases of intake, compression, expansion, and exhaust. This cycle of operation is achieved as a result of the relative rotation of the inner body or rotor and outer body and for this purpose both the inner body or rotor and outer body may rotate at different speeds, but preferably the inner bdy or rotor rotates while the outer body is stationary.

For efficient operation of the engine, its working chambers should be sealed, and therefore an effective seal is provided between each rotor apex portion and the inner surface of the peripheral wall of the outer body, as well as between the end faces of the rotor and the inner surfaces of the end walls of the outer body.

Between the apex portions of its outer surface the rotor has a contour which permits its rotation relative to the outer body free of mechanical interference with the multi-lobed inner surface of the outer body. The maximum profile which the outer surface of the rotor can have between its apex portions and still be free to rotate without interference is known as the "inner envelope" of the multi-lobed inner surface, and the profile of the rotor which is illustrated in the accompanying drawings approximates this "inner envelope."

For purposes of illustration, the following description will be related to the present preferred embodiment of the engine in which the inner surface of the outer body defines a two-lobed epitrochoid, and in which the rotor or inner body has three apex portions and is generally triangular in cross section but has curved or arcuate sides.

It is not intended that the invention be limited, however, to the form in which the inner surface of the outer body approximates a two-lobed epitrochoid and the inner body or rotor has only three apex portions. In other embodiments of the invention the inner surface of the outer body may have a different plurality number of lobes with a rotor having one more apex portion than the inner surface of the outer body has lobes.

In a rotating combustion engine of the type described above, as the rotor rotates relative to the outer body, each of its three working faces goes through all four phases of the cycle of operation in succession, i.e., intake, compression, expansion, and exhaust. Accordingly, the total heat input to each face of the rotor during the complete cycle of operation can be substantially high, and this is especially true when the engine is operating at a high number of revolutions per minute.

It has been found desirable to use a rotor fabricated from a light weight metal alloy in many applications of the rotating combustion engine. A light weight metal alloy, such as an aluminum alloy, provides the important benefits and advantages of ensuring a great saving of weight in the principal moving part of the engine, and also provides a rotor having high thermal conductivity. The latter characteristic is particularly beneficial in preventing the formation of hot spots within the rotor, while the former characteristic greatly reduces energy losses due to overcoming inertia of the rotor.

A rotor constructed of a light weight metal alloy, however, demands adequate and efficient cooling, as such alloys will fail by overheating at a considerably lower temperature than a material such as cast iron or steel. Accordingly, although the present invention is in no way limited to light weight metal alloy rotors, it is particularly useful when used with such rotors.

In accordance with the present invention, means are provided for cooling the rotor of a rotating combustion engine during operation, or, more particularly, means are provided for combined cooling of the rotor and lubrication of the shaft and rotor bearing.

In the present preferred embodiment of the invention, the means for cooling the rotor comprise a plurality of sets of passages within the rotor. Each set of passages is equally spaced about the rotor axis and is disposed adjacent to and radially inward from each rotor apex portion. The means for cooling the rotor also comprise a suitable cooling and lubricating fluid, such as oil, and appropriate means for passing and distributing the cooling fluid through the shaft, rotor bearing, and rotor proper in an efficient cooling circuit.

In view of the foregoing, it is a primary object of the present invention to provide a novel fluid cooling system for the rotor of a rotary mechanism.

Another object of the instant invention is to provide a novel fluid cooling system for the rotor of a rotary mechanism in which the cooling circuit has a design which minimizes coolant pressure losses and provides coolant flow passages having smooth hydrodynamic contours, i.e., having no abrupt changes in direction or area, so that the presence of spots in the coolant flow passages which have little or no flow velocity are avoided and eliminated.

Another object of the present invention is to provide a novel fluid cooling system for the rotor of a rotary mechanism which is sufficiently effective and efficient to permit the construction of the rotor from light weight metal alloys, such as aluminum, without danger of overheating of the engine.

Another object of the instant invention is to provide a novel fluid cooling system for the rotor of a rotary mechanism which uses a portion of the mechanism lubricating fluid as the coolant for the rotor.

Another object of the instant invention is to provide a novel fluid cooling system for the rotor of a rotary mechanism which affords adequate cooling of the rotor with a minimum quantity of fluid coolant and yet utilizes coolant passages having a sufficiently large flow area for ease of fabrication and for minimizing clogging of the passages.

Another object of the present invention is to provide a novel cooling system for the rotor which will automatically maintain the coolant flow passages full at all times to minimize losses from turbulence of the cooling fluid.

It is another object of the instant invention to provide a cooling system for the rotor, which will permit the use of one fluid for both cooling of the rotor and lubrication of the mechanism.

Another object of the present invention is to provide a novel cooling system for the rotor in which the coolant passages provide a large and extended heat transfer surface to yield maximum heat transfer or maximum heat input to the coolant.

A further object of the instant invention is to provide a novel fluid cooling system for the rotor of a rotary mechanism which includes means for reducing and minimizing churning and turbulence of the coolant within the rotor to prevent energy losses.

A still further object of the present invention is to provide a restriction in the coolant flow passages at their outlet from the rotor to maintain a full volume of coolant within the coolant passages of the rotor and thereby avoid energy losses from sloshing of the coolant, which may be termed avoidance of the "cocktail shaker effect."

To achieve the foregoing objects, and in accordance with its purpose, the present invention provides means which, as embodied and broadly described, comprise coolant passages within the shaft, shaft eccentric, rotor bearing, rotor, and a collecting ring in the outer body. A suitable coolant fluid, such as oil, is fed into the inlet

of the cooling system in the shaft proper under pressure and is forced to circulate through the combined coolant and lubrication passages. At the rotor bearing the coolant fluid divides and separately lubricates the bearing and cools the rotor.

In the present embodiment, integral fins in each lobe of the rotor provide multiple cooling passages within the rotor with adequate cooling surface to yield maximum heat transfer. At both its inlet and its outlet ends each of these finned coolant passages has a recess which acts as a manifold for distribution and collection of the cooling fluid to and from the finned pasasges.

From the finned passages in the rotor the cooling fluid is returned to an annulus in the bearing and is discharged from this annulus through one or more passages in the shaft ecentric from which the coolant discharges as a jet into a drain annulus in the outer body. The rotor coolant passages have a restriction adjacent to their outlet ends to ensure that the rotor coolant passages or cavities are maintained at full volume of coolant fluid. From the drain annulus in the outer body the coolant fluid is returned to a cooling radiator, and when its temperature has been sufficiently lowered, it is returned to or recirculated through the cooling circuit of the engine.

Additional objects and advantages of the invention will be set forth in part in the description which follows and in part will be obvious from the description, or may be learned by practice of the invention, the objects and advantages being realized and attained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

The invention consists in the novel parts, constructions, arrangements, combinations, and improvements shown and described.

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate one embodiment of the invention and, together with the description, serve to explain the principles of the invention.

Of the drawings:

FIG. 1 is a side elevation of the mechanism with the end wall of the outer body removed to show the rotor positioned within the outer body;

FIG. 2 is a central vertical section of the mechanism taken along the line 2—2 of FIG. 1;

FIG. 3 is a schematic sectional view taken along the line 3—3 of FIG. 2 to particularly show the relation between the terminus of the eccentric exit passage and the outer body drain annulus;

FIG. 4 is an exploded perspective view showing the rotor, the rotor bearing, the shaft proper, and the shaft eccentric, all of these parts being displaced for clarity;

FIG. 5 is a diagrammatic sectional view of the rotor, rotor bearing, and eccentric which particularly shows the path of coolant flow from the hollow shaft, through the shaft eccentric, to the rotor bearing, into the rotor proper, back to the bearing, through the shaft ececntric, and into the housing drain annulus (the latter not being shown); this view is taken on the line 5—5 of FIG. 2;

FIG. 6 is a sectional view taken along the line 6—6 of FIG. 5 which shows the path of coolant flow from the central annulus of the bearing into the inlet manifold of the finned rotor coolant passages and from the manifold into the finned passages themselves;

FIG. 7 is a sectional view taken along the line 7—7 of FIG. 5 showing the path of coolant flow from the finned rotor coolant passages into the rotor outlet manifold, and from there into the exit annulus of the rotor bearing;

FIG. 8 is an exploded schematic perspective view of the rotor, rotor bearing, shaft eccentric, and shaft proper with the shaft and shaft eccentric displaced for clarity; this view which is shown in partially broken out section shows schematically the flow path of coolant fluid through the combined cooling and lubrication system which serves the rotor, rotor bearing, and shaft.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory but are not restrictive of the invention.

Reference will now be made in detail to the present preferred embodiment of the invention, an example of which is illustrated in the accompanying drawings.

In accordance with the invention, a rotating combustion engine and a combined cooling and lubricating system for its rotor, rotor bearing, and shaft are provided. As embodied, and as shown in FIGS. 1 and 2, the present preferred embodiment includes a rotating combustion engine comprising a generally triangular rotor 10 having arcuate sides which is eccentrically supported for rotation within an outer body 12.

Although in the illustrative embodiment shown in the drawings the outer body 12 is fixed or stationary, a practical and useful form of the invention may be constructed in which both the outer body and rotor are rotary, but the eccentric is stationary; in this latter form of the invention, the power shaft is driven directly by rotation of the outer body and the inner body or rotor rotates relative to the outer body.

As shown in FIGS. 1 and 2 and as here preferably embodied, the rotor 10 rotates on an axis 14 which is eccentric from and parallel to the axis 16 of the curved inner surface of the outer body 12. The distance between the axes 14 and 16 is equal to the effective eccentricity of the engine and is designated e in the drawings. The curved inner surface 18 of the outer body 12 has basically the form of an epitrochoid in geometric shape and includes two arched lobe-defining portions or lobes.

As embodied, the generally triangular shape of the rotor 10 corresponds in its configuration to the "inner envelope" or the maximum profile of the rotor which will permit interference-free rotation of the rotor 10 within the outer body 12.

In the form of the invention illustrated, the outer body 12 comprises a peripheral wall 20 which has for its inner surface the curved inner surface 18, and a pair of axially-spaced end walls 22 and 24 which are disposed on opposite sides of the peripheral wall 20.

The end walls 22 and 24 support a shaft 26, the geometric center of which is coincident with the axis 16 of the outer body 12. This shaft 26 is supported for rotation by the end walls 22 and 24 on large and ample bearings 28. A shaft eccentric 30 is rigidly attached to or forms an integral part of the shaft 26, and the rotor 10 is supported for rotation or rotatively mounted upon the shaft eccentric 30 by a rotor bearing 32 which is fixed to the rotor.

As shown in FIGS. 1 and 2, an internally-toothed or ring gear 34 is rigidly attached to one end face of the rotor 10. The ring gear 34 is in mesh with an externally-toothed gear or pinion 36 which is rigidly attached to the stationary end wall 24 of the outer body 12.

From this construction, it may be observed that the gearing 34 and 36 does not drive or impart torque to the shaft 26 but merely serves to index or register the position of the rotor 10 with respect to the outer body 12 as the rotor rotates relative to the outer body and removes the positioning load which would otherwise be placed upon the apex portions of the rotor 10.

As shown most clearly in FIG. 1, the rotor 10 includes three apex portions 38 which carry radially movable sealing members 40. The sealing members 40 are in substantially continuous gas-sealing engagement with the inner surface 18 of the outer body 12 as the rotor 10 rotates within and relative to the outer body 12.

By means of the rotation of the rotor 10 relative to the outer body 12, three variable volume working chambers 42 are formed between the peripheral working faces 44 of the rotor 10 and the inner surface 18 of the outer body 12. As embodied in FIG. 1, the rotation of the rotor relative to the outer body is counterclockwise and is so indicated by an arrow.

A spark plug 46 is mounted in the peripheral wall 20 of the outer body 12, and at the appropriate time in the engine cycle, the spark plug 46 provides ignition for a compressed combustible mixture which, on expansion, drives the rotor in the direction of the arrow.

Also as shown in FIG. 1, one lobe of the epitrochoidal surface 18 is provided with an intake port 48, and the other lobe is provided with an exhaust port 50. As the rotor 10 rotates, a fresh charge is drawn into the working chambers 42 through the intake port 48. This charge is then successively compressed, ignited, expanded, and finally exhausted through the exhaust port 50.

All four successive phases of the engine cycle: intake, compression, expansion, and exhaust, take place within each one of the variable volume working chambers 42 each time the rotor 10 completes one revolution within the outer body, and for each reovlution of the rotor, the engine completes a cycle.

The working faces 44 of the rotor 10 are provided with cut-out portions or channels 52 which permit combustion gases to pass freely from one lobe of the epitrochoidal inner surface 18 to the other lobe, when the rotor is at or near the top dead center compression position. Also, the compression ratio of the engine may be controlled by adjusting the volume of the channels 52.

Since the gear ratio between the rotor ring gear 34 and the outer body gear or pinion 36 is 3:2, each time the rotor 10 completes one revolution about its own axis 14, the shaft 26 rotates three times about its axis 16.

In accordance with the invention, means are provided which will efficiently cool the rotor and which, at the same time, will lubricate the rotor bearing and shaft. As embodied, this combined cooling and lubrication system for the rotor 10, rotor bearing 32, and shaft 26 comprises a central hollow passage 54 within the shaft 26 and having its axis coincident with the axis 16 of the shaft 26. The means also comprises a series of interconnected passages for coolant flow within the shaft 26, shaft eccentric 30, rotor bearing 32, and rotor 10.

One or more radial passages 56 extends from the shaft central passage 54 through the shaft eccentric 30 to the outer periphery of the shaft eccentric where these radial passages communicate with an inlet annulus 58 in the inner diameter of the rotor bearing 32 which is approximately intermediate from the ends of the bearing.

Since the relative surface velocity of the shaft 26 with respect to the rotor 10 is high, the combined lubricating and cooling fluid entering the inlet annulus 58 from the radial feed passage 56 is essentially tangential (FIG. 5). Accordingly, when the combined lubricating and cooling fluid enters the inlet annulus 58, it is revolving at almost shaft speed, and this phenomenon provides a pressure boost to the fluid due to "shaft pumping."

Within the rotor, there is one set of finned passages for each rotor apex portion. Accordingly, the rotor 10 has three sets of finned passages 64, and these finned passages 64 are located adjacent to but radially inward from the apex portions, as shown in FIGS. 2, 4, 5, and 8.

Each set of finned passages 64 is provided with an inlet manifold 62, and the cooling fluid is fed from the inlet annulus 58 through appropriate inlet slots 60 in the rotor bearing 32 into the inlet manifold 62. From within the inlet manifold the coolant fluid is substantially uniformly distributed to the finned passages 64. Similarly, at its outlet end each set of finned passages is provided with an outlet manifold 66 which acts as a collecting recess for the fluid flowing out of the passages 64.

From each outlet manifold 66, the fluid flows through one or more restricted passages 68 in the rotor bearing 32 into an exit annulus 70 adjacent to one end of the rotor bearing 32, preferably the end opposite from the gearing 34 and 36 (FIGS. 4, 5, 6, and 8).

FIG. 6 shows the flow of the cooling fluid through the inlet slot 60 into the inlet manifold 62 and its distribution from the inlet manifold into the finned passages 64. Similarly, FIG. 7 shows the collection of the fluid from the finned passages 64 in the outlet manifold 66 and its flow across the outlet manifold toward one end of the manifold wherein it is directed through the restricted passage 68 and into the exit annulus 70 of the rotor bearing 32.

As can best be seen in FIG. 5, the inlet slots 60 are circumferentially offset from the inlet manifold 62 in a rotational direction opposite to the direction of fluid flow to minimize pressure losses in the fluid by reducing the change in direction which the fluid must undergo passing from the central annulus 58 into the inlet manifold 62.

The series of internal finned passages 64 in the rotor 10 are of sufficient size to permit ease of machining but are sufficiently small to provide a large amount of finned surface area to provide efficient heat transfer.

As can best be seen in FIGS. 4 and 8, a portion of the combined lubricating and cooling fluid is directed from the inlet annulus 58 between the inner surface of the rotor bearing 32 and the outer peripheral surface of the shaft eccentric 30. This portion of the fluid acts primarily as a lubricant rather than a coolant, and spreads between the inner surface of the bearing 32 and the outer surface of the eccentric 30 to provide a continuous oil film which flows axially outward from the central annulus toward each end face of the rotor, so that one portion reaches the gearing side of the rotor and the other portion is collected in the exit annulus 70.

In accordance with the invention, means are provided for carrying the combined cooling and lubricating fluid to a desired collecting point from the cooling circuit within the rotor 10 and shaft eccentric 30. Also, in accordance with the invention, means are provided to ensure that the cooling circuit within the rotor proper is maintained full with fluid at all times to minimize power losses that otherwise might occur because of sloshing of the fluid within the rotor cooling circuit activities.

As embodied, the means for ensuring that the cooling circuit within the rotor proper is maintained full of fluid at all times comprises the restricted passage 68 within the rotor bearing 32. This restricted passage 68 acts as a restricted orifice for the outlet of the coolant fluid from the rotor cavities and thus ensures that the cavities contain a full reservoir of fluid at all times. Since the cavities are continuously maintained full, churning or sloshing of the coolant within the rotor and consequent energy losses are prevented.

In the present embodiment, the means for directing the fluid to a collecting recess within the outer body comprises one or more exit passages 72 in the shaft eccentric 30 and a drain annulus or annular gutter 74 within the outer body.

As shown in FIGS. 2 and 3, the annular gutter 74 is located in the end wall 22 of the outer body 12 and, as shown most clearly in FIG. 3, the outlet end of the exit passage 72 in the eccentric 30 is in the same plane with the axis 16 of the outer body 12. The exit passage 72 forms a slightly restricted orifice so that when the combined lubricating and cooling fluid passes from the exit annulus, where it is under some pressure, through the passage 72, it is formed into a jet having a sufficient component of axial velocity to carry the fluid directly into the annular gutter 74.

The outlet end or terminus of the exit passage 72 is axially aligned with the inlet end of the annular gutter 74 so that the fluid jet from the exit passage feeds directly into the gutter. In this manner, the present invention eliminates the need for an intermediate passage leading from the exit passage 72 to the annular gutter 74.

Because of the centrifugal force on the shaft eccentric 30, a tangential velocity component is necessarily imparted to the exiting fluid. Obviously, it is desirable to keep this tangential velocity component relatively small,

otherwise if the tangential velocity were too great, the fluid might be thrown radially outward and away from the annular gutter 74 into the space between the end wall 22 of the outer body and the adjacent end face on the rotor 10 from whence, in the absence of perfect sealing, the fluid might find its way into the working chambers 42. To keep this tangential velocity component of the fluid jet as small as possible as the fluid leaves the exit passage 72, the outlet end of the exit passage is located as radially close to the shaft axis 16 as possible.

Normally, the exit passage 72 is in the same plane as the shaft 16 as this permits the passage to be bored easily in manufacturing. It is possible, however, to bore the passage so that its direction of flow slants in a direction opposite to that of rotation of the shaft eccentric, and in this manner, the tangential velocity component can be eliminated by subtracting from it the directional component imposed on the passage by the direction given to its bore during manufacture.

The annular gutter 74 is provided at its lower extremity with an outlet passage 76 which carries the fluid from the scupper into a drain reservoir 78. The fluid is then scavenged from the drain reservoir and cycled through a cooling radiator and appropriate filters and other accessories, if needed, and then eventually returned to the system via the shaft central passage 54.

From the foregoing, it is apparent that the novel combined cooling and lubricating system provided by the present invention yields the following positive benefits, advantages, and unexpected results:

(1) The system performs the functions of cooling and lubricating the shaft, rotor bearing, and rotor with one fluid.

(2) The provision of means for imparting an axial velocity to the fluid as it leaves the eccentric permits completion of the cooling circuit from the rotating eccentric to the stationary outer body without the need for an intermediate passage between the eccentric and the outer body.

(3) The provision of means to restrict the flow of the fluid as it leaves the rotor cooling passages ensures that the fluid cavities within the rotor are maintained full at all times and churning or sloshing losses are thus prevented.

(4) The provision of an efficient cooling system for the rotor giving maximum heat transfer capacity permits the use of a light weight metal alloy rotor without danger of overheating the rotor.

(5) The system provides for using a major portion of the lubricating fluid as a coolant, and the lubrication and cooling portions of the combined system are in parallel so that stoppage or failure of a part of the lubrication portion will not affect the function of the cooling portion and vice versa; thus, the virtues of two independent systems are obtained through the use of a combined system which achieves economies by reducing the number of parts and the complexity of design which would be required for two independent systems.

In the foregoing detailed description of the present preferred embodiment, it is apparent that this embodiment is restricted to mechanisms in which the outer bodies are stationary and the rotors and eccentrics are rotary, but it is not intended to limit the scope of the invention to such a mechanism. It is obvious with mechanical changes which would be obvious to a person skilled in the art, alternative embodiments of the invention could be constructed in which both the outer bodies and rotors are rotary and the eccentrics are stationary with the power shaft being taken off the outer body.

Accordingly, the invention in its broader aspects is not limited to the specific mechanisms shown and described, but also includes within the scope of the accompanying claims any departures made from such mechanisms which do not sacrifice its chief advantages.

What is claimed is:

1. A rotary mechanism comprising a hollow outer

body; a rotor mounted within the outer body for rotation relative to the outer body; the rotor having an internal cavity for the flow of a coolant fluid through the rotor; the cavity having an inlet and an outlet, the outlet having a restricted portion for restraining free flow of the fluid and maintaining the rotor cavity full of the coolant fluid; a rotatable shaft having an eccentric portion, the rotor being rotatably mounted upon the eccentric portion; an exit annulus within the rotor communicating with the outlet; a fluid collecting recess within the outer body; an exit passage within the eccentric portion communicating with the exit annulus, the exit passage having a slightly restricted portion for jetting the coolant fluid from the exit passage into the recess.

2. A rotary mechanism comprising a hollow outer body having an axis, axially-spaced end walls, and a peripheral wall interconnecting the end walls; a rotor mounted within the outer body for rotation relative to the outer body on an axis eccentric from and parallel to the axis of the outer body; the rotor having end faces disposed adjacent to the end walls and a plurality of circumferentially-spaced apex portions in sealing engagement with the inner surface of the peripheral wall to form a plurality of working chambers between the rotor and the peripheral wall that vary in volume upon relative rotation of the rotor within the outer body; passage means within the rotor for the flow of a coolant fluid through the rotor; the passage means included an inlet and an outlet; a fluid collecting recess within one end wall of the outer body open toward the adjacent rotor end face; and means for jetting the coolant fluid from the outlet of the passage means into the opening of the recess.

3. The invention as defined in claim 2, in which the fluid collecting recess comprises an annular gutter in the end wall of the outer body.

4. The invention as defined in claim 2, in which the outlet for the rotor passage means is restricted in cross section and in which the fluid in the rotor is under pressure whereby the restriction insures that the rotor passage means is maintained full of coolant fluid.

5. The invention as defined in claim 2, in which the means for jetting the fluid comprises a second passage means downstream from the outlet of the rotor passage means; the second passage means being restricted in cross section and positioned in a direction to impart a velocity to the fluid in a substantially axial direction, whereby the fluid is jetted into the fluid collecting recess in the end wall.

6. The invention as defined in claim 5, in which the means for jetting the fluid into the fluid collecting recess also comprises pressure on the fluid upstream from the outlet of the second passage means.

7. The invention as defined in claim 2, in which the rotor passage means includes a plurality of sets of passages; there being one set of passages for each apex portion of the rotor.

8. The invention as defined in claim 7, in which each set of passages includes a plurality of fins that act as heat transfer surfaces to transfer heat from the rotor into the coolant fluid.

9. The invention as defined in claim 7, in which each set of passages is symmetrically arranged about the rotor axis adjacent to and radially inward from each rotor apex portion.

10. The invention as defined in claim 2, in which the rotary mechanism includes a rotatable shaft having an eccentric portion, the rotor being rotatably mounted upon the eccentric portion.

11. The invention as defined in claim 10, in which the rotor includes a bearing bore having a bearing surface, the bearing surface being in contact with the eccentric portion of the shaft and in which the shaft includes a central bore; the eccentric portion includes a radial passage communicating with the central bore; and the bearing surface of the rotor has an inlet annulus communicating with the radial passage in the eccentric portion and also communicating with the inlet to the passage means.

12. The invention as defined in claim 11, in which the inlet annulus is located intermediate the end faces of the rotor and in which the inlet annulus serves to feed a portion of the coolant fluid between the bearing surface and the eccentric portion toward each end face of the rotor to lubricate the eccentric portion and bearing surface.

13. The invention as defined in claim 11, in which the bearing surface also includes an exit annulus communicating with the outlet of the rotor passage means; the eccentric portion includes an exit passage communicating with the exit annulus; and in which the fluid collecting recess in one end wall of the outer body is adjacent to the exit passage; the coolant fluid in the exit passage being under pressure; the exit passage being restricted in cross section whereby fluid is discharged from the exit passage with sufficient velocity to jet it into the fluid collecting recess.

14. The invention as defined in claim 13, in which the terminus of the exit passage in the eccentric portion is only slightly radially removed from the periphery of the shaft.

15. The invention as defined in claim 13, in which the outlet for the rotor passage means is restricted in cross section; in which the rotor passage means includes a plurality of sets of passages; there being one set of passages for each apex portion of the rotor; in which each set of passages includes a plurality of fins that act as heat transfer surfaces to transfer heat from the rotor to the coolant fluid; and in which the restricted portion of the outlet is located between the finned rotor passages and the exit annulus.

16. The invention as defined in claim 13, in which the exit passage in the eccentric portion is slightly restricted in cross section to impart a jet to the coolant fluid as it leaves the exit passage, the jet having sufficient axial velocity to carry the fluid into the fluid collecting recess in the outer body end wall.

17. The invention as defined in claim 2, in which the coolant fluid is a low viscosity lubricant.

18. In combination with a rotary mechanism having a hollow outer body and a rotor disposed therein having a plurality of circumferentially-spaced apex portions, the improvement of a cooling system for the rotor comprising a plurality of sets of passage means within the rotor for the flow of a coolant fluid through the rotor, there being one set of passage means within each apex portion of the rotor, each set of passage means comprising a plurality of inter-connected passages, the rotary mechanism including a rotatable shaft having an eccentric portion, the rotor being rotatably mounted upon the eccentric portion and including a bearing bore having a bearing surface, the bearing surface being in contact with the eccentric portion of the shaft, the shaft having a central bore, the eccentric portion including a radial passage communicating with the central bore, and the bearing surface of the rotor having an inlet annulus communicating with the radial passage in the eccentric portion and also communicating with an inlet to the sets of passage means within the rotor.

19. The invention as defined in claim 18, in which the inlet annulus is located intermediate the end faces of the rotor and in which the inlet annulus serves to feed a portion of the coolant fluid between the bearing surface and the eccentric portion toward each end face of the rotor to lubricate the eccentric portion and bearing surface.

20. The invention as defined in claim 19, in which the cooling fluid is a low viscosity lubricant.

21. The invention as defined in claim 18, in which the bearing surface also includes an exit annulus communicating with the outlet of the passage means; and the eccentric portion includes an exit passage communicating with the exit annulus.

22. The invention as defined in claim 21, in which the coolant fluid in the rotor passages is under pressure, and in

which the terminus of the passages includes a portion of restricted cross-section between the rotor passages and the exit annulus, whereby the rotor passages are maintained full of coolant fluid.

References Cited in the file of this patent

UNITED STATES PATENTS

581,418	Green	Apr. 27, 1897
601,136	Green	Mar. 22, 1898
664,776	Porter	Dec. 25, 1900
990,742	Jacobs	Apr. 25, 1911
1,228,806	Morris	June 5, 1917
1,331,177	Bair	Feb. 17, 1920
1,598,867	Lundelius	Sept. 7, 1926
1,712,945	Thannhauser	May 14, 1929
2,079,192	Upshaw	May 4, 1937
2,969,049	Dillenberg	Jan. 24, 1961

FOREIGN PATENTS

570,641	Canada	Feb. 7, 1959