United States Patent [19]

Scheibe

[11] **3,846,052**

[45] **Nov. 5, 1974**

[54] **METERING PUMP**

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[73] Assignee: **General Motors Corporation,** Detroit, Mich.

[22] Filed: **Aug. 8, 1973**

[21] Appl. No.: **386,603**

[52] **U.S. Cl.** .... **418/84,** 184/6.28, 184/33, 123/196 R

[51] **Int. Cl.** **F01c 21/04**

[58] **Field of Search** .... 123/196 R; 184/31, 35, 184/33, 6.28; 418/84, 88; 415/90

[56] **References Cited**

UNITED STATES PATENTS

2,056,434	10/1936	Muller	184/33
3,435,914	4/1969	Atsumi	184/6.28
3,764,234	10/1973	Morgan et al.	418/84
3,788,782	1/1974	Morgan	418/84

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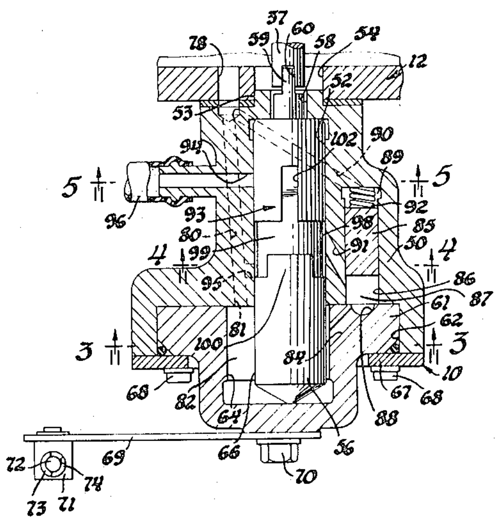
Attorney, Agent, or Firm—Ronald L. Phillips

[57] **ABSTRACT**

An oil metering pump for metering oil to lubricate an engine's gas seals has a pump section that delivers oil at a rate that increases with increasing engine load, a pressure control valve that operates to control the pumped oil so that its pressure is dependent on that developed by the pumping pump section and is independent of varying inlet pressure to the pump, and a discharge-bypass valve that is driven at a speed proportional to engine speed and operates to alternately deliver the pressure controlled oil back to the pump inlet and to lubricate the seals so that there is maintained substantially uniform oil flow for seal lubrication at constant engine loads.

4 Claims, 5 Drawing Figures



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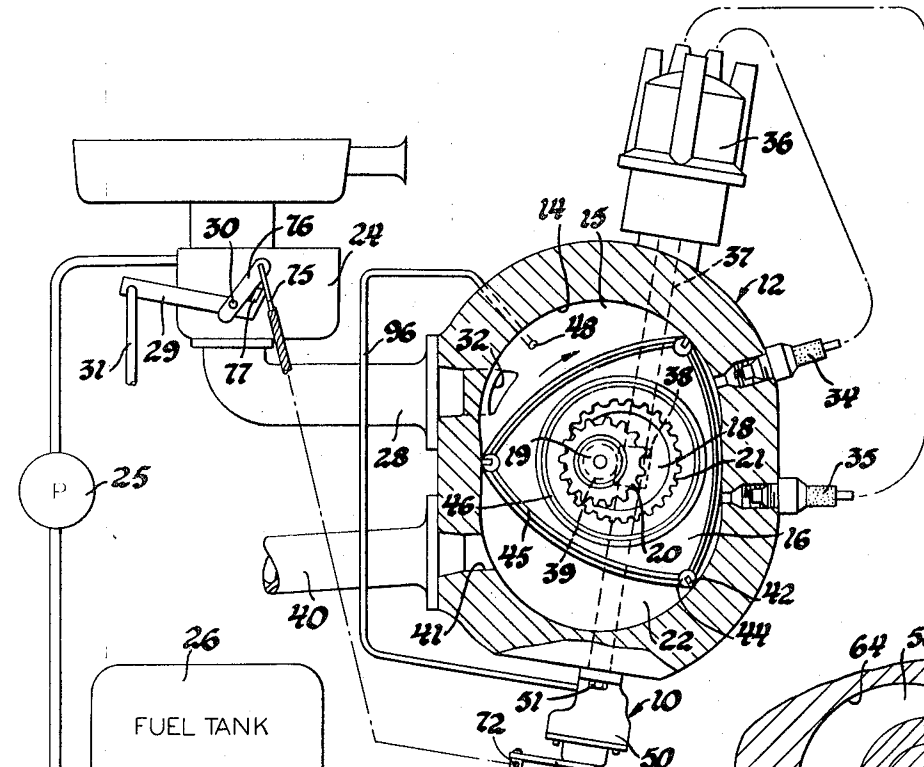

Fig.1

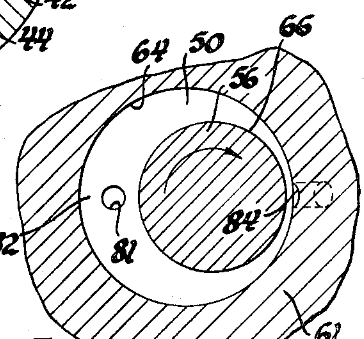

Fig.3

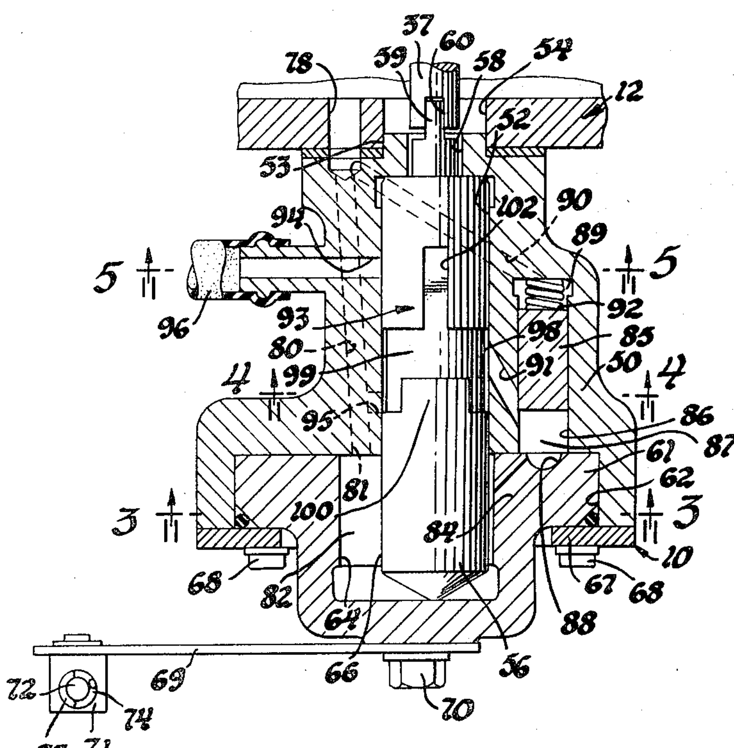

Fig.2

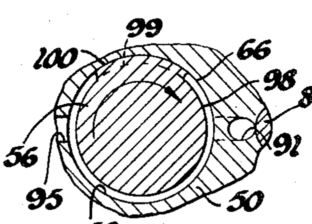

Fig.4

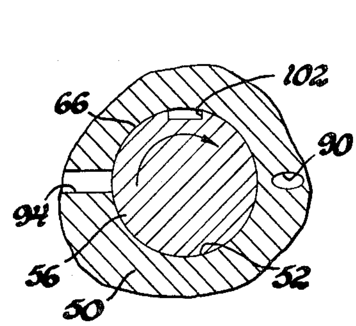

Fig.5

METERING PUMP

This invention relates to fluid metering pumps and more particularly to a fluid metering pump for metering oil to lubricate an engine's seals at a rate that increases with increasing engine load and with timed intermittent flow that is substantially uniform at constant engine loads.

It is current practice in certain engines to supply oil to lubricate the gas seals in accordance with engine load by metering the oil at a rate that increases with increasing engine speed and torque demand as indicated by engine throttle opening. In the application of such oil metering to a rotary engine, it has been found that more efficient seal lubrication can result by providing an intermittent oil flow that is timed to occur with respect to a certain event in the engine's cycle. This is also recognized in applicant's copending U.S. Pat. application Ser. No. 360,328 filed May 14, 1973, entitled "Metering Pump" and assigned to the same assignee. However, it has been further found that where both the metered quantity of oil is very small and the intermittent flow time is very short, there may not be effected the desired relatively uniform flow of oil at constant engine loads.

The present invention is directed to providing a metering pump that effects a timed intermittent oil flow at a rate that increases with increasing engine load and is also substantially uniform at constant engine loads. The metering pump comprises a pump section that delivers oil from a pump inlet port to a pump outlet port at a rate that increases with increasing engine load. A pressure controlled delivery passage has a controlled connection with the pump outlet port via a pressure control valve which is biased by oil pressure from the pump inlet port and the pump outlet port so that the oil pressure in the pressure controlled delivery passage is dependent on the pressure developed by the pump section and is independent of varying pressure at the pump inlet port. A pump discharge passage provides for delivering oil from the pump to lubricate the engine's seals and there is in addition provided a bypass passage that is connected to the pump inlet port. A rotary discharge-bypass valve which is driven at a speed proportional to engine speed operates to connect the pressure controlled delivery passage alternately to the pump discharge passage and the bypass passage so that oil from the pressure controlled delivery passage is intermittently delivered back to the pump intake passage. This effects substantially uniform oil flow through the pressure control delivery passage at substantially constant engine loads to maintain substantially uniform oil flow for seal lubrication at constant engine loads.

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

Another object is to provide a new and improved metering pump providing timed intermittent flow at a variable rate.

Another object is to provide a metering pump for metering oil to lubricate an engine's seals with timed intermittent flow that increases with increasing engine load and is substantially uniform at substantially constant engine loads.

Another object is to provide a metering pump for metering oil to lubricate an engine's seals having a pump section that operates to deliver oil at a rate that increases with increasing engine load, a pressure control valve that operates to control pumped oil so that its pressure is dependent upon that developed by the pump section, and a discharge-bypass valve that is driven at a speed proportional to engine speed that alternately delivers the pressure controlled oil back to the inlet of the pump section and to lubricate the engine's seals to thereby effect an intermittent oil flow for seal lubrication at a rate that increases with increasing engine load and is substantially uniform at constant engine loads.

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

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

FIG. 2 is an enlarged longitudinal view with parts in section of the pump shown in FIG. 1.

FIG. 3 is an enlarged view of the pump taken along the line 3—3 in FIG. 2.

FIG. 4 is an enlarged view of the pump taken along the line 4—4 in FIG. 2.

FIG. 5 is an enlarged view of the pump taken along the line 5—5 in FIG. 2.

Referring to FIG. 1, there is shown a metering pump **10** according to the present invention employed to meter oil to lubricate the gas seals in a rotary engine **12** of the currently commercial automotive type. This type engine has a multi-piece housing having an inwardly facing peripheral wall **14** and a pair of opposed side walls **15**, only one of which is shown. The peripheral wall **14** has the shape of a two-lobed epitrochoid or a curve parallel thereto and a rotor **16** having the general shape of a triangle is mounted in the cavity thus formed on an eccentric **18** of a crankshaft **19** which s rotatably mounted outboard of the rotor in the engine housing. An external toothed annular gear **20** is received about and concentric with the crankshaft **19** and is fixed to the engine housing. The gear **20** meshes with an internally toothed gear **21** that is concentric with and fixed to one side of the rotor **16**. The gear **21** has one and one-half times the number of teeth as the gear **20** with the result that there is enforced a fixed cyclic relation between the rotor and the crankshaft such that the crankshaft makes three complete revolutions for every one complete revolution of the rotor. As rotor **16** turns, the three apexes follow the peripheral wall **14** and the rotor faces cooperate with the peripheral wall and with the side walls **15** to define three variable volume working chambers **22** that are spaced around and move with the rotor within the housing.

A carburetor **24** supplied with fuel by a fuel pump **25** from a fuel tank **26** delivers an air-fuel mixture to an intake manifold **28** under the control of the carburetor's throttle valve whose opening is controlled by a throttle lever **29** which is fixed at one end to the throttle valve's shaft **30**. The other end of lever **29** is pivotally connected to a rod **31** 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 is pivoted in a counterclockwise direction as viewed in FIG. 1. The intake manifold **28** is connected in the engine housing to deliver the air-fuel mixture to opposed intake ports **32**, only one of which is shown, in the side walls **15**. On rotor rotation in the direction of the arrow in FIG. 1, the air-fuel mixture is sequentially periodically admitted to the chambers 22 by the traversing motion of the rotor relative to the intake ports 32 whereafter the air-fuel mixture is trapped and compressed in readiness for ignition. Sequential ignition of the air-fuel mixture in the chambers is effected by a pair of spark plugs 34 and 35 which receive timed ignition pulses from a distributor 36 whose shaft 37 is driven by the crankshaft, this drive being effected by a pinion 38 which is secured to a midportion of the distributor shaft and meshes with a worm gear 39 formed on or fixed to the crankshaft. With combustion, the rotor 16 is forced to continue rotating and eventually each working chamber following the expansion phase is exhausted to an exhaust manifold 40 via an exhaust port 41 that opens through the peripheral wall 14 and is periodically traversed by the rotor apexes.

Sealing of the chambers 22 is effected by apex seals 42 each of which extends the width of the rotor and is mounted at a rotor apex, corner seals 44 each of which is mounted on a rotor side at each rotor apex, and apex seals 42 each of which is mounted on a rotor's side and extends between pairs of corner seals with the corner seals each providing a sealing link between the adjacent ends of two side seals and one apex seal. The apex seals are urged radially outward by spring means, not shown, to continuously engage the peripheral wall 14 and both the corner seals 44 and side seals 45 on both rotor sides are urged axially outward by suitable spring means, not shown, to continuously engage the side walls 15. In addition, there is provided a circular oil seal 46 mounted in a concentric groove in each rotor side that is biased axially outward by suitable spring means, not shown, to continuously engage the opposite side wall to prevent oil that is used for lubrication of the engine's rotary parts from moving radially outward to the gas seals.

In the present state of the art, the materials of which the gas seals and the surfaces on which these seals slide require a metered oil supply which is delivered thereto either by mixing with the fuel as is present commercial practice or in some other manner such as with a gas seal lubrication system like that described in copending U.S. application Ser. No. 271,785, entitled "Rotary Engine Gas Seal Lubrication System," filed July 14, 1972 by James M. Casey and assigned to the same assignee. In this latter type gas seal lubrication system which is the type shown in FIG. 1, the metered oil is supplied to a pair of oil feed ports 48, only one of which is shown, that are located in the side walls 15. The oil feed ports 48 are located opposite each other at the same radial and angular locations relative to the crankshaft axis and close to and past the side wall intake ports 32 in the direction of rotor rotation so that they are traversed or wiped by the rotor side seals during rotor motion the same as the side wall intake ports. With this arrangement the side wall oil feed ports 48 thus feed oil onto the side walls as the side seals sequentially wipe past after having wiped past the side wall intake ports. As a result, most of the oil thus delivered is wiped across the side walls 15 and the remainder is thrown by centrifugal force to lubricate the peripheral wall 14. For further details of such a gas seal lubrication system, reference should be made to the aforementioned Casey patent application.

Describing now the details of the oil metering pump 10 according to the present invention, the pump has a pump section of the journaled bearing type like that disclosed in my aforementioned U.S. Pat. application Ser. No. 360,328 and comprises a pump body 50 which is secured by a pair of bolts 51, of which only one is shown, to the underside of the engine. As shown in FIG. 2, the pump body 50 has a cylindrical bore 52 which is bored from the lower end thereof and on its upper end has a piloting land 53 fitting in an aperture 54 through the bottom of the engine's housing to align the bore 52 with the distributor shaft 37. A cylindrical pump rotor 56 is rotatably mounted in the bore 52 with its upper end extending through an opening 58 in the pump body and having a tongue 59 which is received in a slot 60 in the lower end of the distributor shaft 37 whereby the pump rotor 56 is driven by the engine. A cylindrical ring shaped pressure control member 61 is turnably mounted about the lower end portion of pump rotor 56 in a counterbore 62 in the lower end of pump body 50 with its cylindrical inner surface 64 eccentric to the oppositely facing rotor's cylindrical outer surface 66 as shown in FIGS. 2 and 3. The pressure control member 61 is retained in the pump body by a cover 67 secured to the lower end of the pump body by cap screws 68 and is made engine throttle responsive by having a lever 69 secured at one end thereto by a stud 70. A swivel 71 is secured to the other end of the lever 69 and slidably receives a rod 72 which after it passes through the swivel has a retaining ring 73 secured thereto with a coil spring 74 located between the swivel and the retaining ring as shown in FIG. 2. The rod 72 is connected by a Bowden wire 75 to a lever 76 which is pivotally supported on the carburetor's throttle valve shaft 30 and is engaged by a tang 77 on the throttle lever 29 to pivot counterclockwise to pull the cable as the throttle is opened to turn the pump's pressure control member 61 in the clockwise direction as viewed in FIG. 3.

Oil for gas seal lubrication is drained from the engine's lubrication system at the bottom of the engine housing via a bored hole 78 in the housing and is then delivered by a drilled pump inlet passage 80 that extends longitudinally through the pump body and terminates in a pump inlet port 81. The pump inlet port 81 opens to the sump region of the pump's pumping chamber 82 which is defined on one side by the step of counterbore 62 and on the other side by the pressure control member 61 and at its annular perimeters by the pressure control member's internal cylindrical surface 64 and the rotor's cylindrical surface 66. With oil supply to chamber 82 as the rotor 56 rotates in the direction indicated by the arrow in FIG. 3, there results an oil pressure distribution about the chamber with the pressure increasing in the direction of rotor rotation. The pressure control member 61 is provided with a pump outlet port 84 which is open to chamber 82 through cylindrical surface 64 and is moved in the direction of increasing pump chamber pressure with turning of the pressure control member as the engine throttle opening is increased, the pressure reaching a maximum where the pumping chamber narrows to a minimum which location is at the pump outlet port position shown in FIG. 3 which is thus the maximum pump outlet port pressure position and occurs at or near wide open engine throttle. This operation effects an oil flow through the outlet port 84 that increases with increasing speed of pump rotor 56 and throttle opening and thus with increasing engine load. For a more detailed understanding of the pump section, reference may be made to my aforementioned U.S. Pat. application Ser. No. 360,328.

According to the present invention oil flow from the pump section just described or from one that provides a similar oil flow that increases with increasing engine load is controlled in such a manner that the oil flow pressure for seal lubrication is dependent on the pressure developed by the pump and is independent of varying pressure at the pump inlet port and in addition the oil flow delivered for seal lubrication is timed to be intermittent yet substantially uniform at constant engine loads. This is accomplished by the provision of a solid cylindrical shaped pressure control valve **85** which is mounted for reciprocal movement in a bore **86** that is drilled up through the step of the counterbore **62** on the pressure side of the pumping chamber **82.** The lower end of the bore **86** is closed by the pressure control member **61** to provide a chamber **87** that is continuously connected via an arcuate port **88** in the upper side of the pressure control member to the pump's outlet port **84** as the pressure control member is turned. The other end of valve bore **86** is closed by pump body **50** to provide a chamber **89** that is connected by a drilled passage **90** to the pump inlet passage **80** and thus receives pump inlet pressure. A pressure controlled delivery port **91** drilled in the pump body **50** intersects at one end with the pump rotor's bore **52** and at the other end with the valve bore **86** in a position so that with upward movement of this valve to a position such as shown in FIG. **2,** the chamber **87** which receives oil from the pump section is opened thereto. Pump inlet pressure thus acts in chamber **89** downward on the valve **85** and pump outlet pressure acts in chamber **87** upward thereon and the valve **85** will move to close the pressure controlled delivery port **91** to the pump outlet port **84** when the pump inlet pressure is greater than the pump outlet pressure and will move in the opposite direction to open the pressure controlled delivery port **91** to the pump outlet port **84** when the pump outlet pressure is greater than the pump inlet pressure plus the effect of gravity acting on valve **85.** Where the effect of gravity is not available to urge valve closure or where additional closing force is desired, a light load spring **92** is arranged in chamber **89** to act on valve **85** to urge valve closing. In either case, the existing pump inlet pressure is effectively subtracted from the pump outlet pressure so that the pressure of the oil supplied to the pressure controlled delivery port **91** is dependent upon the pressure developed by the pump section and independent of varying pressure at the pump inlet which may be gravity fed as shown and have a varying head or pressure fed from a pressure zone in the engine's lubrication system where the pressure will vary.

Where the actual quantity of oil required to be metered is very small and it is desired to provide a timed intermittent oil flow for delivery to the seals in very short time intervals, the actual oil flow rate can be adversely affected particularly at constant engine loads even with the operation of pressure control valve **85.** This adverse effect is minimized or substantially eliminated by the provision of a rotary valve generally designated as **93** which alternately connects the pressure controlled delivery port **91** to a pump discharge port **94** and a bypass port **95,** the discharge port **94** being connected through a nipple by a conduit **96** to the engine's side wall oil feed ports **48** and the bypass port **95** being connected to the pump inlet passage **80.** Referring to FIGS. **2, 4** and **5,** the discharge port **94** and bypass port **95** open to the rotor bore **52** at spaced axial locations and at the same angular location with the pressure controlled port **91** opening to this bore at an intermediate axial location and not necessarily the same angular location. The rotary valve **93** is formed as an extension of the pump rotor **56** and thus rotates at a speed proportional to engine speed and has a port **98** in the cylindrical surface **66** that is shaped to cooperate with the cylindrical bore **52** to define fluid pathways to effect such intermittent connections between the pressure controlled delivery port **91** and the discharge and bypass ports **94** and **95.** The valve port **98** which may thus be referred to as a discharge-bypass port is formed with an annular groove **99** that extends completely about the rotary valve **93** as shown in FIG. **4** and is axially located so that it is continuously open to the pressure controlled delivery port **91** as shown in FIG. **2.** The annular groove **99** at its lower end as viewed in FIG. **2** is interrupted by an axially extending portion **100** of the valve's cylindrical surface **66.** The surface portion **100** extends only a short way around the circumference of the rotary valve as shown in FIG. **4** and is axially located as shown in FIGS. **2** and **4** so that the rotary discharge-bypass port **98** is open to the bypass port **95** during a major portion of a rotary valve revolution and through the remaining small portion of the revolution is closed by the surface portion **100.** The annular groove **99** is open on the outer side to an axially extending timing slot **102** that is less in circumferential width than the arcuate surface **100** with which it is axially aligned and extends sufficiently axially so as to only open to the discharge port **94** when the rotary valve's surface portion **100** is closing the bypass port **95,** the discharge port **94** being closed by the valve's cylindrical surface **66** either side of slot **102** when the bypass port **95** is open.

Thus, as the pump rotor **56** rotates and oil flow is delivered to the pressure controlled delivery port **91** at a rate that increases with increasing engine load and at a pressure determined by the operation of the pressure control valve **85,** the valve's bypass control surface **100** first closes the bypass port **95** and then the timing or discharge slot **102** of the discharge-bypass port **98** passes over the discharge port **94** allowing oil to flow to the engine's oil feed ports **48** with the time of opening being very short in view of the width of the timing slot **102** in comparison with the valve's circumference. Then after the timing slot **102** has passed the discharge port **94,** the discharge-bypass port **98** opens to the bypass port **95** allowing oil to then flow from the pressure controlled delivery port **91** back to the pump inlet port **81** for the remaining major portion of a valve rotation. As a result, there is substantially uniform flow of oil through the pump at all times and particularly at constant engine loads and thus there is effected intermittent but substantially uniform flow to the pump discharge port **94** at constant engine loads which might not be the case without such bypass operation recognizing that with no bypass, flow through the pump would be intermittently blocked when the desired timed output flow is not to occur and such blockage of flow is conducive to erratic pressure fluctuations that would in turn cause the timed flow after removal of the blockage to be erratic.

The above described embodiment is illustrative of the invention which may be modified within the scope of the appended claims.

I claim:

1. An oil metering pump for metering oil to lubricate an engine's seals comprising a pump inlet port, a pump outlet port, pumping means for pumping oil from said pump inlet port to said pump outlet port at a rate that increases with increasing engine load, a pressure controlled delivery port, pressure control valve means oppositely biased by oil pressure from said pump inlet port and from said pump outlet port for providing controlled connection of said pump outlet port to said pressure controlled delivery port so that the oil pressure in said pressure controlled delivery port is dependent on the pressure developed by said pumping means and is independent of varying pressure at said pump inlet port, a pump discharge port for delivering oil from said pump to lubricate the engine's seals, a bypass port connected to said pump inlet port, and discharge-bypass valve means driven at a speed proportional to engine speed for connecting said pressure controlled delivery port alternately to said pump discharge port and said bypass port so that oil from said pressure controlled delivery port is intermittently delivered back to said pump inlet port to effect substantially uniform oil flow through said pressure controlled delivery port at substantially constant engine loads to maintain substantially uniform oil flow for seal lubrication at substantially constant engine loads.

2. An oil metering pump for metering oil to lubricate an engine's seals comprising a pump inlet port, a pump outlet port, pumping means including a pump rotor driven at a speed proportional to engine speed for pumping oil from said pump inlet port to said pump outlet port at a rate that increases with increasing engine load, a pressure controlled delivery port, pressure control valve means oppositely biased by oil pressure from said pump inlet port and from said pump outlet port for providing controlled connection of said pump outlet port to said pressure controlled delivery port so that the oil pressure in said pressure controlled delivery port is dependent on the pressure developed by said pumping means and is independent of varying pressure at said pump inlet port, a pump discharge port for delivering oil from said pump to lubricate the engine's seals, a bypass port connected to said pump intake port, and a discharge-bypass passage rotatable with said pump rotor for connecting said pressure controlled delivery port alternately to said pump discharge port and said bypass port so that oil from said pressure controlled delivery port is intermittently delivered back to said pump inlet port to effect substantially uniform oil flow through said pressure controlled delivery port at substantially constant engine loads to maintain substantially uniform oil flow for seal lubrication at substantially constant engine loads.

3. An oil metering pump for metering oil to lubricate an engine's seals comprising a pump inlet port, a pump outlet port, pumping means including a pump rotor driven at a speed proportional to engine speed for pumping oil from said pump inlet port to said pump

outlet port at a rate that increases with increasing engine load, a cylindrical valve bore, a pressure controlled delivery port open to said valve bore, pressure control valve means oppositely biased by oil pressure from said pump inlet port and from said pump outlet port for providing controlled connection of said pump outlet port to said pressure controlled delivery port so that the oil pressure in said pressure controlled delivery port is dependent on the pressure developed by said pumping means and is independent of varying pressure at said pump inlet port, a pump discharge port open to said valve bore for delivering oil from said pump to lubricate the engine's seals, a bypass port connected to said pump inlet port and open to said valve bore, said pump motor having a cylindrical valve extending into said valve bore past all of the ports open thereto, and said valve having a discharge-bypass port continuously open to said pressure controlled delivery port and alternately open to said pump discharge port and said bypass port as said valve rotates so that oil from said pressure controlled delivery port is intermittently delivered back to said pump inlet port to effect substantially uniform oil flow through said pressure controlled delivery port at substantially constant engine loads to maintain substantially uniform oil flow for seal lubrication at substantially constant engine loads.

4. An oil metering pump for metering oil to lubricate an engine's seals comprising a pump inlet port, a pump outlet port, pumping means including a pump rotor driven at a speed proportional to engine speed for pumping oil from said pump inlet port to said pump outlet port at a rate that increases with increasing engine load, a cylindrical valve bore, a pressure controlled delivery port open to said valve bore, pressure control valve means oppositely biased by oil pressure from said pump inlet port and from said pump outlet port for providing controlled connection of said pump outlet port to said pressure controlled delivery port so that the oil pressure in said pressure controlled delivery port is dependent on the pressure developed by said pumping means and is independent of varying pressure at said pump inlet port, a pump discharge port open to said valve bore at a location axially spaced from said pressure controlled delivery port for delivering oil from said pump to lubricate the engine's seals, a bypass port connected to said pump inlet port and open to said valve bore at a location axially spaced from said pressure controlled delivery port and said pump discharge port, said pump rotor having a cylindrical valve extending into said valve bore past all of the ports open thereto, and said valve having a discharge-bypass port in the cylindrical surface thereof continuously open to said pressure controlled delivery port and alternately open to said pump discharge port and said bypass port as said valve rotates so that oil from said pressure controlled delivery port is intermittently delivered back to said pump inlet port to effect substantially uniform oil flow through said pressure controlled delivery port at substantially constant engine loads to maintain substantially uniform oil flow for seal lubrication at substantially constant engine loads.

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