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Palma et al.

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[54] **ROTARY ENGINE OIL METERING PUMP**

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[52] **U.S. Cl.** ..... **123/196 R,** 123/8.01, 123/73 AD, 184/31, 417/221

[51] **Int. Cl.** **F01n 1/02,** F16n 13/20

[58] **Field of Search**.....123/8.01, 139 BD, 196 R, 123/73 AD; 417/220, 221; 184/6.5, 417/31, 35; 91/497

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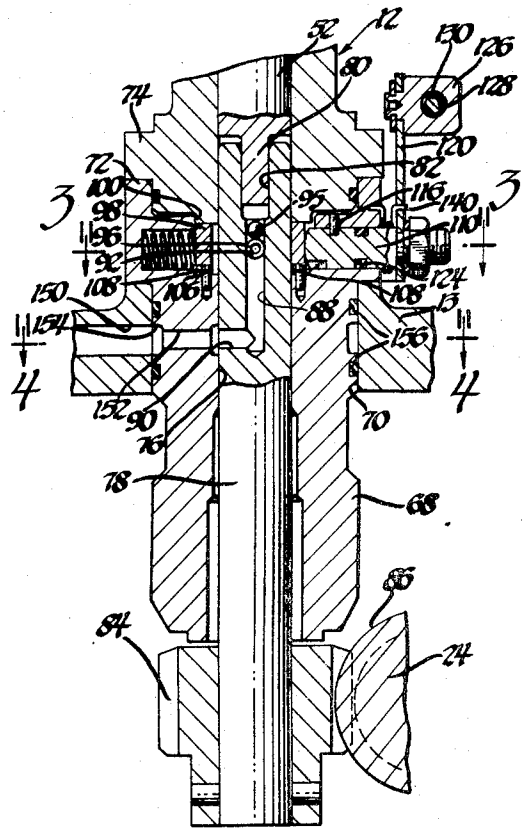
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Attorney, Agent, or Firm—R. L. Phillips

[57] **ABSTRACT**

A rotary engine is provided with an oil metering pump having a shaft rotatably mounted in the pump's body that is driven by the engine and has an expansible pump chamber which is contracted and expanded by a plunger that is mounted for reciprocal movement in a radial direction in the shaft. A ring arranged about the pump shaft effects reciprocating motion of the plunger as the shaft turns with the plunger stroke varied by varying the eccentricity of the ring in accordance with engine throttle opening. A single oil supply port in the pump's body is connected via an oil inlet-oil outlet port in the pump shaft to the pump chamber as the chamber is expanding as the shaft turns and this oil inlet-oil outlet port thereafter connects the chamber as it contracts to one oil delivery port in the pump's body and then another all during one complete pump shaft revolution.

3 Claims, 4 Drawing Figures



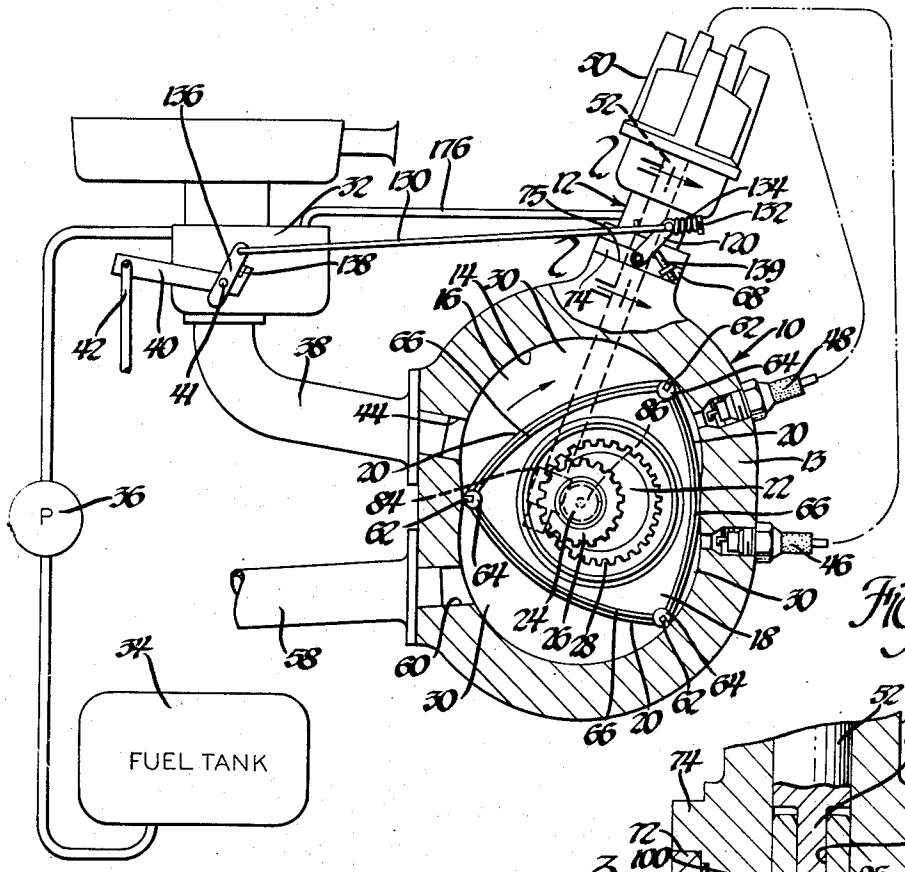


Fig. 1

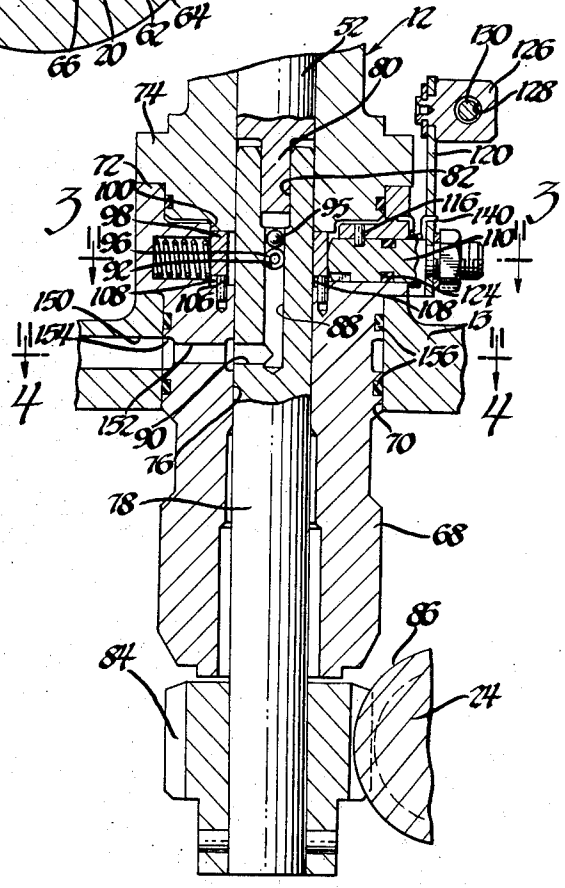


Fig. 2

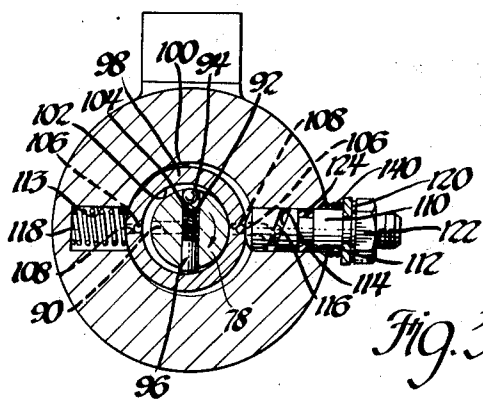


Fig. 3

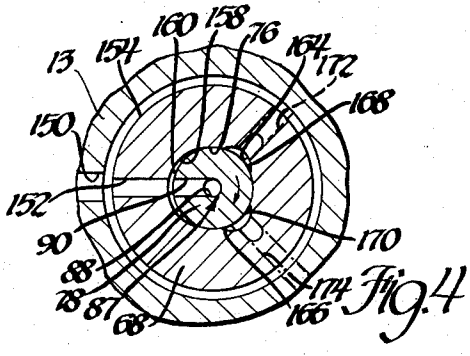


Fig. 4

ROTARY ENGINE OIL METERING PUMP

This invention relates to a rotary engine oil metering pump and more particularly to an oil metering pump that meters oil to lubricate a rotary engine's gas seals in accordance with engine speed and throttle opening.

In a rotary engine, it is desirable to meter oil to lubricate the engine rotor's gas seals at a rate that increases with engine load. One manner of doing this is to meter the oil at a rate that increases with increasing engine speed and torque demand as indicated by engine throttle opening. While there are presently commercial pumps that produce such oil metering operation, there is a continuing effort for simplification and reduction in size of the pump coupled with increased reliability and reduction in cost.

The rotary engine oil metering pump according to the present invention is directed to the above goals and comprises a pump body receiving a rotary pump shaft that is drivingly connected to the engine's shaft so that it turns at a speed proportional thereto when the engine is running. The pump shaft has an oil chamber including a radial bore in which a plunger is mounted for reciprocal movement in a radial direction to vary the volume of the chamber. A ring is mounted in the pump body about the pump shaft and has a radially inwardly facing circular control surface that is arranged opposite the plunger which is biased by a spring to remain in contact therewith as the shift turns. The ring is prevented from rotary movement while being permitted to move in opposite radial directions relative to the pump shaft between positions where it is eccentric with respect to the pump shaft so that the plunger is caused to reciprocate as the pump shaft turns with a stroke that increases with increasing eccentricity of the ring. A shaft mounted on the pump body which moves axially when turned engages the stroke control ring and is controlled with the engine throttle to move the stroke control ring in a direction to increase the plunger stroke and thus pump displacement as the engine throttle is opened. An oil supply passage in the pump body supplies oil to be metered and a pair of oil delivery passages in the pump body deliver the metered oil to lubricate a two-rotor engine. The pump body has an inlet recess cooperating with the pump shaft to provide an inlet port that is connected to the oil supply passage and also has a pair of angularly spaced outlet recesses that cooperate with the pump shaft to provide a pair of angularly spaced outlet ports that are separately connected to the oil delivery passages. The oil chamber in the shaft has an oil inlet-oil outlet port that during a single pump shaft rotation connects the inlet port to the oil chamber as the chamber is expanding and then successively connects the oil chamber to the outlet ports when the oil chamber is contracting. Thus, each of the oil delivery passages receives oil that is metered at a rate that increases with increasing engine speed and throttle valve opening.

An object of the present invention is to provide a new and improved rotary engine oil metering pump.

Another object is to provide a rotary engine oil metering pump having a shaft that is driven by the engine and has an expansible chamber which is contracted and expanded by a plunger that is reciprocally mounted on the shaft and is cause to reciprocate by engagement with a surrounding ring with a stroke varying with the eccentricity of this ring which is controlled with the engine throttle to provide an oil rate that increases with increasing engine speed and engine throttle opening.

Another object is to provide a rotary engine oil metering pump having a shaft that is engine driven and has an expansible chamber with a plunger which is operated by an eccentricly arranged ring whose eccentricity is controlled with engine throttle opening to effect pumping action with a displacement that increases with increasing throttle opening and a displacement per unit of time that increases with increasing engine speed and with this oil being metered from a single oil inlet port successively to two outlet ports during each pump shaft revolution.

These and other objects of the invention will become more apparent with reference to the following description and drawing in which:

FIG. 1 is an elevational view with parts shown diagrammatically and parts in section of a rotary engine having an oil metering pump according to the present invention.

FIG. 2 is an enlarged view of the oil metering pump taken along the line 2—2 in FIG. 1.

FIG. 3 is a view of the oil metering pump taken along the line 3—3 in FIG. 2.

FIG. 4 is a view of the oil metering pump taken along the line 4—4 in FIG. 2.

Referring to FIG. 1, there is shown a rotary combustion engine 10 of current production type having an oil metering pump 12 according to the present invention that meters oil to lubricate the engine's gas seals. The engine 10 comprises a stationary outer body or housing 13 having a rotor cavity that is defined by an inwardly facing peripheral wall 14 and a pair of axially spaced opposed side walls 16, only one of which is shown. The peripheral wall 14 is in the shape of a two-lobed epitrochoid or a curve parallel thereto and a rotor 18 having the general shape of a triangle with three convex peripheral faces 20 is mounted within the rotor cavity on an eccentric 22 of a crankshaft 24. The crankshaft 24 is rotatably mounted outboard of the rotor cavity in the side walls 16 and aligned with the rotor cavity's axis. An annular externally toothed gear 26 is received about and is concentric with the crankshaft 24 and is fixed to the engine housing 13. The gear 26 meshes with an internally toothed gear 28 that is concentric with and fixed to the rotor 18. The gear 28 has one and one-half times the number of teeth as the gear 26 with the result that this gearing enforces a fixed cyclic relation between the rotor and the crankshaft such that the crankshaft which is the engine's output makes three complete revolutions for every one complete revolution of the rotor. The rotor faces 20 cooperate with the peripheral wall 14 and with the side walls 16 to define three variable volume working chambers 30 that are spaced around and move with the rotor within the housing and vary in volume as the rotor rotates about its axis while planetating with respect to the crankshaft axis.

A carburetor 32 supplied with fuel from a fuel tank 34 by a fuel pump 36 delivers a combustible air-fuel mixture to an intake manifold 38 under the control of the carburetor's throttle valve whose opening is controlled by a throttle lever 40 that is connected at one end to the throttle valve's shaft 41. The other end of lever 40 is connected to a rod 42 that is linked to an accelerator pedal, not shown, for control by the vehicle operator, the throttle valve arrangement being such

that it is opened when the throttle lever 40 is pivoted in a counterclockwise direction as viewed in FIG. 1. The intake manifold 38 is connected to an intake port 44 which opens to the rotor cavity through the peripheral wall 14. On rotor rotation in the direction indicated by the arrow in FIG. 1, a combustible air-fuel mixture is sequentially periodically admitted to the chambers 30 by the traversing motion of the rotor apexes relative to the intake port 44 whereafter the air-fuel mixture is trapped and then compressed in readiness for ignition. Sequential ignition of the air-fuel mixture in the chambers 30 is effected by two spark plugs 46 and 48 which receive timed ignition pulses from a distributor 50 that is driven by the crankshaft 24 as will be described in more detail later. The two spark plugs 46 and 48 are on the side of the peripheral wall 14 opposite the side where the intake port 44 is located and are peripherally spaced thereabout so that the plug 46 is said to lead the other plug 48. The spark plugs 46 and 48 may be fired together or only one plug fired according to certain engine operating conditions. With combustion, the peripheral wall 14 takes the reaction to force the rotor 18 to continue rotating and eventually each working chamber following the expansion phase, is exhausted during an exhaust phase to an exhaust manifold 58 via an exhaust port 60 that is open to the rotor cavity through the peripheral wall 14 and is periodically traversed by the rotor apexes.

Sealing of the working chambers 30 is effected by three apex seals 62 each of which extends the width of the rotor and is mounted at one of the rotor apexes, six corner seals 64 each of which is mounted in one of the rotor sides near one of the rotor apexes, and six side seals 66 each of which is mounted in one of the rotor sides and extends adjacent one of the rotor faces between two of the corner seals with the corner seals each providing a sealing link between adjacent ends of two side seals and one apex seal. The apex seals 62 are urged radially outward by spring means, not shown, to continuously engage peripheral wall 14 and both the corner seals 64 and side seals 66 on both rotor sides are urged axially outward by suitable spring means, not shown, to continuously engage the side walls 16.

Having thus described a single rotor arrangement, it will be understood that the engine may have one or more additional rotors with suitable intake, ignition and exhaust provisions as is well known in the art. The oil metering pump 12 according to the present invention is adapted to meter oil to either a single or dual rotor arrangement to lubricate the apex seals 62 and also the corner seals 64 and side seals 66 to minimize the wear of these gas seals and the rotor cavity walls.

Describing now the oil metering pump 12, there is a pump body 68, which as best shown in FIG. 2, is sealingly fitted to a radially extending aperture 70 in the engine housing 13 and retained therein by having a collar 72 fitting between the distributor's base 74 and a boss 75 on the rotor housing 13. The pump body 68 is prevented from turning in aperture 70 by a pin, not shown. The pump body 68 has a cylindrical pump shaft bore 76 in which a pump shaft 78 is rotatably mounted in axial alignment with the distributor shaft 52. The distributor shaft 52 has a tongue 80 that is received within a slot 82 at the upper end of the pump shaft 78 and the lower end of the pump shaft 78 has a pinion 84 secured thereto that meshes with a worm gear 86 formed on the crankshaft 24. Thus, the pump shaft 78 is driven by the crankshaft 24 at a speed proportional thereto and also provides a drive connection between the crankshaft and the distributor shaft 52.

Referring to FIGS. 2, 3 and 4, pump shaft 78 has an expansible oil chamber 87 comprising an axially extending bore 88 and a pair of radially extending bores 90 and 92. The radial bores 90 and 92 intersect the axial bore 88 at axially spaced points along the pump shaft and are arranged 90° to each other with the bore 90 leading the bore 92 relative to the turning direction, as best shown in FIG. 3, for reasons which will become more apparent later. The radial bore 92 extends completely through the shaft and is closed at one end by a press fitted ball 94 and the other radial bore 90 extends only half-way through the pump shaft to meet with the blind lower end of axial bore 88. The upper end of axial bore 88 is closed by a press fitted ball 95. The bore 90 serves as both an inlet to and an outlet from the chamber 87, as will be described in more detail later, and hence will also be referred to as oil inlet-oil outlet port 90. The oil chamber 87 is expanded and contracted by a cylindrical plunger 96 which, as shown in FIG. 3, is mounted for reciprocal movement in the bore 92 and operates to increase the volume of the oil chamber on radially outward movement and decrease the volume on radially inward movement.

A plunger stroke control ring 98 is mounted in the pump body 68 about the pump shaft 78 in an annular radially inwardly facing recess 100 as shown in FIGS. 2 and 3. The ring 98 has a radially inwardly facing circular stroke control surface 102 arranged radially opposite the plunger 96. A spring 104 mounted in bore 92 between ball 94 and plunger 96 biases the plunger radially outward to continuously contact the stroke control surface 102 of the stroke control ring 98. The stroke control ring 98 is guided for movement in fixed opposite radial directions relative to the pump shaft 78 between positions where the stroke control ring is eccentric with respect to the pump shaft and is prevented from rotating relative to the pump shaft by a pair of guide pins 106. The guide pins 106 are arranged diametrically opposite each other on opposite sides of the shaft 78 in axially extending holes in one radial wall of the recess 100 and are received in diametrically opposite, radially extending slots 108 in the near side of the stroke control ring 98. Thus, the plunger 96 is caused to reciprocate as the pump shaft 78 turns with a plunger stroke that increases with increasing eccentricity of the stroke control ring 98 to provide a pump displacement that increases with increasing eccentricity of the stroke control ring and a pump displacement per unit of time that increases with increasing pump shaft speed which is proportional to engine speed.

The eccentricity of the stroke control ring 98 is controlled by a displacement control shaft 110 that is mounted in a bore 112 in the pump body 68 for turning about an axis aligned with the direction of movement of the ring 98. The displacement control shaft 110 has a helical groove 114 which receives a pin 116 which is press fitted to the pump body 68 at right angles to bore 112 so that when the displacement control shaft 110 is turned in the counterclockwise direction, as viewed in FIG. 1, it advances leftward, as viewed in FIG. 3, to positively move the displacement control ring 98 leftward to increase its eccentricity against the bias of a spring 118 that is mounted in a blind end radial bore 113 in the pump body 68 on the opposite side. The

spring 118 acts to maintain the ring 98 in contact with the shaft 110 and thus move rightward when the shaft 110 is turned in the opposite direction which has the effect of decreasing the ring's eccentricity.

The shaft 110 is linked to the throttle linkage so that it is turned to increase the eccentricity of the ring 98 as the throttle is opened. As shown in FIGS. 2, 3 and 4, one end of shaft 110 extends outward of the pump body 68 and has secured thereto a lever 120, this connection being maintained by a nut 122 threaded to the outboard end of the shaft. An oil ring 124 mounted in a circumferential groove in the shaft 110 prevents oil leakage out of the bore 112. The other end of lever 120 has a socket 126 pivotably secured thereto as best shown in FIG. 2. The socket 126 has an aperture 128 slidably receiving a rod 130 which at its righthand end has a snap ring 132 and receives a coil spring 134 between the socket 126 and the snap ring 132 as shown in FIG. 1. The other end of rod 130 is pivotably secured to a lever 136 which is pivotally supported on the carburetor's throttle shaft 41 and is engaged by a tang 138 on the throttle lever 40 to pivot counterclockwise with the throttle lever as the throttle is opened. An adjustable stop provided by a stop screw 139 threaded to a boss on the pump body collar 72 engages the lever 120 to determine the maximum plunger stroke position as described in more detail later. The displacement control shaft 110 is normally biased to this minimum stroke position by a torsion spring 140 which is arranged about the outboard portion of shaft 110 and engages at its opposite ends the pump body 68 and the lever 120, as shown in FIG. 2, this torsion spring force urging clockwise turning of the lever 120 and thus shaft 110 as viewed in FIG. 1. The coil spring 134 maintains the lever 136 against the tang 138 and also yields to permit the rod 130 to slide in socket 126 as the rod is pulled leftward beyond the maximum travel of the displacement control lever 120.

Describing now how oil is supplied to the pump 12, metered and then delivered to lubricate the engine's gas seals, oil is obtained from the engine's pressurized lubrication system which includes a passage 150. The pump body 68 has a radially extending oil supply passage 152 at the same axial location as oil inlet-oil outlet port 90 that is open at its outer end to an annular groove 154 which is aligned with the passage 150 in the aperture 70 of the engine housing 13 with sealing in either axial direction from this fluid connection being provided by a pair of oil ring seals 156 that are received in circumferential grooves in the pump body 68 on either side of the groove 154. The pump body passage 152 at its inner end is open to a crescent shaped inlet recess 158 in the pump shaft bore 76 which cooperates with the pump shaft's outer surface to form an inlet port 160 that is thus connected to receive oil from the engine lubrication passage 150 and is centered on the line of movement of the stroke control ring 98. The pump shaft bore 76 further has a pair of angularly spaced crescent shaped recesses 164 and 166 which also cooperate with the external surface of the pump shaft 78 to form a pair of angularly spaced outlet ports 168 and 170 that are sealed from each other and are angularly spaced and sealed from the inlet port 160 by the shaft 78 where it is received by the bore 76 as best shown in FIG. 4. The inlet recess 158 extends through an arc of less than 180° and the outlet recesses 164 and 166 each extend through an arc of less than 90° with the outlet recesses centered 90° apart and 135° from the center of the inlet recess. Furthermore, all of the recesses 158, 164 and 166 and thus the oil inlet port 160 and oil outlet ports 168 and 170 are at the same axial location as the oil inlet-oil outlet port 90. Thus, the oil inlet-oil outlet port 90 is sequentially opened to the inlet port 160 and then the oil outlet ports 168 and 170 as the pump shaft 78 turns in the direction of the arrow in FIG. 4. Furthermore, this arrangement places the oil inlet port 160 in a zone where the plunger 96 is moving radially outward expanding oil chamber 87 and both the oil outlet ports 168 and 170 in a zone where the plunger 96 is moving radially inward contracting oil chamber 87. The outlet ports 168 and 170 are open to the inner ends of oil delivery passages 172 and 174, respectively, which in turn are connected to deliver oil to lubricate the engine. For example, an oil pipe 176 connects the oil delivery passage 172 to the carburetor 32 to supply oil to the float bowl thereof, as shown in FIG. 1, while another oil pipe, not shown, connects the other oil delivery passage 174 to supply oil to the carburetor for the other rotor. The oil thus delivered is mixed with the fuel and then fed with the fuel through the intake port to the rotor cavity where it is distributed to lubricate the gas seals as they slide on the housing walls. It will also be understood that the oil may be delivered directly into the carburetor's jet circuit or into the air stream in the carburetor throat or directly to the housing walls on which the seals slide.

Describing now the oil metering operation, the pump shaft 78 is driven through the worm gear drive by the engine crankshaft 24 at a speed proportional thereto and with the engine throttle closed and the engine idling the displacement control shaft 110 and thus the stroke control ring 98 at a minimum eccentric position, the plunger 96 by its rotation with the pump shaft 78 is caused to reciprocate by being spring biased to follow the stroke control ring's circular cam surface 102. With oil made available to the oil inlet passage 152 and thus to the inlet port 160 and on initial communication of the oil inlet-oil outlet port 90 with inlet port 160 and the port 90 leading the plunger 96 by 90°, oil fills the oil chamber 87 as it expands with the plunger 96 moving radially outward. With continued turning of the pump shaft 78, the oil inlet-oil outlet port 90 passes the inlet port 160 and then communicates with the oil outlet port 168 with the shaft rotating as indicated in FIG. 4. At the same time, the plunger 96 is being caused by the stroke control ring 98 to move radially inward causing the oil to be displaced from the oil chamber 87 into the oil outlet port 168. With the oil outlet ports 168 and 170 in the decreasing displacement zone, the plunger continues to move radially inward while the oil inlet-oil outlet port 90 is closed off from the oil outlet port 168 and opened to the other oil outlet port 170 so that the latter port then receives the remaining half of the oil that is being displaced by the oil metering pump. This oil metering rate is determined by sizing of the pump and calibration thereof for the particular use to meet the minimum oil requirements which occur at engine idle with no load demand. Then when the rotary speed of the pump shaft 78 increases with increasing engine speed irrespective of whether the engine throttle is opened, the pumping cycles per unit of time increase accordingly and thus the oil is metered to the outlet ports 168 and 170 at a rate which increases with increasing engine speed. When the engine throttle is

opened, the pump stroke and thus pump displacement increases irrespective of engine speed so that increasingly more oil is delivered. FIG. 3 shows the stroke control ring 98 in its maximum eccentric position which produces the maximum pump displacement. Thus, the oil is metered to the outlet ports at a rate which increases with both increasing engine speed and throttle opening and thus with engine load. It will also be understood that for engines where only one metered oil supply is required, the pump is easily adapted thereto by simply connecting one of the oil outlet ports back to the oil inlet port 160 or by having only one oil outlet port. Furthermore, it will be understood that the oil supply to the pump may be by gravity feed instead of by the engine's lubrication pressure supply.

The above described embodiments are illustrative of the invention which may be modified within the scope of the appended claims:

We claim:

1. In an oil metering pump for metering oil to lubricate a rotary engine having gas seals, an output shaft and a throttle, a pump body having a pump shaft bore, a pump shaft rotatably mounted in said bore, means operatively drivingly connecting said pump shaft to be driven by said output shaft at a speed proportional thereto, said pump shaft having an oil chamber including a radial plunger bore, a plunger reciprocally mounted in said plunger bore operative to increase the volume of said oil chamber on radially outward movement and decrease the volume on radially inward movement, a plunger stroke control ring mounted in said pump body about said pump shaft having a radially inwardly facing circular stroke control surface arranged radially opposite said plunger, means for biasing said plunger radially outward to continuously contact said stroke control surface of said stroke control ring, means for preventing rotation of said stroke control ring while permitting movement of said stroke control ring in fixed opposite radial directions relative to said pump shaft between positions where said stroke control surface is eccentric with respect to said pump shaft whereby said plunger is caused to reciprocate as said pump shaft turns with a plunger stroke that increases with increasing eccentricity of said stroke control surface to provide a pump displacement that increases with increasing eccentricity of said stroke control surface and a pump displacement per unit of time that increases with increasing pump shaft speed, means for increasing the eccentricity of said stroke control surface as said throttle is opened, an oil supply passage in said pump body for supplying oil to be metered, an oil delivery passage in said pump body for delivering metered oil to lubricate the gas seals of the engine, said pump shaft bore having an inlet recess cooperating with said pump shaft to define an inlet port connected to said oil supply passage, said pump shaft bore further having an outlet recess cooperating with said pump shaft to define an outlet port angularly spaced from said inlet port, said outlet port connected to said oil delivery passage, all of said ports being located at the same axial location along said pump shaft, said oil chamber in said pump shaft having an oil inlet-oil outlet port at the same axial location as said inlet port and said outlet port for sequentially connecting said inlet port to said oil chamber when said oil chamber is expanding and then connecting said oil chamber to said outlet port when said oil chamber is contracting all during one pump shaft revolution whereby oil is metered from said oil supply passage to said oil delivery passage at a rate that increases with increasing output shaft speed and throttle opening.

2. In an oil metering pump for metering oil to lubricate a rotary engine having gas seals, an output shaft and a throttle, a pump body having a cylindrical pump shaft bore, a cylindrical pump shaft rotatably mounted in said bore, means operatively drivingly connecting said pump shaft to be driven by said output shaft at a speed proportional thereto, said pump shaft having an oil chamber including a cylindrical radial plunger bore, a cylindrical plunger reciprocally mounted in said plunger bore operative to increase the volume of said oil chamber on radially outward movement and decrease the volume on radially inward movement, a plunger stroke control ring mounted in said pump body about said pump shaft having a radially inwardly facing circular stroke control surface arranged radially opposite said plunger, a spring mounted in said oil chamber for biasing said plunger radially outward to continuously contact said stroke control surface of said stroke control ring, means for preventing rotation of said stroke control ring while permitting movement of said stroke control ring in fixed opposite radial directions relative to said pump shaft between positions where said stroke control surface is eccentric with respect to said pump shaft whereby said plunger is caused to reciprocate as said pump shaft turns with a plunger stroke that increases with increasing eccentricity of said stroke control surface to provide a pump displacement that increases with increasing eccentricity of said stroke control surface and a pump displacement per unit of time that increases with increasing pump shaft speed, a displacement control shaft mounted on said pump body engaging said stroke control ring, means for causing said displacement control shaft to positively move said stroke control ring in one of its fixed radial directions to increase the eccentricity of said stroke control surface when said displacement control shaft is turned in one angular direction, a spring mounted in said pump body for biasing said stroke control ring to follow said displacement control shaft and move in the opposite radial direction to decrease the eccentricity of said stroke control surface when said displacement control shaft is turned in the opposite angular direction, means operatively connecting said throttle and said displacement control shaft to vary the angular position of said displacement control shaft with opening of said control valve wherein said displacement control shaft is turned in said one angular direction as said throttle valve is opened, an oil supply passage in said pump body for supplying oil to be metered, an oil delivery passage in said pump body for delivering metered oil to lubricate the gas seals of the engine, said pump shaft bore having an inlet recess cooperating with said pump shaft to define an inlet port connected to said oil supply passage, said pump shaft bore further having an outlet recess cooperating with said pump shaft to define an outlet port angularly spaced from said inlet port, said outlet port connected to said oil delivery passage, all of said ports being located at the same axial location along said pump shaft, said oil chamber in said pump shaft having an oil inlet-oil outlet port at the same axial location as said inlet port and said outlet ports for sequentially connecting said inlet port to said oil chamber when said oil chamber is expanding and

then connecting said oil chamber to said outlet port when said oil chamber is contracting all during one pump shaft revolution whereby oil is metered from said oil supply passage to said oil delivery passage at a rate that increases with increasing output shaft speed and throttle opening.

3. In an oil metering pump for metering oil to lubricate a rotary engine having gas seals, an output shaft and a throttle, a pump body having a cylindrical pump shaft bore, a cylindrical pump shaft rotatably mounted in said bore, means operatively drivingly connecting said pump shaft to be driven by said output shaft at a speed proportional thereto, said pump shaft having an oil chamber including a cylindrical radial plunger bore, a cylindrical plunger reciprocally mounted in said plunger bore operative to increase the volume of said oil chamber on radially outward movement and decrease the volume on radially inward movement, a plunger stroke control ring mounted in said pump body about said pump shaft having a radially inwardly facing circular stroke control surface arranged radially opposite said plunger, a spring mounted in said oil chamber for biasing said plunger radially outward to continuously contact said stroke control surface of said stroke control ring, means for preventing rotation of said stroke control ring while permitting movement of said stroke control ring in fixed opposite radial directions relative to said pump shaft between positions where said stroke control surface is eccentric with respect to said pump shaft whereby said plunger is caused to reciprocate as said pump shaft turns with a plunger stroke that increases with increasing eccentricity of said stroke control surface to provide a pump displacement that increases with increasing eccentricity of said stroke control surface and a pump displacement per unit of time that increases with increasing pump shaft speed, a displacement control shaft mounted on said pump body engaging said stroke control ring, means for causing said displacement control shaft to positively move said stroke control ring in one of its fixed radial directions to increase the eccentricity of said stroke control surface when said displacement control shaft is turned in one angular direction, a spring mounted in said pump body for biasing said stroke control ring to follow said displacement control shaft and move in the opposite radial direction to decrease the eccentricity of said stroke control surface when said displacement control shaft is turned in the opposite angular direction, means operatively connecting said throttle and said displacement control shaft to vary the angular position of said displacement control shaft with opening of said control valve wherein said displacement control shaft is turned in said one angular direction as said throttle is opened, an oil supply passage in said pump body for supplying oil to be metered, a pair of oil delivery passages in said pump body for delivering metered oil to lubricate the gas seals of the engine, said pump shaft bore having an inlet recess cooperating with said pump shaft to define an inlet port connected to said oil supply passage, said pump shaft bore further having a pair of angularly spaced outlet recesses cooperating with said pump shaft to define a pair of angular spaced outlet ports angularly spaced from said inlet port, each of said outlet ports connected to one of said oil delivery passages, all of said ports being located at the same axial location along said pump shaft, said oil chamber in said pump shaft having an oil inlet-oil outlet port at the same axial location as said inlet port and said outlet ports for sequentially connecting said inlet port to said oil chamber when said oil chamber is expanding and then successively connecting said oil chamber to said outlet ports when said oil chamber is contracting all during one pump shaft revolution whereby oil is metered from said oil supply passage to said oil delivery passages at a rate that increases with increasing output shaft speed and throttle opening.

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