This invention relates to a lubricating pump for 2-cycle gasoline internal combustion engine.

A principal object of the invention is to provide effective lubrication of 2-cycle engines by supplying only lubricating oil to necessary parts of the engine.

Another object of the invention is to enable lubricating oil to be measured in accordance with engine load and revolutions, irrespective of pressures at points to be lubricated, oil passage resistance, and other factors, and also permit the oil to be controlled in amount depending on the operating conditions of the engine.

Another object of the invention is to enable the total amount of oil supply to be adjusted, whenever necessary, from the outside.

Still another object of the invention is to supply lubricating oil to engine parts by hand before starting the engine, thereby to prevent any engine trouble due to lack of lubricating oil at the time of starting.

Most of 2-cycle gasoline engines hitherto in use employ crankcase scavenging system, by which rotary parts inside the cylinder and crankcase are lubricated by lubricating oil mixed with fuel and discharged together with the fuel from the carburetor. This lubrication system has presented practically no problem in Japan and other countries where mixed oil is abundantly available. However, in the areas where 2-cycle engines are not in general use, mixed oil is not readily obtained, and whenever it is desired to alter the mixing ratio of fuel to lubricating oil, all the trouble of mixing and blending them suitably together must be taken. In this case, in order to mix lubricating oil with fuel, a readily mixable oil has to be chosen. This often limits the use of the lubricating oil which is appropriate for 2-cycle engines, making it necessary to use oil of unsatisfactory quality.

In case of mixed lubrication, the lubricating oil is used as diluted by fuel, and is therefore unable to completely fulfill its ordinary functions. Further, lubricating oil is usually mixed in excess for safety reason because the amount of oil cannot be easily regulated to suit the operating conditions of the engine, and it is also difficult to supply the oil in an amount suitable for the number of revolutions of the engine or load thereof. Hence, 2-cycle engines are destined to be troubled with seizure of piston, spark plug bridge, deposition of carbon in the combustion chamber, and exhaust system, and scattering of dense oily mist in exhaust gas.

The present invention is concerned with a lubricating device for performing effective lubrication by supplying only lubricating oil to engine parts, in order to solve all the foregoing problems of lubrication of 2-cycle gasoline engines, and more specifically with a lubricating pump of the structure which permits lubricating oil to be measured in proportion to the load on and the number of revolutions of an engine, irrespective of the viscosity of oil, pressures at lubricating points, and flow rate coefficient, and to be regulated in the flow rate correspondingly to the operating conditions of the engine, and further to be supplied from one or more desired outlet ports. To be more precise, the invention provides a lubricating pump which sucks in oil through a suction port by means of a plunger, distributes a measured amount of oil to outlet ports at each stroke by means of a distributor, supplies oil in proportion to the number of revolutions of engine, and if necessary enables the total amount of oil to be readily adjusted in response to instruction from the outside.

Now, the invention is described with reference to the appended drawings showing an embodiment thereof, which is lubricating pump provided with two discharge ports.

FIG. 1 is a longitudinal sectional view of a lubricating pump according to the invention;

FIG. 2 is a sectional view taken along the line II--II of FIG. 1, indicating a unidirectional clutch of worm wheel;

FIG. 3 is a sectional view taken along the line III--III of FIG. 1;

FIG. 4 is a perspective view of a plunger cam-distributor assembly having two discharge ports;

FIG. 5 is a developed view illustrating the relations among the positions of inlet port, discharge port, and oil port, and the position of the cam follower pin, and the shapes of plunger cam opposite to said ports;

FIG. 6 is a front elevation view of a notch and stopper pin provided on boss end of pulley;

FIG. 7 is a developed view illustrating the relations between the positions of discharge port, inlet port, oil port, and cam follower pin, and the cam shape of plunger cam in the case the amount of oil supplied is to be changed by discharge port;

FIGS. 8, 9, and 10 illustrate plunger cam as mounted on plunger to provide an integral unit, FIG. 8 being a longitudinal sectional view showing modifications from the assembly shown in FIG. 1, FIG. 9 being a perspective view of plunger and plunger cam mounted integrally thereon, and FIG. 10 being a developed view illustrating the relations between the positions of discharge port, inlet port, and oil port, and the oppositely disposed cam follower pin and plunger cam; and

FIGS. 11 and 12 are illustrative views of a pump provided with a single discharge port, FIG. 11 being a cross sectional view corresponding to one taken along the line III--III of FIG. 1, and FIG. 12 being a perspective view of plunger cam and distributor.

In the drawings, numeral 1 designates a worm; 2 designates worm wheel; 3, distributor; 4, plunger; 5, plunger spring; 6, pump case; 7, case cover; 8, plunger cam; 9, shim; and 10, cam follower pin. In this case, the plunger cam 8 is press fitted on the outside of the distributor 3, and the worm wheel 2 is loosely fitted on the outside of said plunger cam 8. As shown in FIG. 2, a notch 32 provided on the worm wheel 2 and a pin 30 and spring 31 fitted in the plunger cam 8 constitute a unidirectional clutch.

As the worm 1 is driven, the worm wheel 2 is revolved, and the plunger cam 8 and distributor 3 are revolved altogether by means of the unidirectional clutch. The distributor 3 rotates inside a cylindrical portion provided in the pump case 6, and its axial movement is controlled by a boss 6a of the pump case 6 and a boss 7a of the case cover 7, and the shim 9 pressing the both sides of the plunger cam 8.

On the plunger cam 8 is mounted, as shown in FIG. 4, a cylindrical cam 11 having projections equal in number to the two outlet ports. Into the plunger 4 fitted in the cylinder 14 of the distributor 3, the cam follower pin 10 is press fitted, with its tip extending to a notch 13 provided on the case cover 7, thereby holding the plunger 4 against rotation, but enabling the latter to move in the axial direction.

The plunger 4 is kept pressed inwardly of the cylinder 14 of the distributor 3 by means of the plunger spring 5, while the cam follower pin 10 is pressed against the cam face of the cylindrical cam 11 of the plunger cam 8. In FIG. 1, numeral 39 designates a nut.
As the distributor 3 rotates, the cam follower pin 19 slides along the end of the cylindrical cam 11, and, depending on this angle of rotation, the plunger 4 slides laterally inside the cylinder 14 of the distributor 3.

The cylinder 14 of the distributor 3 is completely enclosed by a filler metal 35 and sealing material 36. Referring to FIGS. 1 and 3, numeral 15 indicates an oil chamber, 16 suction ports, and 17, discharge ports, which are all provided in the pump case 6, said suction ports 16 and discharge ports 17 being provided flush with an oil port 18. The oil port 18 opens or closes those ports open in the cylinder 14 of the plunger 4 as a result of rotation of the distributor 3. The housing 10 is rotatably coupled with the position of the cylindrical cam 11 of the plunger cam 8 as hereunder described. (Refer to FIG. 5 which is a developed view of the assembly.) The cylindrical cam 11 is so shaped that it can apply a stroke to the plunger 4 only when the oil port 18, rotating integrally with said cylindrical cam, is in communication separately with the suction port 16 or discharge ports 17. The notch 13 which positions the cam follower pin 10 is provided in connection with the suction port 16 and discharge ports 17, so that the plunger 4 can be moved correspondingly as said in FIG. 3, numeral 37 designates steel balls; 38 designates springs.

In FIG. 5, the symbol $h$ indicates the height of the cylindrical cam 11 of plunger cam 8. The oil port 18 and the cylindrical cam 11 move together integrally rightward. The suction ports 16 and discharge ports 17 are kept stationary, while the cam follower pin 10 can move only vertically. Thus, as the oil port 18 and cylindrical cam 11 begin to move from the position A in FIG. 5, and as the oil port 18 begins to be in communication with a suction port 16, the cam follower pin 10 moves downwardly while sliding along the cylindrical cam 11, and proceeds to the position B in FIG. 5, where the oil port 18 is brought out of communication with the suction port 16, and the cam follower pin 10 discontinues its movement. The same applies to the next discharge port 17. Therefore, as the distributor 3 in FIG. 1 turns, bringing the oil port 18 into communication with the suction port 16, the plunger 4 is urged rightward by the cylindrical cam 11, so that oil is sucked up from the oil chamber 15 into the cylinder 14. As the distributor 3 further rotates, the suction port 16 is closed by the circumference wall of the distributor, and the plunger 4 stops.

Then, the oil port 18 begins to be in communication with a discharge port 17, when the plunger 4 is moved leftward along the cylindrical cam 11, thereby delivering the oil inside the cylinder 14 toward the discharge port 17. Thus, by turning the distributor 3, oil can be positively delivered to each discharge port at each stroke. Since the quantity of oil which is discharged by the plunger 4 at each stroke depends on the height $h$ of the cylindrical cam 11 (indicated in FIG. 5) along which the cam follower pin 10 slides, it is possible to change the amount of discharge through the discharge ports every per stroke, by simply controlling the axial movement of the cam follower pin from the outside so as to alter said height $h$.

Next, the method of adjusting the oil supply by means of a mechanism which is coupled with the throttle opening of the carburetor is illustrated below.

Referring again to FIG. 1, a plunger stroke adjusting disc 21 is mounted on the outward end of the plunger 4 and is fixed by a lock nut 22. On the case cover 7 are mounted a pulley 23 for adjusting the quantity of oil supply, a spring 24 for urging the pulley back, and a stopper pin 26. Around the circumference of the pulley 23, an adjusting wire 28 is wound, which is coupled with the throttle opening. On the boss end of the pulley 23, as shown in FIG. 6, a cam-shaped notch 27 which is capable of subjecting the pulley 23 to axial displacement with respect to its angle of rotation is provided on the cylinder. The pulley 23 is set in a position so that the pulley return spring 24 applies pressure in the axial direction thereby permitting the notch 27 to slide along the stopper pin 26. In FIG. 1, numeral 25 designates a washer.

If the adjusting wire 28 is pulled from the outside, the pulley 23 revolved, balanced with the pulley return spring 24, and the notch 27 of the pulley slides along the stopper pin 26, so that the pulley 23 is axially displaced exactly following the shape of the notch 27. When the adjusting wire 28 is not pulled, the pulley 23 is wound back by the pulley return spring 24, until the C portion of the notch 27 is brought into contact with the stopper pin 26, and is fixed in placing. The axial movement of the pulley 23 is reduced to zero while the stopper pin 26 is in contact with the C portion of the notch 27. There is a cam formation whereby the pulley can then move leftward. The pulley return spring 24 is so designed that, in a set condition, the pressure it exerts in the axial direction endures greater load than the plunger spring 5. The plunger stroke adjusting disc 21 joins the plunger 4 in a stroke, but is kept in the position facing the boss end of the pulley 23, against going through the stroke any farther. This gives a limit to the height $h$ of the cylindrical cam 11 that is adjustable along the cam follower pin 10, so that the plunger stroke can be controlled. The position of the plunger can be adjusted by pulling the adjusting wire 28 and displacing the pulley boss end 29.

Further referring to FIG. 1, a handle 34 is fixed by an end pin 33 to the left end of the distributor 3. If the handle 34 is turned in the same direction as the distributor 3, the plunger cam 8 also rotates to release the unidirectional clutch of the worm wheel 2. Thus, not only can the distributor 3 and plunger cam 8 be revolved irrespective of the worm wheel 2, but the plunger 4 is allowed to go through its stroke. It is therefore possible to supply oil manually simply by turning said handle 34 either way.

Next, the procedures for changing the total quantity of oil supply and for adjusting the minimum oil supply will be described.

Adjustment must first be made by turning the handle 34 so that the position of the plunger 4 is at the terminal point of a suction stroke (i.e. the point where the cam follower pin 10 is on the top of the cylindrical cam 11). The minimum quantity of oil supply per stroke depends solely on the clearance between the inner side of the plunger stroke adjusting disc 21 and the boss end 29 of the pulley 23 at the time force is not applied to the adjusting wire 28, while the plunger itself is in a position above defined, that is, while the pulley 23 is in the C portion of the notch 27. With such a structure, the oil supply can be adjusted to a minimum by measuring above the clearance, using adjusting shim 20 of different thickness, and displacing the plunger stroke adjusting disc 21 so as to obtain a desired clearance, and then tightening the nut 22 to fix the adjusting disc 21 in the position so adjusted. Thus, by changing the position of the plunger stroke adjusting disc 21 thereby changing the clearance, not only the minimum oil supply per stroke but the total oil supply can be varied as desired. Steel balls 37 shown in FIG. 3 are urged by springs 38 toward the tapered portions on the sides of the discharge ports 17 of the pump case 6. In the discharge stroke of the plunger, the steel balls 37 are pushed off for discharge of oil, while in the other stroke they prevent leakage of oil through the clearance between the pump case 6 and the distributor 3 into the suction ports 16 and discharge ports 17.

As will be understood from the embodiment provided with two discharge and suction ports as above described, the lubricating oil pump for internal combustion engines according to the invention is subject to numerous modifications. Because the diameters of the oil ports and discharge and suction ports, and the distances among the discharge and suction ports can be freely selected by changing the out-
side diameter of the distributor, any pump having a desired number of discharge ports can be manufactured by forming cams corresponding in number to that of the discharge ports which are freely selected as above.

FIGS. 11 and 12 show another embodiment of the invention provided with a single discharge port. In the figures, like numerals indicate like parts, 16a designating a suction port, 17a discharge port, 37a steel ball, and 38a steel ball pressure spring.

Also, by incorporating a plunger cam having a cylindrical cam 11 with different heights h and h' as shown in FIG. 7, the pump can vary the amount of oil supplied through each discharge port. In FIG. 7, the oil port 18 and cylindrical cam 11 together move rightward, and, while the discharge port 17 and suction port 16 are kept stationary, the cam follower pin 10 alone can move up and down. Hence, the shape of the cylindrical cam 11 and the relative position of the oil port 18, and the relative positions of the discharge port 17 and cam follower pin 10 are always fixed laterally. Only if these relative positions are correlated suitably, the cam shape with respect to a set of discharge and suction ports can be fixed to provide integrity. This means that, by varying the cam shape related to the discharge port, the quantity of oil to be delivered through the port can be changed accordingly.

While the above embodiment comprises a structure wherein the cylindrical cam 11 is fixed to the distributor 3, the cylindrical cam 11 may be fixed to the plunger, as shown in FIGS. 8 through 10, to perform the similar functions as above. Referring to FIG. 8, a flange 8a is press fitted to the distributor 3, and further a cam follower pin 10b is press fitted in the flange 8a. A cylindrical cam 11b is press fitted to the plunger 4, and a projection 12 correlated to the cam shape is provided, which fits in the notch 13b formed on the pump cover 7. This, when combined with the same structure as in the embodiment described above, can readily attain the purpose of the invention.

Thus, in a 2-stroke engine which does not incorporate a mixed lubricating system but is lubricated only by lubricating oil delivered to the cylinders and rotary parts inside the crank chamber, oil is introduced through scavenging ports into combustion chambers and is further discharged out of the engine unit by the scavenging action of the crank chamber, in the same manner as in the mixed lubricating system. It is therefore necessary to replenish oil constantly to maintain an oil film formed over essential parts of the engine. However, if the oil is supplied in excess, part of it may find its way into the combustion chambers, as in the case of the mixed lubricating system, consequently affecting the engine performance adversely with bridging of spark plugs, firing irregularly, deposition of carbon on exhaust systems of combustion chambers, and sticking of piston rings, and further causing such undesirable phenomena as smoky exhaust gas and atomizing of oil. Conversely, if the oil supply is too small, the rotary and sliding surfaces of the engine parts are worn increasingly, and even seizure of pistons and damage of bearings may result. In order to lubricate this type of engine, a small amount of oil must be constantly delivered in an effective way to engine parts depending on the running condition of the engine, thereby to preclude any fluctuation in the amount of oil supplied due to the ambient conditions (e.g., pressure, and flow resistance) of the points to be lubricated, and also to ensure adequate lubrication regardless of any change in the viscosity of oil due to ambient temperature.

A lubricating apparatus which is to satisfy those requirements must be capable of measuring a limited quantity of oil proportionally to the operating conditions of the specific engine, and of positively delivering the oil to the engine parts to be lubricated. These functions are accomplished by the apparatus according to the invention, wherein the distributor 3 rotates within the cylinder of the pump case 6 to bring the oil port 18 into communication with the suction port 16 and discharge port 17, thereby allowing the plunger 4 in its stroke to positively suck up and discharge oil while these ports are not in communication with one another, the plunger is kept out of stroke, with the oil port 18 completely closed by the cylinder wall of the pump case, and the suction port 16 and discharge port 17 closed by the circumferential wall of the distributor 3. In this way, the ports are positively opened or closed, thereby attaining sealing effect perfectly.

Furthermore, because the plunger 4 can be fitted in the axial direction into the distributor 3 to minimize the volume of the cylinder 4, the ill effect by capture of air in minor stroke of the plunger 4 can be lessened, and oil can be fed in an effective way. The quantity of oil to be delivered out through the discharge ports are measured automatically at each stroke by the plunger for each port, and is delivered out by the distributor which opens or closes the ports by turns. Therefore, oil is supplied at a constant rate, regardless of any change in the ambient conditions or viscosity of oil.

Since the plunger size can be set independently, suitable plunger diameter and stroke may be selected within permissible ranges of mechanical accuracy, so that a limited quantity of oil can be supplied constantly. While the quantity of oil to be supplied is proportional to the number of engine revolutions, it can be automatically controlled to best meet the running conditions of the engine, because the plunger stroke is adjustable at will. This adjustment is effected by associating the modification of the plunger stroke with the throttle opening of carburetor. Alternatively, it is accomplished by taking advantage of such indications detected that can satisfactorily follow the movements in the crank chamber, negative pressure in the manifold or other engine loads.

Further, under the invention, the adjusting disc is adjusted by means of a shim to increase the plunger stroke, so that lubrication is made to meet specific running conditions of individual engines intended for different uses.

In addition, a unidirectional clutch is provided between the worm wheel and plunger cam, in order that the distributor may be turned from the outside to fill the piping with oil. Therefore, it is possible to start an engine after its piping has been filled with oil, instead of starting the engine without the piping leading to the lubricating points, for example immediately after mounting of the lubricating pump on the engine.

What I claim is:

1. A lubricating pump for a 2-cycle gasoline internal combustion engine comprising a pump case including a cylindrical portion, a distributor rotatably fitted in said cylindrical portion of the pump case, said distributor being rotated at a speed in proportion to the engine speed, said distributor having a cylinder axially formed therein, a plunger slidably mounted in said cylinder, said distributor having a radial oil port therein, said pump casing having at least one suction port and at least one discharge port therein adapted for being successively in communication with said oil port as the distributor rotates; cam means and cam follower means between said distributor and said plunger for reciprocating the plunger in the distributor cylinder; said cam means being constructed so that the oil port such that the latter is in communication with a suction port as the plunger is undergoing suction stroke in the cylinder so that oil is drawn into the cylinder, whereas when the plunger is undergoing pressure stroke the oil port is in communication with a discharge port for delivery of oil, and a plunger spring urging the cam means and the cam follower means into engagement.

2. A lubricating pump for a 2-cycle gasoline internal combustion engine comprising a pump case including a cylindrical portion, a distributor independently mounted in said cylindrical portion of the pump case, distribution means for delivering oil to the engine parts to be lubricated, and lubricating means for delivering oil through the discharge ports to the engine parts to be lubricated, wherein the distribution means comprises a distributor, a suction port, a discharge port, cam means, cam follower means, and plunger means, and wherein the lubricating means comprises a plunger reciprocatingly mounted within the distributor, the pump case, and the suction port, the discharge port, and the distributor being independently set to deliver oil at a rate determined by the engine running conditions, the distributor being connected by a driving mechanism to the engine so that the distributor is rotated at a speed in proportion to the engine speed, and the plunger being reciprocated by a plunger spring means.

3. A lubricating pump for a 2-cycle gasoline internal combustion engine comprising a pump case including a cylindrical portion, a distributor independently mounted in said cylindrical portion of the pump case, lubricating means for delivering oil to the engine parts to be lubricated, and distribution means for delivering oil through the discharge ports to the engine parts to be lubricated, wherein the distribution means comprises a distributor, a suction port, a discharge port, cam means, cam follower means, and plunger means, and wherein the lubricating means comprises a plunger reciprocatingly mounted within the distributor, the pump case, and the suction port, the discharge port, and the distributor being independently set to deliver oil at a rate determined by the engine running conditions, the distributor being connected by a driving mechanism to the engine so that the distributor is rotated at a speed in proportion to the engine speed, and the plunger being reciprocated by a plunger spring means.
2. A lubricating pump according to claim 1, wherein the cam means is a cylindrical cam secured to the distributor and extending axially thereof, said cam follower means comprising a pin secured to said plunger and extending substantially perpendicular thereto in contact with the cam, a case cover connected to the pump case and accommodating a portion of the plunger, said case cover having an axial notch receiving said pin thereby preventing rotation of the plunger and restricting the same to reciprocating movement only in an axial direction.

3. A lubricating pump according to claim 1, wherein said cam means is a cylindrical cam secured to said plunger, said cam follower means comprising a pin extending axially from said distributor into contact with the cam, a case cover connected to the pump case and accommodating a portion of the plunger, said case cover having an axial notch, a projection on the periphery of said cylindrical cam engaged in the axial notch in the case cover to prevent rotation of the plunger and restrict the same to undergo reciprocating movement only in an axial direction.

4. A lubricating pump according to claim 1 comprising a cam mechanism operative in response to the running condition of the engine and cooperating with the plunger to regulate the pressure stroke thereof and control the volume of oil which is fed.

5. A lubricating pump according to claim 1 comprising a cam mechanism operative in response to the throttle opening of a carburetor and cooperating with the plunger to regulate the pressure stroke thereof and control the volume of oil which is fed.

6. A lubricating pump according to claim 4, comprising a case cover connected to the pump case, said cam mechanism comprising a pulley turnably mounted on said case cover and having an inclined notch at one end thereof, a stopper pin secured to the plunger and engaged in said inclined notch, a spring acting on the pulley to urge the same against the stopper pin and a plunger stroke adjusting disc at the outward end of said plunger.

7. A lubricating pump according to claim 6, wherein said disc is adjustable on the outward end of said plunger to regulate the minimum volume of oil discharged, by changing the axial position of said plunger stroke adjusting disc externally of the case cover.

8. A lubricating pump according to claim 1 comprising a worm wheel loosely mounted on the distributor, a worm engaged with the worm wheel to drive the same, said worm being rotated at a speed proportional to that of the engine; a unidirectional clutch between said distributor and said worm wheel for transmitting drive therebetween, a handle at the outward end of said distributor for independently rotating the same to effect delivery of oil when the worm is at rest.

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