

[54] LUBRICATION SYSTEM OF A TWO-STROKE INTERNAL COMBUSTION ENGINE

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[56]

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[57]

ABSTRACT

In the disclosed lubricating system for an internal combustion two-stroke engine there is incorporated a positive displacement worm-type pump of which the worm is directly connected with the crankshaft of the associated engine. In this way the reliability of the performance of the lubricating system is enhanced.

2 Claims, 5 Drawing Figures

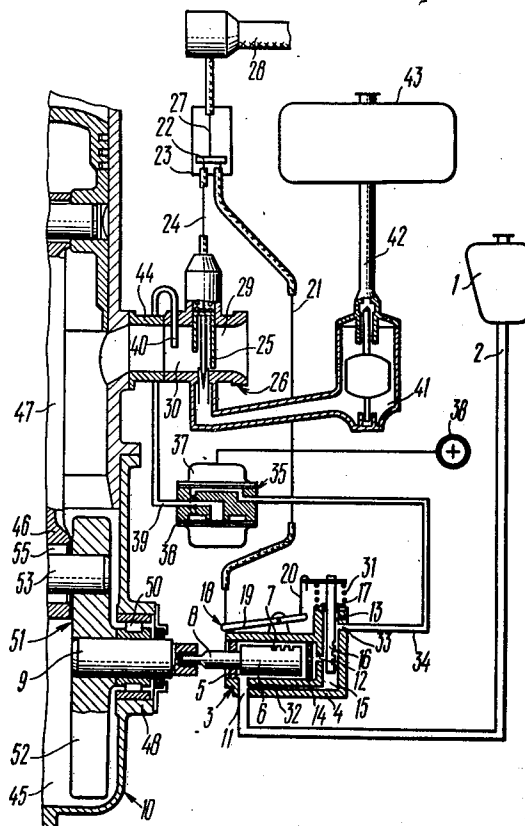
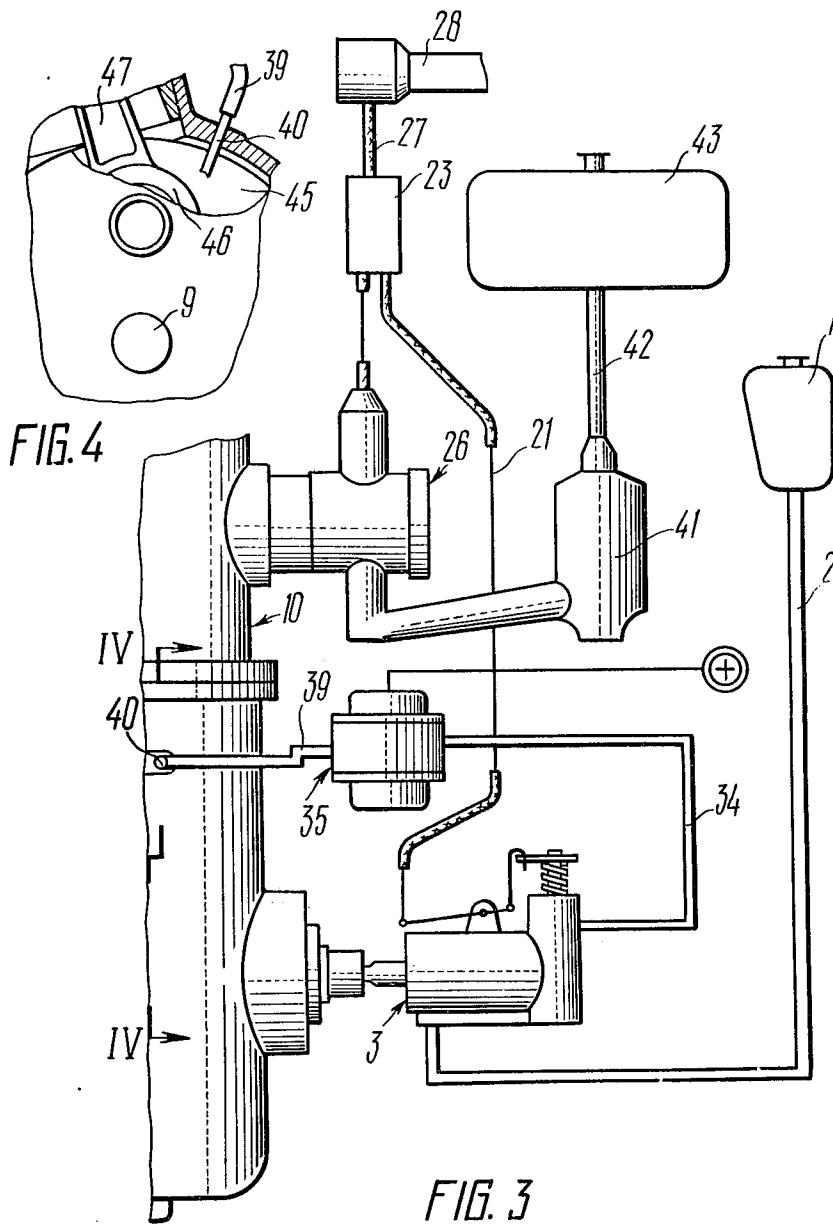
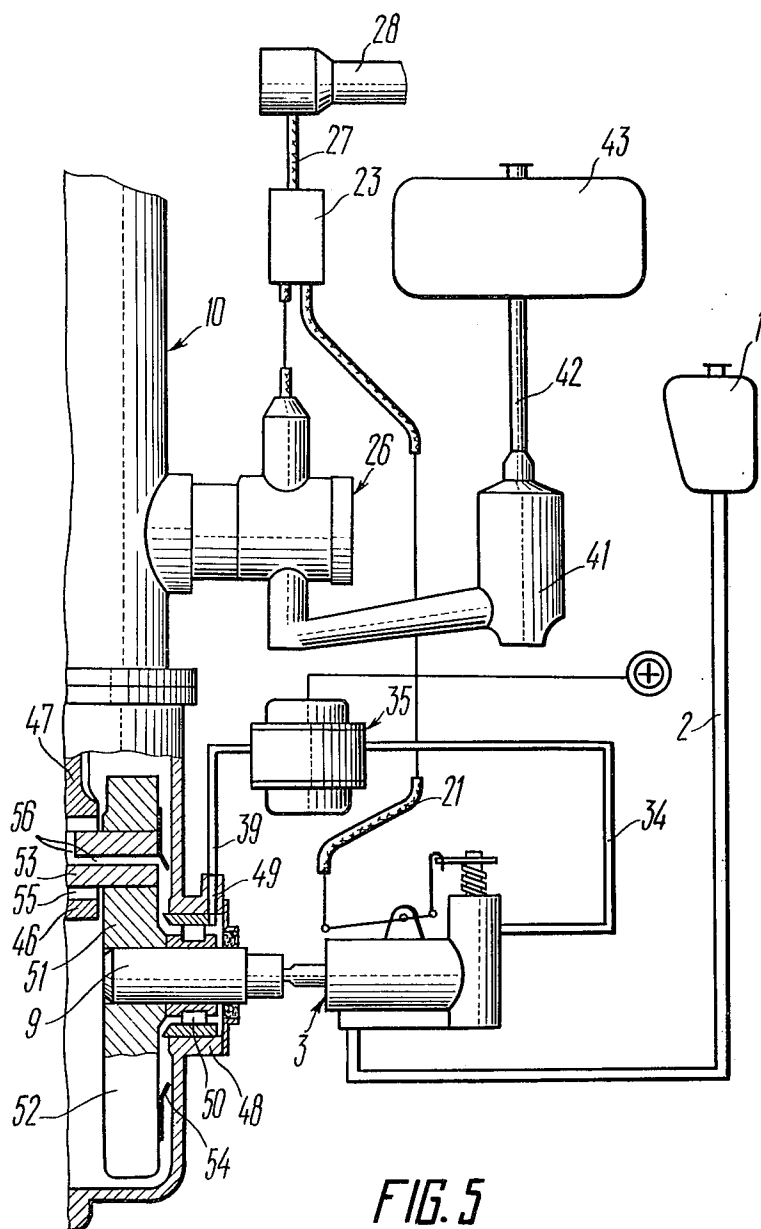


FIG. 1





LUBRICATION SYSTEM OF A TWO-STROKE INTERNAL COMBUSTION ENGINE

The present invention relates to lubrication system incorporable in internal combustion engines of the two-stroke kind.

The present invention may be used to utmost advantage in the lubrication systems of internal combustion engines of the carburettor type, for instance, in two-stroke engines mounted on motorcycles and the like.

Known in the art is a lubrication system of an internal combustion engine of the two-stroke type, including means for introducing a fuel into this engine through a carburettor, wherein the crankshaft of the engine is operatively connected with the movable member of a pump adapted for continuous supply of a liquid lubricant to a metering device hydraulically connected with said fuel introduction means.

In this known lubrication system the pump effecting the continuous supply of the liquid lubricant is in the form of a screw-type pump of which the rotatable screw is connected with the crankshaft of the engine through a belt transmission. The pump has the outlet thereof connected to a conduit through which the liquid lubricant, e.g. oil, is supplied under pressure to a metering device. This conduit incorporates a spring-urged by-pass valve through which a part of the oil, determined by the resistance of the metering device defined by the fuel consumption rate, is returned into the oil supply container. The rest of the oil passes through the metering device including a series connection of a needle valve and a slit-type throttling means. The needle valve is actuated by means of an actuating solenoid. An electric current flows through the coils of the actuating solenoid in response to the displacement of a plunger mounted in a cylinder adjoining the fuel supply conduit through which the fuel is pumped from a fuel tank by an independent pump into the float chamber of the carburettor, the plunger being thus responsive to the pressure of the fuel in this fuel supply conduit. The known system further includes means for mixing the oil with the fuel, incorporated into the conduit through which the fuel is supplied into the float chamber of the carburettor. The mixing means includes a locally expanded portion of the last-mentioned conduit, into which there projects a tube connecting this conduit with the metering device of the lubrication system.

The oil flows from the oil container into the oil pump by gravity. As it has been already mentioned, a part of this oil is returned into the container, whereas the other part of which the value depends on the actual load of the engine is fed to the mixing means through the metering device and the conduit under a gauge pressure developed by the oil supply pump. In the mixing means the oil is mixed with the fuel, and this mixture is fed through the check valve of the carburettor into the float chamber of the latter, as the mixture contained in this float chamber is being drawn therefrom, whereby a guaranteed level of the mixture is maintained in the float chamber, predetermined by the adjustment of the float assembly. In this way the abovedescribed known lubrication system enables to control the fuel to oil ratio in accordance with the varying load of the engine.

However, a serious disadvantage of this known lubrication system arises from the presence of the intermediate link connecting the crankshaft of the engine with

the screw of the oil pump. This feature complicates the drive of the pump and introduces a certain time lag into the operation of the system.

Another disadvantage of the known system is the fact that the oil is added to the fuel within the mixing means mounted upstream of the carburettor, whereby there is always present in the float chamber of the carburettor a certain amount of the fuel-oil mixture of a specific composition, which amount can be consumed by the engine within a certain time. Consequently, when the operational duty of the engine varies, the mixture of a corresponding optimal composition would be fed thereto only after a certain period needed for operation of the metering device and for burning the amount of the previous fuel-oil mixture which had been contained in the float chamber of the carburettor.

In the known lubrication system the check valve at the inlet of the carburettor acts simultaneously as the check valve of the metering device. Therefore, the operation of the metering device depends on the counter-pressure in the conduit connecting the fuel pump with the carburettor. Thus, the point of introduction of the oil is limited by the last-mentioned conduit, since the pressure therein is always lower than in the conduit through which the oil is supplied into the mixing means. Consequently, the applications of the abovedescribed known lubrication system is limited by the engines wherein the fuel is supplied into the carburettor by an independent pump, in order to create within the mixing device a value of pressure, sufficient for reliable operation of the metering device, as well as for the action of the bypass valve thereof, so as to afford for controlling the operation of the lubrication system.

It is an object of the present invention to provide a lubrication system incorporable in two-stroke internal combustion engines, which should be simple and reliable in operation.

These and other objects are attained in a lubrication system incorporable in two-stroke internal combustion engines including means for introducing a fuel into the engine through a carburettor, wherein the crankshaft of the engine is operatively connected with the movable member of a pump adapted for continuous supply of a liquid lubricant to a metering device hydraulically connected with the fuel introduction means, in which system, in accordance with the present invention, said pump adapted for continuous supply of a liquid lubricant is in the form of a positive displacement worm-type pump, said movable member of said pump including a worm directly connected to said crankshaft of said engine, whereby the rate of supply of said liquid lubricant by said pump is directly proportional to the number of revolutions per minute of said crankshaft of said engine.

Therefore, the time of response of the system is substantially reduced, and there is achieved a mode of operation where any variation of the operational duty of the engine is practically immediately followed by a corresponding variation of the fuel to oil ratio in the flow of the mixture supplied into the cylinder or cylinders of the engine.

It is advisable that said lubricant pump and said metering device should be accommodated within a single housing so that the outlet passage of the pump should be the inlet passage of the metering device, the outlet passage of the last-mentioned device being hydraulically connected with the apparatus introducing the fuel into the engine, the metering device including a

helically threaded stud received within a smooth-walled sleeve, the helical thread defining with the smooth internal wall of the sleeve a throttling passage.

With the pump and the metering device being arranged in the above manner, the entire system becomes more compact, takes less metal and is more convenient to mount on the engine.

It is further advisable that the metering device should have mounted immediately downstream of the outlet thereof a diaphragm-type delivery valve for hydraulic connection of the metering device with any point of the apparatus introducing the fuel into the cylinder or cylinders of the engine through the carburettor.

The incorporation of the abovesaid delivery valve considerably broadens the range of possible overall arrangements of the lubricating system, since it eliminates any limitations as to the point of introduction of the oil at a desired pressure; furthermore, it provides for maintaining a pressure value at the outlet of the metering device, which is optimal for adjustment of the device and its reliable performance, independently of the pressure within the fuel supply conduit. Given hereinbelow is a description of possible embodiments of a lubricating system for a two-stroke internal combustion engine in accordance with the invention, with reference being made to the accompanying set of drawings, wherein:

FIG. 1 illustrates schematically a lubricating system incorporated in an internal combustion engine, constructed in accordance with the present invention;

FIG. 2 is a modification of the system shown in FIG. 1, wherein the lubricating oil is introduced into the engine through the fitting connecting the carburettor with the crank-chamber of the engine;

FIG. 3 illustrates schematically an embodiment of a lubricating system incorporated in an internal combustion engine in accordance with the present invention, wherein the oil is introduced through the crank chamber of the engine;

FIG. 4 is a sectional view along line IV—IV of FIG. 3;

FIG. 5 is another embodiment of a lubricating system incorporated in an internal combustion engine in accordance with the present invention, wherein the oil is introduced through the main crankshaft bearing. Referring now in particular to the appended drawings, the herein disclosed lubricating system incorporable in a two-stroke internal combustion engine includes a container 1 (FIG. 1 for a supply of liquid lubricant, i.e. lubricating oil, the container 1 communicating via a conduit 2 with a worm-type positive displacement pump 3. The latter has a housing 4 with a cylindrical bore 5 accommodating a worm 6. The internal wall of the bore 5 is smooth. In the presently described embodiment the pump 3 incorporates the worm 6 having a single helical groove 7 cut in the periphery thereof, i.e. the worm 6 is a single-thread one. The worm 6 includes a stem 8 projecting outside of the housing 4. This stem 8 is intended for connecting the worm 6 of the pump 3 directly to the crankshaft 9 of the internal combustion engine 10, the crankshaft thus serving as the drive shaft of the pump assembly 3.

The helical groove 7 of the worm 6 is rectangular in cross-section, the width-to-height ratio of the profile of this groove being preferably within a range from 1:1 to 4:1. The hydraulic diameter of the groove 7, defined as the ratio of four times the area of the cross-section to the wettable perimeter of this cross-section, is preferably not in excess of 0.5 mm. With these parameters of

the helical groove 7 the displacement of the pump has been found to be practically independent of the viscosity of the oil being pumped and of the length of the worm 6.

This may be explained by the fact that the abovedescribed helical groove 7 resembles the so-called capillary slit wherein the flow of the liquid is determined by the adhesion thereof to the material of the housing 4 and to that of the worm 6. The housing 4 of the pump 3 has two passages 11 and 12 cut therein, communicating with the bore 5 adjacent to the respective end faces of the worm 6, the passage 11 serving as a supply passage through which oil is supplied into the pump 3 from the conduit 2 connected with the oil container 1, the other passage 12 being a delivery passage through which the oil under pressure is delivered by the pump 3 into a metering device 13 mounted in the same housing 4 of the pump 3, which means that the delivery or outlet passage 13 of the pump 3 is the inlet passage of the metering device 13. The bore 5 of the housing 5 has an oil filter 14 mounted therein upstream of the passage 12. The metering device 13 includes a bore 15 cut in the housing 4, accommodating a stud 16 having a helical thread cut in the periphery thereof. The portion of the stud 16 with this helical thread acts as a throttling means, the helical thread in the periphery thereof defining with the internal wall of the bore 15 a throttling passage through which the oil is forced to flow. The passage 12 extends at right angles to the axis of the bore 15, so that the oil stream leaving the passage 12 is directed onto the periphery of the abovedefined throttling means. The stud 16 is reciprocally received in the bore 15, the stud having a smooth portion projecting outside of the housing 4 through a packing 17, adapted to be connected to an actuator. The latter includes a linkage 18 incorporating a double-arm lever 19 of which one arm is connected with the last-mentioned end portion of the stud 16 by a rod 20, while the other arm is connected by a cable 21, e.g. a Bowden cable to a plunger 22 reciprocally mounted in a sleeve 23 mounted, in its turn, on the associated vehicle (not shown). The same plunger is connected by a cable 24 to the throttle 25 of the carburettor 26 of the engine. At the opposite side the plunger 22 is connected by a cable 27 to the control handle 28 of the throttle 25, the latter separating the intake 29 through which air is drawn into the carburettor 26 from the space 30 in the carburettor 26, disposed downstream of the throttle 25.

To return the stud 16 into its initial position corresponding to idling of the engine a compression spring 31 is received about the smooth end portion thereof. The bore 15 communicates with a pair of passages 32 and 33, the passage 32 being a by-pass through which a part of the oil is returned into the inlet passage 11 of the pump, whereas the passage 33 communicates with the delivery conduit 34 incorporating a diaphragm-type delivery valve 35 having a diaphragm 36. The function of the valve 35 in a continuous-delivery lubricating system is to maintain a pre-set pressure in the delivery conduit 34 and to prevent faulty oil metering on account of eventual sucking-in of the oil, as the latter is introduced into the space 30 of the carburettor 26, downstream of the throttle 25 thereof, in which space the pressure more often than not is below the atmospheric pressure, particularly when the engine is running under a relatively small load. When the engine is not running the valve 35 acts as the closure means of the lubricating system, preventing any outflow of the

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oil from the system, the oil filling every internal space of this system. Thus, the herein disclosed system is always ready to function, which is essential in the case of internal combustion engines wherein any time lag in the supply of the lubricant threatens a breakdown of the engine.

The delivery conduit 34 is associated at the point thereof upstream of the valve 35 with a signal device including a pressure transducer 37 and an indicator 38 monitoring the pressure in the conduit 34 and in the valve 35. The outlet passage of the valve 35 communicates with a conduit 39 ending with an atomizer 40 projecting into the space 30 downstream of the throttle 25 of the carburettor 26. The latter includes a float chamber 41 communicating via a conduit 42 with a fuel tank 43. The above arrangement is the most typical in lubricating systems with the lubricant being fed by a pump.

There is shown in FIG. 2 of the appended drawings a slightly modified lubricating system for a two-stroke internal combustion engine, likewise incorporating a pump 3 effecting continuous supply of the lubricant.

In the embodiment shown in FIG. 2 the conduit 39 downstream of the delivery valve 35 ends with an atomizer 40 entering a fitting 44 connecting the carburettor 26 with the crank chamber 45 of the engine 10. Introduction of the oil into the stream of the combustible mixture within the fitting 44 is effected in cases where for some reason it is either impossible or ill-advisable to accommodate the atomizer 40 directly in the carburettor 26, downstream of the throttle 25 thereof.

There is illustrated in FIGS. 3 and 4 an embodiment of the present invention wherein the oil is introduced into the engine 10 in a somewhat different way. The conduit 39 ending with the atomizer 40 is projecting into the crank chamber 45 of the engine 10 through the wall of this chamber. The atomizer 40 is positioned in the closest possible proximity to the path of the lower or big end 46 of the connecting rod 47 connected with the respective crank (not shown) mounted on the crankshaft 9 of the engine 10. Owing to this feature, the motion of the combustible mixture in the chamber 45 envelopes the atomizer 40 at any running speed of the engine with an intensity depending solely on the angular speed of the crankshaft 9, which improves the conditions of atomization of the oil and mixing thereof with the air-fuel mixture, when the fuel and oil are fed separately into the engine 10.

There is shown in FIG. 5 still another modification of the herein disclosed lubricating system for introduction of oil into the engine 10. In this embodiment the conduit 39 is introduced into the main bearing assembly 48 of the crankshaft 9. This is effected by the housing of the main bearing assembly 48 having made therein a passage 49 via which the oil is supplied to the bearing member 50 contacting with the crankshaft 9. Adjoining the bearing member 50, a crank 51 is mounted on the crankshaft 9, the crank 51 including a circular plate 52 with a pair of openings of which one provides for mounting of plate 52 on the shaft 9, whereas the other opening receives therein the journal 53 of the crank 9. The plate 52 has mounted thereon an oil deflector 54. The journal 53 is received in the bearing 55 mounted in the big end 46 of the connecting rod 47. To feed the oil to the bearing 55 of the big end 46 of the connecting rod 46, the journal 53 has made therein a passage 56. Upon leaving the big end 46 the oil mixes with the fuel-air mixture.

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It is expedient to introduce the oil through the main bearing assembly 48 of the crankshaft 9 in hopped-up high-rpm two-stroke engines wherein the oil and the fuel are fed separately into the engine.

It should be understood that apart of the abovedescribed embodiments with different modifications of the means introducing the oil into two-stroke carburettor internal combustion engines, the herein disclosed lubricating system incorporating a continuous delivery oil pump may be associated with other modifications of the oil introduction means.

The herein disclosed lubricating system for a two-stroke carburettor engine operates, as follows. The oil flows by gravity from the container 1 via the conduit 2 to the inlet passage 11 adjoining the worm 6 of the pump 3. The pump 3 is driven by the crankshaft 9 of the associated engine 10, connected directly to the stem 8 of the worm 6. As the worm 6 is thus rotated, the oil flows through the helical groove 7 toward the filter 14 where it is cleared of mechanical impurities, connected directly to the stem 8 of the worm 6. As the worm 6 is thus rotated, the oil flows through the helical groove 7 toward the filter 14 where it is cleared of mechanical impurities, whereafter it is directed via the passage 12 onto the periphery of the stud 16. Therefrom the oil flows along the helical thread of this stud 16 toward the passages 32 and 33, which means that the flow of the oil from the pump 3 is divided in a proportion determined by the ratio of the lengths of the passages defined between the helical thread of the stud 16 and the internal wall of the bore 15, disposed at the opposite sides of the passage 12. Via the passage 32 the oil returns into the passage 11 communicating with the bore 5 accommodating therein the worm 6. Via the passage 33 the oil flows into the conduit 34 along which it flows further on toward the delivery valve 35. It should be noted that there is maintained within the conduit 34 throughout the operation of the pump 3 a gauge pressure of about 0.4 kg/sq.cm at minimal displacement of the pump, which pressure is essential for normal performance of the system, irrespectively of the varying duty of the engine 10. The duty of the engine 10 is controlled by rotation of the handle 28, which rotation is transmitted via the cable 27, e.g. a Bowden cable, to the plunger 22 in the sense that the latter is displaced accordingly in the sleeve 23, either upwardly or downwardly (meaning the situation displayed in the appended drawings). The displacement of the plunger 22 is transmitted simultaneously via the cable 24 to the throttle 25 of the carburettor 26 and via the cable 21, the lever 19 and the rod 20 the stud 16 of the oil metering device. The stud 16 is thus displaced axially of the bore 15, whereby the ratio of the throttling passages in the flowpath of the oil from the passage 12 to the passages 32 and 33 varies, which means that the ratio of the parts of the oil directed, respectively, back into the pump and into the conduit 34 toward the delivery valve 35 varies accordingly. The gauge pressure of the oil in the conduit 34 is responded to by the transducer 37 and is shown on the indicator 38. In this way the performance of the system is monitored.

The pressurized flow of the oil in the valve 35 makes the diaphragm 36 yield, and the oil flows into the passage communicating with the conduit 39. The oil flows via the conduit 39 into the atomizer 40 projecting in the space 30 downstream of the throttle 25 of the carburettor 36. At the same time fuel from the tank 43 flows via the conduit 42 into the float chamber of the

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carburettor 26. From this float chamber 41 the fuel flows toward the area of the throttle 25 of the carburettor 26, where the fuel is mixed with the air drawn in through the air intake 29 of the carburettor 26, in which way the combustible fuel-air mixture is formed. The amount of this mixture fed into the engine 10 is controlled by displacing the throttle 25. Immediately downstream of the throttle the stream of the combustible mixture flows by the atomizer 40 and entrains droplets of oil which this stream carries therealong into the engine 10, towards the bearings and cylinders thereof.

In modifications where the conduit 39 with the atomizer 40 is projecting into the fitting 44 connecting the carburettor 26 with the engine 10, the droplets of oil are entrained by the stream of the combustible mixture leaving the carburettor 26, at the inlet of the crank chamber 45 of the engine 10.

In still other modifications where the conduit 39 with the atomizer 40 is projecting directly into the crank chamber 45 of the engine 10 the droplets of oil are entrained from the atomizer 40 by the swirling stream of the combustible mixture agitated by the rotating crank 51, whereby the droplets mix with this stream and are carried thereby toward the bearings 50 and 55 and into the cylinder or cylinders of the engine 10.

In modifications where the conduit 39 communicates with the engine through the passage 49 in the main bearing assembly 48 of the crankshaft 9 the oil is directed onto the bearing 50 wherefrom it flows into the crank chamber 45 and is directed by the deflector 54 mounted on the plate 52 of the crank 51 of the crankshaft 9. The centrifugal forces make the oil flow further on via the passages 56 in the journal 53 of the crank 51 toward the bearing 55 of the big end 46 of the connect-

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ing rod 47. From this bearing the oil flows out through the clearances between the bearing 55 and the plates 52 of the crank 51, to be entrained by the combustible mixture which latter carries the oil into the cylinder or cylinders of the engine 10 and toward other surfaces, subject to friction.

What is claimed is:

1. A lubricating system incorporable in a two-stroke internal combustion engine including means for introducing fuel into said engine through a carburetor, said system including a worm-type oil pump to effect continuous positive supply of a liquid lubricant into said engine, said oil pump having a worm connected directly to the crankshaft of said engine and a metering device comprising a smooth sleeve and a helically threaded stud received in said sleeve, the thread of said stud and the walls of said sleeve defining a throttling passage; said pump and said metering device being arranged in a common housing and connected hydraulically with each other so that the outlet passage of said pump serves as the inlet passage of said throttling passage of said metering device whose outlet passage is connected hydraulically with said means for introducing fuel into said engine.

2. A lubricating system incorporable in a two-stroke internal combustion engine as claimed in claim 1, wherein hydraulic connection between the outlet passage of the throttling means and the means for introducing fuel into the engine is effected through a diaphragm-type delivery valve so that said metering device can be connected hydraulically with any point of said means for introducing fuel into the engine.

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