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(54) Method for lubricating a two-cycle internal combustion engine and lubricating oil supplying system

Verfahren zur Schmierung einer Zweitakt-Brennkraftmaschine und Schmierölzufuhrsystem

Méthode de lubrification d'un moteur à deux-temps, à combustion interne et système de prélèvement de l'huile de lubrification

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- **PATENT ABSTRACTS OF JAPAN vol. 12, no. 121 (M-686)(2968) 15 April 1988 & JP-A-62 248 812 (NIPPON SOKEN INC) 29 October 1987**

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Description

This invention relates to a method for lubricating a two-cycle internal combustion engine and a lubricating oil supplying system as indicated in the preamble portions of claims 1 and 20.

The advantages of two-cycle internal combustion engines in so far as simplicity and high output for a given displacement are well knon. Conventionally, it has been the pracice to lubricate two-cycle engines by mixing lubricant with the fuel consumed by the engine. However, this method of lubrication, although simple and low in costs, does not provide adequate control for the amount of lubricant consumed. That is, when fuel and lubricant are mixed, it is necessary to insure that the mixture will satisfy the most severe operating condition. As a result, excess lubricant is supplied under most operating conditions.

To avoid these problems and to insure better lubrication, lubricant control and reduction of lubricant consumption, it has been proposed to employ a separate lubricating system for two-cycle engines. Such separate lubricating systems employ a pump that pumps lubricant to the engine for its lubrication. This lubricant may be delivered to the induction system for the engine, directly to components to be lubricated or a combination of the above.

Normally, a form of a reciprocating type of pump is employed which is driven by the engine for supplying the lubricant. Such pumps have the advantage of providing accurate control of the amount of lubricant delivered and are capable of delivering relatively small amounts of lubricant. However, the amount of lubricant delivered by such a pump is related directly to engine speed and the lubricant requirements of the engine are not necessarily so related.

One way in which the amount of lubricant pumped has been controlled is by controlling the effective stroke of the lubricant pump either by changing the stroke or by use of a spill type valve which in effect changes the stroke pump. Figure 1 is a graphical view showing the way in which the lubricant is controlled with conventional systems and the actual lubricant requirements for the engine. This figure is a graphical view showing the relationship of engine speed to lubricant amount. Normally, the amount of lubricant supplied to the engine is controlled along a curve as shown by the curve "a" wherein the output of the lubricating pump is varied dependent upon accelerator or throttle valve position. It will be seen that the amount of lubricant supplied is increased along a slope from a given engine speed up until a maximum amount and then is held constant.

The dotted line curve "b" shows the actual lubricant requirements for the engine. As may be seen, the approximation curve using throttle valve or accelerator position can relatively closely match engine lubricating requirements under a wide range of steady state conditions.

However, because the lubricant control is varied in response to throttle valve position and throttle valve position changes more rapidly than engine speed, this type of control can produce excess lubricant under transient conditions. This is depicted by the dot/dash line curve "c" in Figure 1 which shows the effect of the operator suddenly opening the throttle valve. When this occurs, the lubricant amount is rapidly increased even though the engine speed has not increased in the same proportion.

In addition to the afore-noted defects, the use of mechanisms to change the stroke of the pump or spill valves requires relatively expensive pumps and can be subject to mechanical failure.

Therefore a lubricating oil supplying system has already been proposed in order to overcome the afore-noted problems. In said system a return passage is connected to the lubricating oil supply passage and a three-way solenoid control valve is connected to selectively discharge lubricant supplied from an oil pump to the engine (flow position of the control valve) or to the return passage (non-flow position of the control valve) to return the oil supplied from the oil pump to the suction side of said pump. Such a control valve preferably is of the solenoid type which is duty controlled (Japanese patent publication Hei 2-139307). From JP-U-2-139 307 a method for lubricating a two-cycle internal combustion engine and a lubricating system according to the preamble portions of claims 1 and 20 is known. In such a conventional system, in which a duty controlled three-way solenoid valve is used, the engine can be supplied with an appropriate amount of lubricating oil corresponding to the engine operating conditions as any excess of lubricating oil is returned to the suction side of the oil pump by controlling the duty ratio of the solenoid valve according to the engine operating conditions.

However, it is difficult to find out an appropriate control strategy for setting the duty ratio of the solenoid valve. Normally, i.e. in case of an engine driven type lubricating oil pump of the plunger type being used the plunger reciprocating time varies according to the engine revolution speed and, depending on the setting of the control interval, the period when the three-way control valve opens the supply passage side in order to supply lubricating oil to the engine is displaced from the advancing period of the pump plunger which leads to the effect that the supply of lubricating oil to the engine may become disproportional to the duty ratio of the solenoid valve control. If, on the other hand, the duty control interval or duty control period is too long the responsiveness of oil supply, for example during rapid acceleration etc., may become insufficient.

Moreover, in addition to the afore-noted problems, even by means of duty controlling the three-way solenoid valve, it has proven to be difficult to supply an amount of lubricating oil which corresponds to the instant engine operating conditions. More particularly, after once lubricating oil is allowed to be supplied to the supply passage side of the control valve, it is no longer possible to change the amount of lubricating oil supply to the engine until a next control period of the control valve is started. For example, in case where the engine is rapidly deccelerated by fully closing the throttle while running at a high speed and the lubricating oil is being abundantly supplied, the lubricating oil will be supplied to the engine with a supply rate suitable for the high speed running state although the engine has been turned to a state by decceleration which does not require so much oil any longer. That is, frequently the amount of lubricating oil supplied to the engine exceeds the necessary amount and white smoke is apt to be generated from the exhaust pipe, due to an excessive amount of burnt oil.

Moreover, when supplying the lubricating oil through an opening of a duty control solenoid valve sometimes there is a problem that the oil supply becomes incorrect under transient operating conditions of the engine, for example when the current supply of lubricating oil is small as the engine is running at a low speed but when then the engine is rapidly accelerated by abruptly opening the throttle.

Finally, as frequently some delay in the valve body response after the solenoid receives a driving signal for opening or closing the control valve and, accordingly, the intended supply of lubricating oil becomes inaccurate provided that this effect of delayed response of the control valve is not introduced into the control strategy. In order to minimise the effect of delayed operation of the valve body of the control valve and, accordingly, to improve the accuracy of oil supply it is effective to render the supply period (delivery period) as long as possible. This is effective as the delayed response characteristic of the control valve is constant without dependency on the supply period and, therefore, the contribution of the error resulting from the delayed valve response becomes smaller as the supply period is extended.

On the other hand, a prolongation of the supply period also results in a prolongation of the return period, during which the lubricating oil is directed to the return passage to be returned to the suction side (including the oil tank) of the oil pump. Thus, if the engine operating condition abruptly changes accompanied by an abrupt increase of oil consumption by the engine while, at that time, the lubricating oil is just not supplied to the engine side an insufficient lubrication of the engine is likely to occur when the engine is running at high speed.

To summarise the afore-noted difficulties with the known duty controlled solenoid valve adapted to meter an appropriate amount of lubricating oil to the engine, it has been noted that, specifically under transient operating conditions, the amount of lubricating oil supplied to the engine does not follow as closely to the changes of the operating conditions as desired.

Accordingly, it is a main objective of the present invention to provide an improved method for lubricating a two-cycle internal combustion engine, wherein the amount of lubricant supplied to the engine can be closely tailored to the actual running conditions, even under transient conditions. Moreover, it is an objective of the present invention to provide an improved lubricating system for such an engine, preferably adapted to perform said improved lubricating method.

According to the present invention said objective is performed by a method comprising the features of claim 1. The two-cycle engine operates a control valve in response to the engine operating conditions to vary the period of time whent the control valve is in its flow or non-flow positions for controlling the amount of lubricant delivered to the engine.

According to a preferred embodiment of this invention the control valve is solenoid operated and a control unit provides a control of the duty ratio and/or duty control period, i.e. of one ON/OFF cycle of the solenoid.

Moreover, preferably the flow position of the control valve, which enables lubricating oil to be discharged from the valve to the engine, is provided during an OFF state of the solenoid, whereas a non-flow position of the control valve, during which the supply of lubricating oil to the engine is blocked but the lubricating oil supplied by the oil pump is recirculated through the control valve to the suction side of the oil pump or is fed directly into an oil tank provided upstream of the oil pump, is established during an activated ON state of the solenoid. In this way it can advantageously be ensured that, even under a malfunction of the control valve leaving same in its inactivated rest position, in any case a sufficient lubricating of the engine takes place.

In order to appropriately bind the oil supply to the varying operating conditions, it is preferred that, under the proviso that the control valve takes its flow position when it remains inactivated and assumes its non-flow position when triggered, the duty control period of the solenoid is shortened in response to an increase in engine speed and is prolongated in response to a decrease in engine speed. Moreover, in a similar way also a rapid increase of the opening speed of the engine throttle can be considered in that the duty control period is shortened in response to such an increasing, specifically a rapidly increasing opening speed of the throttle.

Through this method and its preferred embodiments the engine can be supplied with an appropriate amount of lubricating oil closely following even varying engine operating conditions. For example, in cases where the duty control period is shortened as the engine speed increases and is elongated as the engine speed decreases, the delivery interval of the lubricating oil pump coincides with the duty control period and the supply of lubricating oil to the engine is controlled to an appropriate amount corresponding to the selected duty ratio, i.e. to the engine operating conditions. Moreover, in cases where the duty control period is shortened as the opening speed of the throttle increases, the responsiveness of the supply of lubricating oil to the engine is improved.

According to yet another preferred embodiment of the present invention, adapted to render the oil supply to closely follow up the engine operating conditions, specifically transient ones. An instant engine operating condition is detected and an instant duty ratio is calculated and said calculated duty ratio is adapted to approach an optimal duty ratio, said adaptive control of said calculated duty ratio, which is performed until same equals to the optimal duty ratio belonging to the corresponding engine operating conditions, leads to the effect that the amount of oil supply to the engine can be varied undelayed to closely follow varying operating conditions and lubricating oil can always be supplied with an optimum amount. Incidentally, a duty control period comprises one lubricating oil supply period and one lubricating oil return period and the modification of the calculated duty ratio is performed by keeping constant the non delivery period while the other one is varied.

Particularly, the oil discharge to the engine is controlled by means of varying the termination timing of the variable lubricating oil supply period or the lubricating oil return period, at least one of which is variable in response to the engine operating conditions.

According to yet another preferred embodiment of the present method, the OFF period of the solenoid is kept constant while the ON period is made variable, setting the OFF period to a value which assures a least amount of lubricating oil necessary for running the engine to be supplied. According to yet another preferred embodiment of the present invention, it is also possible to set the OFF period of the solenoid to be variable in response to the engine operating conditions, specifically in a stepwise manner with a fixed rate according to the engine revolution speed, while the ON period is variable according to the engine operating conditions as well; i. e. in this embodiment, both the lubricating oil supply period as well as the lubricating oil return period are variable in a different manner so that the amount of lubricant delivered to the engine is not only controlled in terms of the duty ratio of operating the solenoid control valve but also in terms a duty control period adjustment. Thus, also the duty control period can be changed according to the duty ratio which complies with the instant engine operating conditions.

According to yet another preferred embodiment of the present invention, a control method, embodied by a control unit of the control valve, a calculating means calculates during a discharge of lubricating oil to the engine a desired amount or demand of lubricating oil in response to the detected engine revolution speed in order to determine an oil supply interruption timing. Moreover, another calculating means of the control unit calculates the amount of oil consumption through the engine in response to the detected engine revolution speed, the throttle opening conditions and the time lapsed from the last changeover of the control valve in order to establish a return flow of lubricating oil to recirculate same to the oil pump, while a timing of restarting oil supply to the engine is set by a timer means switching the control valve from its non-flow position to its flow position when the amount of oil supplied to the engine is substantially equal to the amount of the calculated oil consumption through the engine.

In this way lubricating oil is newly supplied to the engine after the oil supply during a preceding cycle has been consumed. Thus, the lubricating oil can always be supplied with an appropriate amount and generation of white smoke due to burnt oil excessively supplied can be avoided.

According to a preferred embodiment of the aforementioned control strategy an OFF period of the solenoid of the control valve is kept constant while its ON period is varied according to the engine operating conditions. Moreover, in order to perform the afore-indcated function the timer means for setting the start timing of new oil supply to the engine subtracts the amount of oil consumption through the engine from the amount of oil supplied through the oil pump and integrates the obtained difference to switch the solenoid of the control valve when the resulting value becomes zero or negative. Moreover, preferably, as a safety measure it is assured that, also in this case, appropriate lubricating of the engine takes place, even if a malfunction of the components of the control unit should occur. For that reason, the timer means for setting the start timing of oil supply after integrating the result of subtraction compares whether or not the oil return period during which a return flow of lubricating oil to the suction side of the oil pump is established is longer or shorter than a predetermined period in order to switch off the solenoid, regardless of the results of the integration of the subtracted values of oil supply and oil consumption when said oil return period is longer than a preset time period. In this way it is assured that, in any case, the control valve will be returned in its flow position after lapse of a predetermined period irrespective of the results and signals provided by the calculating means of the control unit.

According to yet another preferred embodiment of the present control method, the control strategy provides for keeping constant the lubricating oil supply period while an oil supply start timing setting means sets the timing for interrupting the oil return period to switch the control valve from its non-flow condition to its flow condition according to the instant engine operating conditions.

In the latter case a calculating means of the control unit calculates a desired amount of lubricating oil in response to the detected engine revolution speed, whereas another calculating means of the control unit calculates the amount of oil consumption through the engine in response to the detected revolution speed, the throttle opening conditions and the time lapsed from the last changeover of the control valve to establish a return flow of lubricating oil to the suction side of the oil pump and a detecting means detects a residue amount for switching over the control valve from the non-flow condition to the flow condition when said amounts of oil supply and oil consumption are substantially equal to each other wherein said calculating means for calculating the amount of oil supply and oil consumption together with the detecting means for the residue amount establish the setting means for setting the oil supply start timing of the control valve.

According to yet another preferred embodiment of such a control strategy, the lubricating oil supply period is variable according to a predetermined duty ratio and/or duty control period at which an amount of oil supply to the engine appropriate for the instant engine operating conditions can be obtained. Specifically, the engine revolution speed is considered to reflect the engine operating conditions.

Aside from the effect that also through this embodiment of the present invention, the provision of lubricating oil to the engine can be closely adjusted to the engine running conditions and, therefore, to the actual demands for lubricating the engine, the latter-mentioned embodiment leads to the effect that the operation delay of the switching valve can be reduced by prolongating the lubricating oil supply period. A reduction of the duty control period, rendering also the oil supply period shorter but increasing the duty ratio, leads to an improved response characteristic of the oil supply with respect to rapidly changing engine operating conditions. Simultaneously at any time a sufficient supply of lubricating oil by setting appropriate timings and durations in response to the engine operating conditions detected can be assured and the accuracy of oil supply to the engine can be enhanced.

In order to perform the objective of providing an improved lubricating system for an engine as indicated above adapted to perform the method according to the present invention, said lubricating system comprises the features of claim 20. A lubricant pump is provided, which is driven in time relation by said engine, said lubricant pump delivering a substantially fixed amount of lubricant during each cycle of its operation. Moreover, conduit means extend from said lubricant pump to the engine for delivering lubricant thereto via a valve means disposed in conduit means for selectively controlling the flow of lubricant to the engine for return to the suction side of the lubricant pump, said valve means is adapted to assume a flow position in which lubricant flow to the engine is permitted, and a non-flow position in which lubricant flow to said engine is interrupted. More specifically, said lubricant system comprises a control means for operating said valve means in such a manner as to vary the time period when said valve means is in its flow position and/or is in its non-flow position for controlling the amount of lubricant delivered to said engine.

According to a preferred embodiment of said lubricating system, the control means operates the valve means in response to the engine operating conditions, such as engine revolution speed, throttle position, throttle opening speed or vehicle speed.

Further preferred embodiments, specifically of the lubricating system in view of the relatively control means are laid down in the further sub-claims.

In the following the present invention is explained in greater detail by means of several embodiments thereof which are illustrated in the associated drawings, wherein:

Fig. 1 is a graph showing the relationship between the engine speed and a duty control period for a conventional lubricating oil supply system,

Fig. 2 is a block diagram of a lubricating oil supplying system according to an embodiment of the present invention,

Figs. 3a and 3c show an operating cycle of the plunger of the lubricating oil pump for low and high engine speeds,

Figs. 3b and 3d show duty control periods for lower and higher engine speeds corresponding to the respective operating cycles as shown in Figs. 3a and 3c,

Fig. 4 is a block diagram of a lubricating oil supplying system of an embodiment of the present invention similar to that of Fig. 2,

Fig. 5 is a block diagram of a control unit used in the lubricating oil supplying system of Fig. 4,

Fig. 6 is a flow chart for illustrating the method for the supply of lubricating oil to an engine to the embodiment of Figs. 4 and 5,

Figs. 7a to 7c are graphs illustrating the method for supplying lubricating oil to an engine according to the embodiments of Figs. 4 to 6 among which:

Fig. 7a indicates the change of the engine speed,

Fig. 7b shows the change of the duty ratio according to engine speed,

Fig. 7c illustrates the switching action of the three-way solenoid control valve used in the oil supply system of Fig. 4, specifically the change of the duty ratio and the duty control period,

Fig. 8 is a graph illustrating the relationship between the engine speed and the duty control period,

Fig. 9 is a block diagram of a lubricating oil supplying system according to yet another preferred embodiment of the present invention,

Fig. 10 is a block diagram of the control unit used in the lubricating oil supplying according to Fig. 9,

Fig. 11 is a flow chart illustrating the method for controlling the lubricating oil supply to the engine according to this embodiment of the present invention,

Figs. 12a to 12f are graphs illustrating the control method for supplying lubricant to the engine according to Fig. 11, among which

Fig. 12a is a graph showing the change of the flow rate requirement of the lubricating oil for the engine over time,

Fig. 12b is a graph showing the change of the oil pressure overtime during the operation of the oil pump,

Fig. 12c is a graph showing the ON/OFF switching timing of the solenoid of the control valve of the lubricating oil supplying system of Fig. 9,

Fig. 12d is a graph showing the change of the amount of oil supply overtime,

Fig. 12e is a graph showing the relationship between the amount of oil supply and the amount of consumption of the lubricating oil,

Fig. 12f is a graph showing the residue amount of lubricating oil obtained by subtracting the amount of oil comsumption of the amount of oil supply,

Fig. 13 is a block diagram similar to Fig. 10 featuring the control unit used in the lubricating oil supplying system of Fig. 9 according to yet another preferred embodiment of the present invention,

Fig. 14 is a graph showing a duty ratio map to be used for the oil supply interruption timing means of the control unit indicated in Fig. 13,

Fig. 15 is a graph showing the amount of lubricating oil supply obtained through the lubricating oil supplying system as indicated in Fig. 9,

Fig. 16 is a flow chart illustrating the method for appropriately lubricating the engine through the lubricating system as shown in Fig. 9,

Fig. 17 is a flow chart for illustrating the operation of setting the oil supply period of the lubricating oil supplying system as shown in Fig. 9,

Figs 18a to 18f are graphs similar to Figs. 12a to 12f for this other embodiment of controlling the lubricating oil supply to the engine,

Figs. 19a and 19b are control timing charts to disclose the duty ratio and duty control period wherein:

Fig. 19a shows the condition when the supply period is long,

Fig. 19b shows the condition when the supply period is short,

Fig. 20 is a graph showing another example of a duty ratio map sought in the control unit of the lubricating oil supplying system,

Fig. 21 is a graph showing the amount of supply of lubricating oil obtained when the duty ratio map shown in Fig. 20 is employed, and

Fig. 22 is a flow chart illustrating the operation for setting the oil supply period in a case in which the duty ratio map as shown in Fig. 20 is employed.

Referring to a first embodiment of the present invention as, in its apparatus aspects, illustrated in Fig. 1, said figure discloses a lubricating oil supplying system, hereinafter referred to as lubricating system, designed in accordance with an embodiment of the present invention and provided to perform a method for supplying an appropriate amount of lubricating oil to an engine in compliance with a first embodiment of the present invention. Said lubricating system 1 is designed to supply lubricant to a two-cycle internal combustion engine 2. The lubricating oil supply to the engine 2 by the system 1 can be supplied either to the induction system of the engine 2 or to the various components of the engine to be lubricated directly through a direct lubricating means, or a combination of these systems. Accordingly, it is to be understood that any of the known types of prior art lubricant delivery systems internally of the engine can be employed in conjunction with the lubricating system. The lubricating system 1 includes an oil tank 5 in which a storage of lubricant is contained. An introducing passage 6 forms a conduit to supply the lubricant (oil) from the tank 5 to a reciprocating type lubricating pump 3, hereinafter referred to as oil pump 3, which is driven by the engine 2. A conventional plunger type oil pump 3 maybe employed and, as shown in Figs. 3a and 3c, the output of the pump will be substantially the same for each pumping cycle. Accordingly, when the engine speed increases the number of pumping pulses generating during a given time period will increase. As a result the output of the oil pump 3 will increase as the engine speed increases. Fig. 3a discloses the pump delivery at low speeds while Fig. 3c shows the pump delivery at high engine speeds.

A supply passage 4 to a control valve assembly, more particularly, to a three-way solenoid operated control valve 8. The control valve 8 includes a valve body 10 of the spool type slidably received by an internal bore of the valve case 9. A solenoid coil 12 is provided and supplied with an exciting current to operate the valve body 10 in order to switch said control valve 10. A return spring 11 normally at the valve body 10 to a first position as shown in Figure 2 wherein the valve body 10 is in a position to open the communication with a supplying port 9a that communicates the supply passage 4 upstream of the control valve 10 to another portion of the supply passage 4 downstream of the control valve 10 leading to the engine 2, that downstream portion of the supply passage 4 delivers the lubricant to the engine lubricating system.

When the solenoid coil 12 is engergized the vlave body 10 will be drawn upwardly to compress the return spring 11, blocking the supply port 9a and communicating the supply passage 4 delivering the oil from the oil pump 3 to the control valve 10 to a return passage 7 that delivers the oil back to the introducing passage 6 at the suction side of the oil pump 3 bypassing said oil pump 3. As a result, when the control valve 10 is in its non-flow condition wherein the solenoid coil 12 is energized the output pressure from the oil pump 3 will be returned back to its suction side and no lubricating oil will be delivered to the engine 2 from the supply port 9a.

The solenoid coil 12 is energized by means of an electrical circuit that includes a battery 15 and a main switch 14. These elements power a control unit 13 (CPU) which is programed to supply the desired pulses to the solenoid coil 12 depending upon sensed engine conditions. These conditions may include the engine speed which is supplied from a suitable engine speed sensor and an accelerator position that is sensed by an appropriate throttle position sensor. In addition, other conditions such as the opening velocity of the throttle, both of engine operation and of ambiant conditions may be supplied to the control unit 13.

As is derivable from Figures 3b and 3d, when the control unit 13 outputs an engergizing signal for a time period B the control valve 10 will be in its non-flow position (energized) and no lubricant will be delivered to the engine 2. During an OFF period wherein the solenoid coil 12 is de-energized and the valve body is in its lower most position as shown in Figure 2 (flow position of the control valve 10) lubricating oil will be delivered for a time period a (overall control period of one control cycle, hereinafter called as duty control period) minus B (A minus B). Hence, the amount of oil delivered during a given time period will be determined by the duty ratio A minus B (stroke A multiplied by 100%). It should also be noted that because the oil pump 15 is driven at a fixed ratio of speed relative to the speed of the engine 2, a shorter time interval of de-energization of the solenoid coil 12 will provide a greater amount of oil flow than the same time period when the engine is operating at higher speed. Thus, the time interval, i.e. the duty control period A must be adjusted in relation to the engine speed and is designed such that, as seen in Figure 3b, when the engine is operating at a slow speed the duty control period A is longer than when the engine is operating at higher speeds as indicated in Figure 3d. The ratios of duty cycles will be determined by the actual requirements of the engine and this can then be programmed into the control unit 13 so as to provide the appropriate amount of lubricating oil on all engine speeds. In that way excessive oil supply and also smoke in the exhaust gas is prevented.

As noted previously, however, merely controlling the duty cycle in relation to the engine speed alone will only provide adequate control under steady state conditions but will not accommodate transient engine operating conditions. Therefore according to the control method of the present invention the control unit 13 also senses when the accelerator is opened at a rapid rate and, when this occurs, the duty cycle is shortened for a given engine speed condition so as to ensure that an excessive amount of oil is not supplied to the engine and it can be reliably quaranteed that the amount of lubricants supplied will be appropriate for the actual running conditions of the engine 2.

Of course the described control routine depends on the actual requirements of a given engine but it should be readily apparent that with the described system and the method for duplicating a two-cycle engine it is possible to provide good control of the amount of oil supplied to the engine by varying both the length of time when the oil is supplied and the control valve 10 is in its flow position, and the duty ratio ((b - a)/a) as well as by means of adjusting the duty control period a. That is the amount of oil to be supplied to the engine is controlled by changing the ratio of (a - b)/a as well as by varying a and b.

In this embodiment, since the duty control period A is controlled such that it becomes longer during low speed engine revolution and shorter during high speed engine revolution, the duty control period A is adapted to a length suited to the operating cycle of the plunger of the oil pump 3 and an amount of oil supply corresponding to the duty ratio can be assured. Furthermore, under rapid accelerating conditions the responsiveness of the system is improved since the duty control period A is controlled to be shorter even in the case where the enaine revolution speed is low.

A next embodiment of the present invention hereinafter will be described with reference to Figures 4-8. The layout of the lubricating system 1 as shown in Figure 4 substantially complies with that of Figure 1 and, therefore, will not be described again in greater detail. Also, in this case the lubricating oil pump 3 driven by the two-cycle engine 2 is communicated at its suction side with a lubricating oil tank 5, while its delivery side supplies lubricating oil to a three-way solenoid operated control valve 8 and a control unit 13 is provided for controlling the three-way solenoid valve 8. The lubricating oil pump 3 is of the reciprocating plunger type driven by the engine and has a structure for adjusting the reciprocating stroke of the plunger according to the degree of throttle opening. The three-way solenoid operated control valve 8 is communicated with the lubricating oil tank 5 through a lubricating oil return passage 7, while being communicated with the engine 2 through a lubricating oil supply passage 4. Again, the three-way control valve 8 is solenoid controlled to switch between both the supply and return passages 4,7. The ON/OFF action of the solenoid is controlled by the control unit 13 and the three-way solenoid operated control valve 8 is switched to its non-flow state when the solenoid is in the ON state and is switched to the flow condition when the solenoid is in the OFF state. In this case, the control unit 13 has a structure for duty controlling the three-way solenoid operated control valve 13 by energizing or de-energizing it according to a pre-determined duty ratio, again, as in the aforementioned embodiment, the duty ratio is defined by dividing the overall duty control period (one cycle (ON/OFF state)) through the time period in which the solenoid is de-energized (OFF state) i.e. by dividing the lubricating oil supply period wherein the three-way solenoid operated control valve 8 is in its switched OFF flow condition by the duty control period (sum of the supply period and the return period).

(Duty ratio (%) = (OFF period/(ON period + OFF period)) x 100%)

The control unit 13 is connected to the battery 15 through remaining switch 14, while it is connected with an ignition system 8 of the engine 2 to calculate the revolution speed of the engine 2. Moreover, the control unit 13 comprises a calculating means 17 for computing the engine revolution speed, a microcomputer 18, a counter 19 and a supply interruption timing setting means as main components thereof.

The calculating means 17 for computing the engine revolution speed has a structure for continuously calculating the engine revolution speed, while the engine is running and outputting the revolution speed responsive signal to the microcomputer 18.

The microcomputer 18 is provided with a read only memory formed by a duty ratio map wherein duty ratios are stored which assure an optimal amount of oil supply related to the associated engine operating conditions correspondingly stored therein. The microcomputer 18 reads out a duty ratio from the duty ratio map according to the engine revolution speed inputted from the revolution speed-calculating means 18 in order to calculate each time the duty control period (OFF period plus ON period of the three-way solenoid valve 8) for the duty control of the valve 8. As the OFF period of the three-way solenoid operated control valve 8, a period is employed which ensures that a least amount of lubricating oil can be obtained which is necessary as a minimum for running the engine. For example, a time period is employed as the OFF period of the control valve 8 during which the plunger of the oil pump 3 can perform at least one reciprocating movement even while the engine is in an idling condition. In this embodiment, in order to perform the oil supply control, the OFF period of the three-way solenoid operated control valve 8 is kept constant, while its ON period is made variable. In other words, the period wherein the control valve 8 assumes its de-energized flow position is kept constant while its energized non-flow position is made variable. It is unnecessary for the ON period to have a minimum value, as it is the case in view of the OFF period.

When determining the OFF period of the solenoid coil 12, it is possible to adjust said OFF period such that it may change according to the engine operating conditions. For example, the OFF period can be varied respectively for the engine operating conditions, such as idling, medium speed running, high speed running etc. The OFF period in this case can either be kept constant or also the OFF period can be varied, preferrably by stages in a step-wise manner but preferrably it can be varied with a fixed rate according to the engine revolution speed. Even in such a case, the ON period (non-flow position of the control valve 8) is varied always according to the engine operating conditions. Moreover, as soon as the operating conditions, such as the engine revolution speed of the engine changes, the duty control period will change according to the duty ratio which corresponds to the changed operating conditions.

The counter as a time counting means 19 provides for counting the lapse of time after the start of the supply of lubricating oil to the engine 2 for each duty control period during which the three-way solenoid operated control valve 8 is switched ON or switched OFF.

The setting means 20 for determining the return interruption timing has a structure for continuously comparing the lapse of time counted by the counter 19, with the current ideal target duty control period obtained from the microcomputer 18. Then, when the lapse of time corresponds to the duty control period, the control valve 8 is switched OFF through said return interruption timing setting means 20, proceeding to the next duty control period. In other words, the timing of terminating the lubricating oil return period (ON periods) is compared with the duty ratio at which an optimal amount of lubricating oil supply for the instant engine operating conditions is obtained and, when it corresponds to that duty ratio, the duty control period is finished.

Referring to Figures 6-8, in the following the method for appropriately lubricating the engine 2 and the operation of the oil supplying system 1 according to this embodiment will be explained. As is apparent from Figure 6, when the main switch 14 is turned ON, first the control unit 13 is initialized at step P1. After the engine has started, the means 17 for calculating the engine revolution speed of the control unit 13 calculates said speed at the step P2 and outputs same to the microcomputer 18. Just after engine starting, since the three-way operated control valve 8 is in the flow condition (OFF state), the lubricating oil delivered from the oil pump 3 is supplied to the engine 2. When the oil is supplied, the counter 12 starts counting the time. After a definite time period has lapsed from the start of supplying lubricating oil to the engine 2, the control valve 8 is energized to switch from its flow position to its non-flow position into the ON state by the microcomputer 18 and the lubricating oil is now directed to the oil return passage 7.

Next, the microcomputer 18 reads a duty ratio corresponding to the detected engine revolution speed from a map at the step P3 and calculates the duty control period at that time in step P4. The duty control period is obtained by dividing the OFF period of the control valve 8, which is constant by the duty ratio. That means, the microcomputer 18 continuously calculates the duty control period while the engine 2 is running. Then the setting means 20 for determining the timing of interruption of the return flow of the oil sets said interruption timing at the step P5. At that time, the lapse of time counted by the counter 19 from the start of supply of lubricating oil is compared with the duty control period obtained in step P4 and, when the lapsed time has reached the duty control period, the process proceeds to the step P6 to turn the three-way operated control valve 8 into its flow condition (OFF state). When the lapse of time has not reached the duty control period, the process returns from the step P5 to the step P1 and the operations described above are repeated.

When the control valve 8 is turned OFF at the step P6, one period of the duty control is finished and the process returns to the step P1. The counter 12 newly starts counting time when the control valve 8 is turned OFF.

In the following the operation of the control valve 8 for a transient operating condition is described, namely with the engine revolution speed rising from a low speed or falling from a high speed, referring to Figure 7.

While the engine 2 is in the idling state shown with an A in Figure 7a, the duty ratio is read out of the duty ratio map of the control unit 13, e.g. 15%. As shown in Figure 7b, the duty ratio changes in general accordance with a change of the engine revolution speed and is made to amount 100% when the engine throttle is fully opened. The duty control period during idling becomes T1 as shown in Figure 7c. This duty control period T1 is taken as the time until the solid line T, which represents that the lapse of time is increasing, reaches the duty control period obtained from the duty ratio (height of the supply start timing line shown in the broken lines in Figure 7c). That means, the return interruption timing at which the control valve (8) is turned from the ON state into the OFF state is taken as the timing at which the period from the oil supply start timing in that duty control period coincides with the ideal control period corresponding to the engine revolution speed.

The double-dotted chain line in Figure 7c is a line representing a timing of interrupting the oil supply to the engine at which the control valve 8 is turned on and the delivery of lubricating oil is interrupted. This timing line of interrupting the oil supply to the engine and the timing line representing the start of fuel supply to the engine (shown in the broken line) are determined from the engine revolution speed on the basis of the duty ratio as shown in Figure 8. As the duty control period for the engine revolution speed, the height of the timing line in Figure 8 is taken representing the start of oil supply to the engine. Since, in this embodiment the OFF time of the control valve 8 is said to be constant, the timing line for the interruption of the oil supply is a line which runs in parallel to the abscissa.

Moreover, when the engine revolution speed rises as shown through the curve section B in Figure 7a, the demand of the engine 2 for lubricating oil increases and the duty ratio similarly increases. When the duty ratio rises, the duty control period becomes shorter with the rise of the engine revolution speed, because the OFF period is constant and the timing line for the start of ON supply slopes down rightwards, as indicated in Figure 7c. For this case, as the return flow interruption timing is taken

Moreover, when the engine 2 assumes its high speed condition with fully open throttle as represented through section D of the curve of Fig. 7d, since the duty ratio becomes 100%, the ON period becomes zero and the duty control period becomes equal to the OFF period. The duty control period in this case is designated with T3 in Fig. 7c. Accordingly, the control valve 8 is continuously in the flow position (OFF state) and the lubricating oil is continuously supplied to the engine 2. When the engine revolution speed begins to fall as shown in the curve section E in Fig. 7a the duty ratio also decreases and the duty control period is prolongated as the engine revolution speed drops. Here, the supply start timing line in Fig. 7c slopes up rightwards and becomes parallel with the horizontal axis after the engine revolution speed became constant. As the return flow interruption timing for this case, the timing indicated with G is taken at which the lapse of time from the start of the OFF state (flow position of the control valve 8) reaches the duty control period. Accordingly, the duty control period becomes G4.

Therefore, since the lubricating sytem 1 for the two-cycle engine 2 compares the return flow interruption timing at which the lubricating oil is directed to the lubricating oil return passage 7 with the duty ratio at which an amount of lubricating oil supply optimal for the instant engine operating conditions is obtained and the duty control period is terminated when it corresponds to the duty ratio, as soon as the engine operating conditions change, the duty control period changes according to the duty ratio suited to the instant engine operating conditions. With the structure of the lubricating system as shown in Fig. 4 supplying lubricating oil to the engine 2 while the control valve 8 is switched off an amount of oil delivery to the engine necessary for running the engine can be secured even when the power supply to the control valve 8 is intercepted.

Although this embodiment controls the delivery of lubricating oil by varying the lubricating oil return period, it is also possible to control the oil supply by varying the lubricating oil supply period, keeping the oil return period contstant.

For this embodiment, as the return flow interrupting timing is compared with the duty ratio which is controlled to reach a duty ratio which is optimal for the detected engine operating conditions and duty control period is terminated when said duty ratio is obtained, the duty control period is changed according to a duty control ratio suited to the instant engine operating conditions as soon as said conditions change, the supplied amount of lubricating oil is always optimum for the current engine operating conditions.

Another embodiment of the present invention, in the following, is described referring to Figs. 9 to 12. Again, generally the layout of the lubricating system 1 substantially corresponds to those of Figs. 2 and 4. With respect to the embodiment of Fig. 2 the control valve 8 has a different structure, specifically the design of the valve body 10 with outwardly projecting flanges subjected to the prebiasing force of the return spring 11 prebiasing the valve body 10 into an upper rest position, and the disposal of the solenoid coil 12 and the disposal of the ports for communicating to the associated conduits distinguish said three-way control valve 8 from that of the embodiment of Fig. 1.

Also in Fig. 9 the same reference numerals designate the same parts and components as already explained in conjunction with the above embodiments. Therefore, a repeated explanation of the basic layout and the components having the same reference numerals is not deemed necessary again.

When the solenoid coil 12 is energized (when ON), the lubricating oil delivered from the lubricating oil pump 3 is returned from the three-way solenoud valve 8 to the lubricating oil tank 5 through the return passage 7. When the solenoid coil is deenergized (when OFF), the lubricating oil is supplied to the engine 2 from the three-way solenolt valve 8.

The numeral 13 denotes a control unit for controlling the action of the three-way solenoid valve 8. This control unit 13 is constructed for switching the ON and OFF of the solenoid coil 12 so that the supplying state and returning state of the lubricating oil may be repeated to control the lubricating oil amount supplied to the engine 2 side. In this embodiment, the OFF time of the solenoid coil 12 is kept constant and its ON time is varied according to the engine operating condition through a method described later.

This control unit is connected to a battery 15 through a main switch 14, and, while being connected to the ignition system of the engine 2 to calculate the revolution spee of the engine 2, it is connected to the throttle system to detect the throttle opening. The numeral 16 denotes the ignition unit of the engine 2, and 17 denotes the throttle. The energizing circuit for the soienoid coii 12 employed in the control unit 13 is a transistor circuit as shown in Fig. 9.

By connecting the solenoid coil 12 with the control unit 13 in such a manner, the solenoid coil 12 is prevented from being turned into the ON state (state in which the lubricating oil will not be supplied to the engine) when the ground side is short-circuited, and the engine seizure can be prevented. Since the lubricating oil is supplied to the engine 2 while the solenoid coil 12 is in the OFF state, engine seizure can be prevented even in the case of circuit disconnection or source failure.

Here, the structure of the control unit 13 is described in detail referring to Fig. 10.

In Fig. 10, the reference numeral 21 denotes a revolution speed calculating means for calculating the average speed of revolution of the engine 2 through the revolution speed signal from the ignition pickup of the ignition unit 16, and 22 denotes a timer.

This timer 22 has a structure for starting counting time just after the starting of the engine 2, generating a trigger signal every lapse of definite time (e.g., 80 ms) and accumulating the trigger number.

The numeral 23 denotes a supply interrupting means for energizing the solenoid coil 12 of the three-way solenoid valve 8 to direct the lubricating oil to the return passage 7. This supply interrupting means 23 has a structure for energizing the solenoid coil 12 when the accumulated trigger number in the timer 22 reaches a set value. That is, the lubricating oil is kept being supplied to the engine 2 side-until this supply interrupting means 23 operates.

As the set value of the accumulated trigger number, a number is employed with which a least amount of lubricating oil necessary for the engine not to generate white smoke while idling can be supplied to the engine before the supply interrupting means 23 operates. For example, if the trigger signal is generated every 80 ms, the set number becomes 12. In this case. the lubricating oil supplying time becomes 960 ms.

The numeral 24 denotes a supply amount calculating means for calculating the lubricating oil supply amount to the engine 2 side. This supply amount calculating means 24 has a structure for calculating the lubricating oil supply amount on the basis of the engine revolution speed while the solenoid coil 12 of the three-way solenoid valve 8 is in the OFF state. The lubricating oil supply amount is calculated by multiplying the delivery amount of the lubricating oil pump 3 per one revolution of the engine 2 by the speed of engine revolution in the lubricating oil supplying time above.

The reference numeral 25 denotes the consumption amount calculating means for calculating the amount of the lubricating oil consumed in the engine 2. This consumption amount calculating means has a structure for calculating the amount of the lubricating oil consumed while the lubricating oil is not supplied to the engine 2 side on the basis of the lubricating oil consumption per unit time obtained from the engine revolution speed , the throttle opening and the lapse of time after the operation starting of the supply interrupting means 23. As the lubricating oil consumption per unit time to be obtained from the engine revolution speed and the throttle opening, values beforehand written in the map 26 are employed.

The numeral 27 denotes a supply starting timing setting means for deenergizing the solenoid coil 12 of the three-way solenoid valve 8 to direct the lubricating oil to the supply passage 4.

This supply starting timing setting means 27 has a structure for subtracting the lubricatig oil consumption amount calculated by the consumption amount calcualting means 25 from the lubricating oil supply amount calculated by the supply amount calculating means 24, integrating the obtained differences, and, when the resulted value becomes zero or negative, deenergizing the solenoid coil 12 of the three-way solenoid coil 8. Further, this supply starting timing setting means 27 resets the accumulated trigger number in the timer 22 to 0 before deenergizing the solenoid coil 12.

That is, as soon as the lubricating oil residue on the engine 2 side is exhausted, lubricating oil is newly supplied to the engine 2 side.

Further, the supply starting timing setting means 27 has a structure for deciding, after integrating the subtraction results, whether the lubricating oil interrupting time (lapse of time after the supply interrupting means starts operating) is longer or shorter than a set time, and, when longer, deenergizing the solenoid coil 12 regardless of the integration result.

Next, the operation of the lubricating oil supplying system for the two cycle engine constructed as above is described referring to the flow chart shown in Fig. 11

When the main switch 14 is turned on, the control unit 13 is reset at P_1 in Fig.3 to be initialized, and the timer is set at P_2. At this time, the accumulated trigger number in the timer 22 is returned to 0.

When the engine 2 is started, apparatus of the engine control system such as the ignition unit 16 are controlled at P_3. With the beginning of engine starting, the timer 22 starts counting time, and, as shown with P_4 through P_6, accumulates the trigger number every definite time. The lubricating oil pump 3 also starts its operation with the engine 2 to deliver the lubricating oil to the three-way solenoid valve 8. In this while, since the accumulated trigger number of the timer 22 is smaller than the set value and the solenoid coil 12 of the three-way solenoid valve 8 is not energized, lubricating oil is supplied from the three-way solenoid valve 8 to the engine 2 side. While the lubricating oil is being supplied to the engine 2 side, the lubricating oil supply amount is calculated by the supply amount calculating means 24.

After the accumulated trigger number reached a set value at P_6, the solenoid coil 12 of the three-way solenoid valve 8 is energized at P_7 by the supply interrupting means 23, and the lubricating oil is not supplied to the engine 2 side but is returned to the lubricating oil tank 5.

When the supply interrupting means operates, the lubricating oil consumption amount is calculated by the consumption amount calculating means at P_8, and the lubricating oil consumption amount is subtracted from the lubricating oil supply amount to calculate the lubricating oil residue amount. The subtraction results are integrated at P_{10} in parallel with the residue calculating operation described above.

Next, the consumption amount calculating means 25 decides whether the lubricating oil interrupting time is longer or shorter than a set time at P_{10}, and, when the lubricating oil interrupting time is shorter than the set time and normal, the process proceeds to P_{11} to decide whether the integrated value is zero or negative or not. If decided zero or negative, the accumulated trigger number of the timer 22 is returned to zero at P_{13} and the solenoid coil 12 of the three-way solenoid valve 8 is deenergized at P_{14}. By this operation, the lubricating oil is again supplied from the three-way solenoid valve 8 side to the engine 2 side. The lubricating oil supplying system 1 according to this invention operates taking a series of actions described above as one cycle, and, after returning to the lubricating oil supplying state at P_{14}, it returns to P_2 to perform the second cycle of its operation.

If decided at P_{11} that the lubricating oil interruption time is longer than the set time, the process is advanced to P_{13}, and the energization of the solenoid coil 12 is interrupted regardless of the integration result. In the case where the integrated value is not zero or negative at P_{12}, the process id returned to the step P_{12}.

The operation of the lubricating oil supplying system 1 according to this invention becomes as shown in Figs. 12(a) through 12 (f). In Fig. 12 is shown the case where the engine 2 is rapidly accelerated from the low speed operating state to the high speed operating state and then returned to the low speed operating state.

When the engine 2 is operated as described above, the lubricating oil requirement of the engine 2 changes according to the engine revolution speed as shown in Fig.4(a), and the time and the number of the lubricating oil deliveries from the lubricating oil pump 3 also changes according to the engine revolution speed as shown in Fig. 12 (b).

Further, on the three-way solenoid valve 8 to be switched, the time during which the solenoid coil 12 is not energized (shown as T_o in Fig. 12) becomes always constant, the lubricating oil return time becomes shorter as the engine speed becomes higher and the lubricating oil supply amount becomes larger according to the engine revolution speed. In Fig. 12(d), the period during which the lubricating oil is supplied is shown with hatching. C_1 through C_6 show control operation cycles.

In Fig. 12(e), the integrated value of the lubricating oil supply amount is shown with A, the integrated value of the lubricating oil consumption amount is shown with

B, and the value obtained by subtracting the lubricating oil consumption amount from the lubricating oil supply amount (lubricating oil residue) is shown in Fig. 12(f). From Fig. 12 (f), it is seen that the lubricating oil is newly supplied after the residue is exhausted.

Therefore, with the lubricating oil supplying system 1 according to this invention, the lubricating oil is newly supplied to the engine after the lubricating oil supplied from the three-way solenoid valve 8 to the engine 2 side has been consumed.

Hereupon, although the embodiment described above is of a structure in which the lubricating oil supply time to the engine side is kept constant and the lubricating oil return time is varied, this invention is not limited to such a structure, but the system according to this invention may be constructed for varying the lubricating oil supply time to the engine side. In such a case, the ON time of the three-way solenoid valve is kept constant and the OFF time is varied by the control unit 13.

With the lubricating oil supplying system for the two cycle engine according to this embodiment since the lubricating oil return interruption timing is set by a supply amount calculating means which calculates the lubricating oil supply amount to the engine side from the engine revolution speed, a consumption amount calculating means which calculates the lubricating oil consumption amount from the engine revolution speed , throttle opening and the lapse of time after the switching valve is switched to the return passage side, and a supply starting timing setting means which switches the switching valve from the return passage side to the supply passage side when the lubricating oil supply amount and the lubricating oil consumption amount agree with each other, the lubricating oil is newly supplied to the engine side after the lubricating oil supplied from the switching valve to the engine side has been consumed.

Therefore, the lubricating oil can be supplied always with an appropriate supply amount, and white smoke is prevented from being generated from the engine.

The control unit 13 for controlling the three-way solenoid valve 8 is constructed for varying the lubricating oil returning time of the three-way solenoid valve 8. The control unit 13 is provided with a supply amount calculating means, a consumption amount calculating means and a supply starting timing setting means for switching the three-way solenoid valve when the lubricating oil residue is exhausted. The lubricating oil is newly supplied to the engine 2 side after the lubricating oil supplied from the three-way solenoid valve to the engine 2 side has been consumed.

Since in the lubricating oil supplying system according to another modification lubricating oil supply period kept constant according to a predetermined duty ratio at which a lubricating oil supply amount appropriate for the current engine operating condition can be obtained and the current engine revolution speed, the effect of the operation delay of the switching valve can be reduced by making the lubricating oil supply period longer, while the control period is shortened and the lubricating oil supply amount changes with a better followability to the engine operating condition change by making the lubricating oil supply period shorter. Therefore, the effect of the delay of the switching valve operation can be reduced while reatraining the lubricating oil from becoming insufficient, and the lubricating oil supply accuracy can be raised.

Another embodiment of the present invention is described referring to Figures 13 to 22. Again, the same reference numerals denote the same components. The layout of the lubricating system corresponds to that of Figure 9. Some modifications are to be noted for the control unit 13 as shown in Figure 13.

The numeral 13 denotes a control unit for controlling the action of the three-way solenoid valve 8. This control unit 13 is constructed for switching the ON and OFF of the solenoid coil 12 so that the supplying state and returning state of the lubricating oil may be repeated to control the lubricating oil amount supplied to the engine 2 side. The OFF period of the solenoid coil 12 is made shorter in the case where the engine is running at a high speed and the lubricating oil supply amount required by the engine is smaller as compared with other cases and its ON period is varied according to the engine operating condition through a method described later.

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This control unit 13 is connected to a battery 15 through a main switch 14, and, while being connected to the ignition system of the engine 2 to calculate the revolution speed of the engine 2, it is connected to the throttle system to detect. the throttle opening. The numeral 16 denotes the ignition unit of the engine 2, and 17 denotes the throttle. The energizing circuit for the solenoid coil 12 employed in the control unit 13 is a transistor circuit as shown in Fig.9.

By connecting the solenoid coil 12 with the control unit 13 in such a manner, the solenoid coil 12 is prevented from being turned into the ON state (state in which the lubricating oil will not be supplied to the engine) when the ground side is short-circuited, and the engine seizure can be prevented. Since the lubricating oil is supplied to the engine 2 while the solenoid coil 12 is in the OFF state, engine seizure can be prevented even in the case of circuit disconnection or source failure.

Here, the structure of the control unit 13 is described in detail referring to Fig. 13.

As shown in Fig. 13, the control unit 13 is provided with a revolution speed calculating means 21, timer 22, supply interrupting means 23, supply amount calculating means 24, consumption amount calculating means 25 and a residue amount calculating means 27. This control unit 13 constitutes the supply starting timing setting means according to this invention.

The revolution speed calculating means 21 has a structure for calculating the average revolution speed of the engine 2 through the revolution speed signal from the ignition pickup of the ignition unit 16.

The timer 22 has a structure for starting time counting just after engine starting, generating a trigger signel every lapse of a definite time (for example, 80 ms) and accumulating the trigger number.

The reference numeral 23 denotes a supply interrupting means for energizing the solenoid coil 12 of the three-way solenoid valve 8 to direct the lubricating oil to the return passage, and this supply interruptinhg means 23 has a structure for energizing the solenoid coil 12 when the accumulated trigger number at the timer 22 reached a set value. That is, lubricating oil is being supplied to the engine 2 until this supply interrupting valve is switched by the supply interrupting means 23 is determined by the duty ratio map shown in Fig. 14, engine revolution speed, throttle opening, etc., and becomes as shown in Fig.15. That is, the lubricating oil supply amount becomes smaller until the engine revolution speed reaches a somewhat higher speed even if the throttle is widely opened. Therefore, while the lubricating oil supply amount becomes smaller when the engine revolution speed is in the low to medium range and the throttle opening is larger, the lubricating oil supply amount becomes smaller also while racing. The graph of Fig. 15 shows also the lubricating oil consumption amount or requirement amount corresponding to the engine operating condition.

Here, the duty ratio map shown in Fig. 14 is described in detail.

The duty ratio map is constructed so that the duty ratio may reach its highest value, 100%, when the engine revolution speed or the throttle opening reaches their maximum. The engine revolution speed or the throttle opening at which the duty ratio reaches 100% is given some degree of revolution speed width or opening width, and the domain in which the duty ratio becomes 100% (the highest portion in Fig. 14) becomes flat.

Further, as the duty ratio for the lower engine revolution speed is set the lowest value for obtaining the lubricating oil supply amount necessary for the engine 2, and the domain in which the duty ratio becomes lowest is also made flat by giving some degree of rotation speed width or throttle opening width to the engine revolution speed or the throttle opening. Although the domains in which the duty ratio becomes 100% or lowest are made flat as described above, since the delivery amount by the lubricating oil pump is proportional to the engine revolution speed because the lubrication oil pump is driven by the engine, the lubricating oil supply amount can be varied as shown in Fig. 15.

By forming the duty ratio map with its domains in which the duty ratio becomes 100% or lowest made flat as described above, the control can be fractionated when the duty ratio corresponding to the engine operating condition takes a value between 100% and the lowest.

That is, since the width of the duty ratio which can be taken in the desired engine operating condition can be made larger, it becomes possible to set the lubricating oil supply amount with a higher accuracy according to each engine operating condition.

The reference numeral 24 denotes a supply amount calculating means for calculating the lubricating oil supply amount to the engine 2 side. This supply amount calculating means 24 has a structure for calculating the lubricating oil supply amount on the basis of the engine revolution speed while the solenoid coil 12 of the three-way solenoid valve 8 is in the OFF state. This lubricating oil supply amount is calculated by multiplying the delivery amount of the iubricating oil pump 3 per one revolution of the engine by the engine revolution speed during the lubricating oil supply period above.

The reference numeral 25 denotes a consumption amount calculating means for calculating the amount of the lubricating oil consumed in the engine 2. This consumption amount calculating means 25 has a structure for calculating the amount of the lubricating oil consumed while the lubricating oil is not supplied to the engine 2 side on the basis of the lubricating oil consumption per unit time obtained from the engine revolution speed, the throttle opening and the lapse of time after the operation starting of the supply interrupting means 23. As the lubricating oil consumption per unit time to be obtained from the engine revolution speed and the throttle opening, values beforehand written in the consumption amount map shown in Fig. 15 are employed.

The reference numeral 27 denotes a residue amount detecting means for deenergizing the solenoid coil 12 of the three-way solenoid valve 8 when the lubricating oil supplied to the engine 2 side has been consumed and directing the lubricating oil to the supply passage 4a.

This residue amount detecting means 27 has a structure for subtracting the lubricatig oil consumption amount calculated by the consumption amount calcualting means 25 from the lubricating oil supply amount calculated by the supply amount calculating means 24, integrating the obtained differences, and, when the resulted value becomes zero or negative, deenergizing the solenoid coil 12 of the three-way solenoid coil 8. Further, this residue amount detecting means 27 resets the accumulated trigger number in the timer 22 to 0 before deenergizing the solenoid coil 12.

That is, as soon as the lubricating oil residue amount on the engine 2 side is exhausted, lubricating oil is newly supplied to the engine 2 side.

Further, the residue amount detecting means 27 has a structure for deciding, after integrating the subtraction results, whether the lubricating oil return period (lapse of time after the supply interrupting means 23 starts operating) is longer or shorter than a predetermined time, and, when longer, deenergizing the solenoid coil 12 regardless of the integration result to prevent the lubricating oil return period becomes longer by some reason.

Next, the operation of the lubricating oil supplying system 1 for the two cycle engine constructed as above is described referring to the flow charts shown in Figs. 16 and 17.

When the main switch 14 is turned on, the control unit 13 is reset at P_1 in Fig. 16 to be initialized, and the timer is set at P_2. At this time, the accumulated trigger number in the timer 22 is returned to 0.

When the engine 2 is started, apparatus of the engine control system such as the ignition unit 16 are controlled at P_3. With the beginning of engine starting, the timer 22 starts counting time, outputs a trigger signal at P_4, and adds a unity to the trigger number at P_5. The supply interrupting means 23 sets a lubricating oil supply period (set value of the accumulated trigger numbers) at P_6 and decides whether the accumulated trigger number reached the set value or not at P_7. That is, the timer 22 continues to accumulate the trigger number until the lubricating oil supply period set by the supply interrupting means 23 is reached. The lubricating oil pump 3 also starts operating with the engine 2 and the lubricating oil is delivered to the three-way solenoid valve 8.

When the trigger number accumulated by the timer 22 is less than the set value, since the solenoid coil 12 of the three-way solenoid valve 8 is not energized, the lubricating oil is supplied from the three-way solenoid valve 8 to the engine 2 side. When the lubricating oil is supplied to the engine 2 side,the libricating oil supply amount is calculated by the supply amount calculating means 24. Here, the procedure for setting the the lubricating oil supply period (set value of the accumulated trigger number) is described in detail referring to Fig.17.

At P_6, the supply interrupting means 23 reads in the engine revolution speed R and the throttle opening at the step S_1, and reads out of the duty ratio map shown in Fig.3 a duty ratio D on the basis of this engine revolution speed and throttle opening suitable for the current engine operating condition at the step S_2.

Next, the supply interrupting means 23 decides at the step S_3 whether the duty ratio D above is larger than a predetermined value A or no. When the duty ratio D is larger than A, that is, when the lubricating oil requirement of the engine 2 is larger, the process proceeds to the step S_4 to set the supply period as T_1, and the output signal for setting the supply period as T_1 is outputted to the timer 22 at the step S_6.

When the duty ratio D is smaller than A at S_3 above, that is, when the lubricating oil requirement of the engine 2 is small, the supply interrupting means 23 decides whether the engine revolution speed R is higher than a predetermined speed B or not at S_6. When the engine revolution speed is not higher than the speed B, the process proceeds to S_7 to set the lubricating oil supply period as T_2 and the output signal for setting as T_2 is outputted to the timer 22 at S_8.

When decided at S_6 that the engine revolution speed R is higher than the speed B, the process proceeds to S_9 to set the lubricating oil supply period as T_3 and the output signal for setting as T_3 is outputted to the timer 22 at S_{10}. After outputting the respective output signals at the steps S_5, S_8 and S_{10}, the process proceeds to the step S_6.

That is, the lubricating oil supply period is determined according to to which of three domains T_1, T_2 and T_3 the engine operating condition corresponds, the three domains above being obtained in Fig.3 by dividing the duty ratio surface with a thick line L_1 on which the duty ratio becomes A and a thick line L_2 on which the engine revolution speed becomes B. When the engine operating condition is in the domain T_1 in Fig.3, the lubricating oil supply period is taken as T_1; when in the domain T_2, is taken as T_2; and when in the domain T_3, is taken as T_3. In this embodiment, T_1 and T_2 are set as similar longer periods, and T_3 is set as a period shorter than T_1 and T_2.

The timing at which the lubricating oil supply period is set may be anytime if only it is after engine starting and before the decision flow P_7. If it is just before the decision flow P_7 at which the accumulated trigger number is compared with the set value, as described above for this embodiment, accuracy becomes higher because the engine operating condition is read in each time when a unity is added to the trigger number.

After the accumulated trigger number reached the set value at P_7, the solenoid coil 12 of the three-way solenoid valve 8 is energized by the supply interrupting means 23 at P_8, the lubricating oil is not supplied to the engine 2 side but is returned to the lubricating oil tank 5.

After the supply interrupting means 23 operates and the lubricating oil begins to be returned to the lybricating oil tank 5, the consumption amount calculating means 25 calculates the lubricating oil consumption amount at P_9. Then the lubricating oil residue amount is calculated by subtracting the lubricating oil consumption amount from the lubricating oil supply amount at P_{10}, and, in parallel to the residue amount calculation above,, the subtraction results are integrated at P_{11}.

Next, the consumption amount calculating means 25 decides, after the integration above, whether the lubricating oil return period is longer than the set time or not at P_{12},and, if the lubricating oil return period is shorter than the predetermined longest control period and is normal, proceeds to P_{13} and decides whether the integrated value is equal to zero or negative. When zero or negative, it turns the accumulated trigger number to zero at P_{14}, and deenergizes the solenoid coil 12 of the three-way solenoid valve 8 at P_{15}. By this operation, the lubricating oil is again supplied to the engine 2 side from the three-way solenoid valve 8. The lubricating oil supplying system 1 according to this invention operates taking a series of operations described above as one cycle, and, after it is turned into the lubricating oil supplying state at P_{15}, returns to P_2 to start the next cycle.

If it is decided at P_{12} that the lubricating oil return period is longer than the longest control period, the process proceeds to P_{14} and the energization of the solenoid coil 12 is at once interrupted. If the integrated value is not equal to zero or negative at P_{12}, the process is returns to the step P_2.

The operation of the lubricating oil supplying system 1 according to this invention becomes as shown in Figs. 18 (a) through 18 (f). In Fig. 18 is shown the case where the engine 2 is rapidly accelerated from a low speed opearting state to a high speed operating state and then is returned to the low speed operating state.

When operating the engine 2 as described above, the lubricating oil requirement of the engine 2 changes according to the engine revolution speed as shown in Fig. 18 (a), and the time and the number of deliveries from the lubricating oil pump 3 also change according to the engine revolution speed as shown in Fig. 18 (b).

Further, on the three-way solenoid valve 8 to be switched, the time during which the solenoid coil 12 is not energized (lubricating oil supply period) is varied as $T_1 \sim T_3$ according to the engine operating condition as shown in Fig. 18(c), and the lubricating oil supply amount increases according to the engine revolution speed as shown in Fig. 18(d). In Fig.18(d), the period during which the lubricating oil is supplied is shown with hatching. C_1 through C_7 show control operation cycles.

The control timing chart when the lubricating oil supply period is T_1 or T_2 is as shown in Figs.19(a) and he control timing chart when the lubricating oil supply period is T_3 is as shown in Fig.19(b). In these charts, t1 and t2 show the operation delay of the three-way solenoid valve 8 when opening and and closing, respectively.

As shown in Fig.19(a), the effect of the operation delay is recduced and the supply accuracy is improved by setting the lubricating oil supply period longer. Further, by setting the lubricating oil supply period relatively shorter as T_3, since the control period is shortened and the lubricating oil return period during which the three-way solenoid valve is in the ON state becomes shorter as shown in Fig.19(b), the followability of the lubricating oil supply amount to the engine operating condition change is improved. That is, even if the operating condition of the engine 2 abruptly changes, the lubricating oil requirement of the engine 2 abruptly increases and thus the lubricating oil already supplied is consumed earlier because of the higher engine revolution speed, the next control period is rapidly reached and the lubricating oil is newly supplied.

In Fig.18(e), the integrated value of the lubricating oil supply amount is shown with A, the integrated value of the lubricating oii consumption amount is shown with B, and the value obtained by subtracting the lubricating oil consumption amount from the lubricating oil supply amount (lubricating oil residue amount) is shown in Fig. 18(f). From Fig. 18(f), it is seen that the lubricating oil is newly supplied after the residue amount is exhausted.

Therefore, with the lubricating oil supplying system 1 according to this invention, the lubricating oil return interrupting timing is changed according to the operating condition of the engine, and the lubricating oil is newly supplied to the engine after the lubricating oil supplied from the three-way solenoid valve 8 to the engine 2 side has been consumed.

Further, when the lubricating oil requirement of the engine 2 is small and the engine revolution speed is higher than a predetermined one, since the lubricating oil supply period is set as T_3 which is shorter as compared with that for other cases, the control period becomes shorter and the lubricating oil supply amount will change with a better followability to the engine operating condition change. Except when the control period becomes shorter as described above, since the lubricating oil supply period are set as T_1 and T_2 which are relatively longer and the effect of the operation delay of the three-way solenoid valve 8 is reduced, the lubricating oil supply accuracy becomes higher.

The duty ratio map for obtaining the lubricating oil supply amount is not lmited to that shown in Fig.14 but may be constructed as shown in Fig.20. Another embodiment which employs the duty ratio map shown in Fig.20 is described hereafter.

Fig.20 is a graph showing another example of the duty ratio map, Fig.21 is a graph showing the lubricating oil supply amount obtained when the duty ratio map shown in Fig.20 is employed, Fig.22 is a flow chart showing the lubricating oil supply period setting operation in the case where the duty ratio map shown in Fig. 9 is employed. In these graphs, the members the same as or corresponding to those described referring to Figs. 13 through 19 are given the same reference numerals as those in Figs.13 through 19, and their further description is omitted.

The duty ratio map shown in Fig.20 is provided with a domain (shown in Fig.20 with T_4) where the duty ratio becomes larger than A even when the revolution speed is lower than B. The lubricating oil supply amount obtained when this duty ratio map is employed gradually becomes larger as the engine revolution speed and the throttle opening increases as shown in Fig.21.

The lubricating oil supply period is set as shown in the flow chart of Fig.22. The flow chart shown in Fig.22 is constructed by adding an engine revolution speed deciding flow S_{11} between S_3 and S_4 of the flow chart shown in Fig.16 so that the process may proceed to S_4 when the duty ratio D is larger than A and the engine revolution speed R is higher than the revolution speed B to set the lubricating oil supply period as T_1, and so that, when the engine revolution speed R is equal to or lower than the revolution speed B, the process may proceed to S_{12} to set the lubricating oil supply period as T_4 and thereafter at S_{13} to output a signal to the timer 22 for setting the lubricating oil supply period as T_4. The period T_4 is set as a longer period equivalent to T_1 or T_2 above.

Even when constructed as described above, an effect equivalent to that of the previous embodiment can be obtained.

Although it is the lubricating oil return period that is controlled in the embodiments described above, this invention is not limited to such a structure, but the system according to this invention may be constructed for controlling the lubricating oil supply period to the engine 2 side. In such a case, the ON time of the three-way solenoid valve 8 is varied according to the engine operating condition and the OFF time is controlled by the control unit 13.

Further, although a two cycle motorcycle engine is employed as the control object in the embodiments above, this invention can be applied to a four cycle engine having a structure in which, for example, the mixture of air and fuel is injected into the combustion chamber. That is, this invention is applied to a lubricating oil supplying system for spraying lubricating oii upon the siiding portions of the engine. As the engines to which this invention can be applied, engines for motor cycles, motor cars, and work machines such as outboard motors, lawn mowers, golf carts, etc. can be cited.

Further, it is also possible to provide the duty ratio map shown in Fig.14 or Fig.20 with a domain in which the duty ratio becomes 100% when the engine revolution speed becomes extremely low (zero or lower than idling speed). In other word, it is also possible to give the lubricating oil supplying system 1 a structure for cutting off the driving signal to the three-way solenoid valve 8 when the engine revolution speed becomes extremely low (zero or lower than the idling speed). With this structure, the electric supply to the three-way solenoid valve 8 before starting the engine can be intercepted and the electric power consumption of the solenoid coil 12 of the three-way solenoid valve 8 can be restrained.

Still further, the lubricating oil supplying system 1 for the two cycle engine according to this invention can be also given a structure for opening the three-way solenoid valve 8 only once when starting the engine 2 with a kick-type starter. When given such a structure, the three-way solenoid valve 8 is opened only when kicked for the first time after the main switch 14 is turned on.

In addition, it is also possible to make when starting the engine 2 after it is left out of operation for long, the lubricating oil return period longer by correction than that determined by the system 1 according to this invention just after the engine is started until the engine revolution speed exceeds a predetermined speed or until a predetermined time lapses, because it is thought that some lubricating oil is collected in the engine. Further, it is also possible to construct the system 1 according to this invention so that the control of this invention may not be started just after the engine is started until the engine revolution speed exceeds a predetermined speed or until a predetermined time lapses.

As described above, since the lubricating oil supplying system in this embodiment is provided with a supply starting timing setting means which, while keeping the lubricating oil supply period constant, determines the lubricating oil return interrupting timing according to the current engine operating condition, the lubricating oil supply amount becomes that appropriate for the current engine operating condition when the engine operating condition changes. Therefore, the followability of the lubricating oil supply to the change of the engine operating condition can be raised and the accuracy of lubricating oil supply can be raised with this method.

Since the lubricating oil supplying system according to another aspect of this embodiment is constructed by composing the supply starting timing setting means of the lubricating oil supplying system of a supply amount calculating means for calculating the lubricating oil supply amount to the engine side from the engine revolution speed, a consumption amount calculating means fcr calculating the lubricating oil consumption amount in the engine from the engine revolution speed, throttle opening and the lapse of time after the switching valve is switched to the return passage side, and a residue amount detecting means for switching the switching valve from the return passage side to the supply passage side when the lubricating oil supply amount and the lubricating oil consumption amount agree with each other, the lubricating oil is newly supplied to the engine side after the lubricating oil supplied from the switching valve to the engine side has been consumed. Therefore, the lubricating oil can be supplied always with an appropriate supply amount and white smoke is restrained from being generated from the engine as far as possible.

Claims

1. Method for lubricating a two-cycle internal combustion engine (2), wherein the lubricating oil discharged from an oil pump (3) driven in timed relationship by the engine and delivering a substantially fixed amount of lubricant during each cycle of its operation, is fed to a control valve (8) for selectively controlling the flow of the lubricant to the engine, said control valve having a flow position in which lubricant flow to the engine is permitted and a non-flow position in which lubricant flow to the engine is precluded and a return flow of lubricant from the control valve to the suction side of the oil pump is established, said control valve (8) being operated in response to engine operating conditions for varying the duty ratio ($\frac{a-b}{b}$) of a delivery period (a-b) to an entire duty a control period (a) comprising said delivery period (a-b) in which the control valve (8) is in its flow position and a successive or preceeding non-delivery period (b) in which the control valve is in its non-flow position, **characterised in that** said duty control period (a) is controlled in response to engine operating conditions for controlling the amount of lubricant delivered to the engine (2).

2. Method as claimed in claim 1, **characterised in that** the control valve (8) is solenoid-operated and a control unit provides a control of the duty ratio $\frac{a-b}{a}$

and the duty control period (a) of the solenoid (12).

3. Method as claimed in claim 2, **characterised in that** the flow position of the control valve (8) is provided during an OFF state of the solenoid (12) whereas the non-flow position of the control valve (8) is established during an activated ON state of the solenoid (12).

4. Method as claimed in at least one of the preceding claims 1 to 3, **characterised in that** the duty control period (a) is shortened in response to an increase in engine speed and is prolongated in response to a decrease in engine speed.

5. Method as claimed in at least one of the preceding claims 1 to 4, **characterised in that** the duty control period (a) is shortened in response to an increase, specifically a rapid increase of an opening movement of an engine throttle.

6. Method as claimed in at least one of the preceding claims 1 to 4, **characterised in that** the amount of lubricant discharged from the oil pump (3) is supplied from a supply port (9a) of the control valve (8) to the engine (2) in a non-excited condition of the solenoid (12) representing the flow position of the control valve (8) and the amount of lubricant discharged from the oil pump (3) is completely returned to the suction side of the oil pump (3) in an excited active condition of the solenoid (12) representing the non-flow position of the control valve.

7. Method as claimed in at least one of the preceding claims 1 to 6, **characterised in that** the duty ratio $\frac{a-b}{a}$ is varied by keeping constant the non-delivery period (b) while varying the delivery period (a-b).

8. Method as claimed in claim 8, **characterised in that** a termination timing of the delivery period (a-b) is varied in order to vary the duration of said variable period.

9. Method as claimed in at least one of the preceding claims 1 to 8, **characterised in that** the terminating timing of the variable delivery period (a-b) is variable such that the duty ratio $\frac{a-b}{a}$ equals to an optimal duty ratio for supplying an appropriate amount of lubricating oil to the engine under given engine operating conditions.

10. Method as claimed in at least one of the preceding claims 3 to 9, **characterised in that** the OFF period of the solenoid (12) is kept constant while the ON period is made variable setting the OFF period to a value assuring that a minimum amount of lubricating oil necessary for running the engine (2) is supplied thereto.

11. Method as claimed in at least one of the preceding claims 7 to 9, **characterised in that** the OFF period of the solenoid (12) is variable in response to the engine operating conditions, specifically in a stepwise manner to be variable with a fixed rate according to the engine revolution speed while the ON period is variable according to the engine operating conditions.

12. Method as claimed in at least one of the preceding claims 7 to 11, **characterised in that** the duty control period (a) is changed according to the duty ratio $\frac{a-b}{a}$ suited to instant engine operating conditions.

13. Method as claimed in at least one of the preceding claim 1 to 3, **characterised in that** a calculating means (24) of a control unit (13) calculates a desired amount of lubricating oil in response to the detected engine revolution speed to determine an oil return interruption timing, a calculating means (25) of the control unit (13) calculates the amount of oil consumption through the engine (2) in response to the detected engine revolution speed, the throttle opening conditions and the time lapsed from the last change over the control valve (8) to establish a return flow of lubricating oil and that a start timing for supplying oil to the engine is set by a timer means (27) switching the control valve (8) from its non-flow position to its flow position when the amount of oil supplied to the engine is substantially equal to the amount of oil consumption through the engine.

14. Method as claimed in claim 1, **characterised in that** an OFF period of the solenoid (12) is kept constant while its ON period is varied according to the engine operating conditions.

15. Method as claimed in claims 13 or 14, **characterised in that** the timer means (27) for setting the start timing of oil supply subtracts the amount of oil consumption through the engine (2) from the amount of oil supplied through the oil pump (3) and integrates the obtained difference to switch the solenoid (12) when the resulting value becomes zero or negative.

16. Method as claimed in claim 15, **characterised in that** the timer means (27) for setting the start timing of oil supply, after integrating the subtraction results, compares whether the non-delivery period (b) during which a return flow of lubricating oil to the suction side of the oil pump (3) is established, is longer or shorter than a predetermined period in order to switch off the solenoid (12) regardless of the results of the integration of the subtraction results when said non-delivery period (b) is longer than said predetermined period.

17. Method as claimed in claim 3 **characterised in that** the OFF period of the solenoid (12) is kept constant while an oil supply start timing setting means (27) sets the timing for interrupting the oil return period to switch the control valve from its non-flow condition to its flow condition according to the instant engine operating conditions.

18. Method as claimed in claim 17, **characterised in that** a calculating means (24) of a control unit (13) calculates a desired amount of lubricating oil on the engine side in response to a detected engine revolution speed, a calculating means (25) of the control unit (13) calculates the amount of oil consumption through the engine in response to the detected engine revolution speed, the throttle opening conditions and the time lapsed from the last change-over of the control valve (8) to establish a return flow of lubricating oil to the suction side of the oil pump, and a detecting means (27) detects a residue amount for switching the control valve (8) from the non-flow condition to the flow condition when said amount of oil supply and said amount of oil consumption are substantially equal to each other, said supply and consumption amounts calculating means and said detecting means for the residue amount establishing the setting means for setting the oil supply start timing.

19. Method as claimed in at least one of the preceding claims 1 to 3, 9 or 17, **characterised in that** the delivery period (a-b) is variable according to a predetermined duty ratio $\frac{a-b}{a}$ and/or duty control period (a) at which an amount of oil supply to the engine (2) appropriate for the instant engine operating conditions, specifically the instant engine revolution speed, can be obtained.

20. Lubricating system for an internal combustion engine (2) comprising a lubricant pump (3) driven in timed relation by said engine, said lubricant pump delivering a substantially fixed amount of lubricant during each cycle of its operation, conduit means extending from said lubricant pump to said engine for delivering lubricant thereto, valve means (8) in said conduit means for selectively controlling the flow of lubricant to said engine, said valve means having a flow position in which lubricant flow to said engine is permitted and a non-flow position in which lubricant flow to said engine is interrupted, and control means for controlling said valve means for varying the duty ratio ($\frac{a-b}{a}$) of a delivery period (a-b) to an entire duty control period (a) comprising said delivery period (a-) in which the valve means (8) is in its flow position and a non-delivery period (b) in which said valve means is in its non-flow position, **characterised in that** said control means is adapted to control also the duty control period (a) for controlling the amount of lubricant delivered to said engine (2).

21. Lubricating system as claimed in claim 20, **characterised in that** the control means (13) for operating the valve means (8) is responsive to the engine operating conditions, particularly to an engine revolution speed, a throttle position or a vehicle speed.

22. Lubricating system as claimed in claims 20 or 21, **characterised in that** the lubricating pump (3) is of the reciprocating type driven by the engine (2).

23. Lubricating system as claimed in at least one of the preceding claims 20 to 22, **characterised in that** the lubricating oil pump (3) is connected to the engine (2) through a supply passage (4), an oil tank (5) is connected to the suction side of the lubricating oil pump (2) through an introducing passage (6), a return passage (7) connects the supply passage (4) with the introducing passage (6) so as to bypass the lubricating oil pump (3) and a three-way solenoid valve (8) is provided which is disposed at the connection of the supply passage (4) with the return passage (7), said three-way solenoid control valve (8) being composed of a valve case (9) having a supply port (9a) communicated to the supply passage (4) and a return port (9b) communicated to the return passage (7), a valve body (10) disposed in the valve case (9) to close either one of the supply ports (9a), and the return port (9b) when the other is opened, said valve body (10) being prebiased by an urging spring (11) into its rest position for opening the supply port (9a); and a solenoid coil (12) for moving the valve body (10) to its activated position for opening the return port (9b) when energised, said three-way solenoid valve (8) being controlled by a control unit (13) which receives signals indicating the engine operating conditions to compute the lubricating oil amount necessary for the engine (2) on the basis of these signals, duty-controlling the energisation of the solenoid coil (12) of the three-way solenoid control valve (8) according to the results of said signal processing.

Patentansprüche

1. Verfahren zur Schmierung einer Zweitakt-Brennkraftmaschine (2), in der das von einer Ölpumpe (3), welche in einem zeitlich festgelegtem Verhältnis von der Brennkraftmaschine angetrieben wird und eine im wesentlichen feste Menge an Schmiermittel in jedem Zyklus ihres Betriebs liefert, ausgegebenes Schmieröl einem Steuerventil (8) zugeführt wird zur selektiven Steuerung des Schmiermittelflusses zu der Brennkraftmaschine, wobei dieses Steuerventil eine Durchlaßstellung hat, in welcher ein Schmiermittelfluß zu der Brennkraftmaschine ermöglicht wird, und eine Sperrstellung hat, in welcher ein Schmiermittelfluß zu der Brennkraftmaschine verhindert und ein Schmiermittel-Rückfluß von dem Steuerventil zur Ansaugseite der Ölpumpe eingerichtet ist, wobei dieses Steuerventil (8) betrieben wird in Abhängigkeit von Motorbetriebszuständen zum Variieren des Leistungsverhältnisses ($\frac{a-b}{a}$) einer Förderperiode (a-b) zu einer gesamten Leistungssteuerungsperiode (a), die diese Lieferperiode (a-b) enthält, in welcher das Steuerventil (8) sich in seiner Durchflußstellung befindet, und einer darauffolgenden oder vorangehenden Nichtförderperiode (b), in welcher sich das Steuerventil in seiner Sperrstellung befindet, **dadurch gekennzeichnet**, daß die Leistungssteuerungsperiode (a) gesteuert wird in Abhängigkeit von Motorbetriebszuständen zur Steuerung der Schmiermittel-Fördermenge an die Brennkraftmaschine (2).

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet**, daß das Steuerventil (8) von einem Elektromagneten betätigt wird und eine Steuereinheit eine Steuerung des Leistungsverhältnisses $\frac{a-b}{a}$ und der Leistungssteuerungsperiode (a) des Elektromagneten (12) durchführt.

3. Verfahren nach Anspruch 2, **dadurch gekennzeichnet**, daß die Durchlaßstellung des Steuerventils (8) während eines AUS-Zustandes des Elektromagneten (12) gegeben ist, wohingegen die Sperrstellung des Steuerventils (8) während des aktivierten EIN-Zustandes des Elektromagneten (12) eingerichtet ist.

4. Verfahren nach mindestens einem der vorstehenden Ansprüche 1 bis 3, **dadurch gekennzeichnet**, daß die Leistungssteuerungsperiode (a) verkürzt wird in Abhängigkeit von einem Anstieg der Motorgeschwindigkeit und verlängert wird in Abhängigkeit von einem Abfall der Motorgeschwindigkeit.

5. Verfahren nach mindestens einem der vorstehenden Ansprüche 1 bis 4, **dadurch gekennzeichnet**, daß die Leistungssteuerungsperiode (a) verkürzt wird in Abhängigkeit von einem Anstieg, insbesondere einem raschen Anstieg einer Öffnungsbewegung einer Motordrossel.

6. Verfahren nach mindestens einem der vorstehenden Ansprüche 1 bis 4, **dadurch gekennzeichnet**, daß die von der Ölpumpe (3) ausgestoßene Schmiermittelmenge von einer Förderöffnung (9a) des Steuerventils (8) zu der Brennkraftmaschine (2) in einem nicht-erregten Zustand des Elektromagneten (12) zugeführt wird, welcher die Durchlaßstellung des Steuerventils (8) darstellt, und daß die von der Ölpumpe (3) ausgestoßene Schmiermittelmenge vollständig zur Ansaugseite der Ölpumpe (3) rückgeführt wird in einem erregten, aktivierten Zustand des Elektromagneten (12), der die Speerstellung des Steuerventils darstellt.

7. Verfahren nach mindestens einem der vorstehenden Ansprüche 1 bis 6, **dadurch gekennzeichnet**, daß das Leitungsverhältnis $\frac{a-b}{a}$ variiert wird durch Konstanthalten der Nicht-Lieferperiode (b), während die Lieferperiode (a-b) variiert wird.

8. Verfahren nach Anspruch 7, **dadurch gekennzeichnet**, daß ein Beendigungszeitpunkt für die Lieferperiode (a-b) variiert wird, um die Dauer dieser variablen Periode zu ändern.

9. Verfahren nach mindestens einem der vorstehenden Ansprüche 1 bis 8, **dadurch gekennzeichnet**, daß der Beendigungszeitpunkt der variablen Förderperiode (a-b) variabel ist derart, daß das Leistungsverhältnis $\frac{a-b}{a}$ gleich einem optimalen Leistungsverhältnis wird zur Förderung einer geeigneten Menge an Schmieröl zu der Brennkraftmaschine unter gegebenen Motorbetriebszuständen.

10. Verfahren nach mindestens einem der vorstehenden Ansprüche 3 bis 9, **dadurch gekennzeichnet**, daß die AUS-Periode des Elektromagneten (12) konstant gehalten wird, während die EIN-Periode variabel gestaltet wird, wobei die AUS-Periode auf einen Wert derart festgesetzt wird, daß eine Minimalmenge an für den Betrieb der Brennkraftmaschine (2) notwendigem Schmieröl diesem zugeführt wird.

11. Verfahren nach mindestens einem der vorstehenden Ansprüche 7 bis 9, **dadurch gekennzeichnet**, daß die AUS-Zeit des Elektromagneten (12) variabel ist in Abhängigkeit von den Motorbetriebszuständen, insbesondere in einer schrittweisen Art, um mit einer festen Rate gemäß der Motordrehzahl variabel zu sein, während die EIN-Periode variabel ist gemäß den Motorbetriebszuständen.

12. Verfahren nach mindestens einem der vorstehenden Ansprüche 7 bis 11, dadurch gekennzeichnet, daß die Leistungssteuerungsperiode (a) geändert wird gemäß demjenigen Leistungsverhältnis $\frac{a-b}{a}$, welches für die augenblicklichen Motorbetriebszustände geeignet ist.

13. Verfahren nach mindestens einem der vorstehenden Ansprüche 1 bis 3, **dadurch gekennzeichnet**, daß eine Berechnungseinrichtung (24) einer Steuereinheit (13) eine gewünschte Schmierölmenge berechnet in Abhängigkeit von der erfaßten Motordrehzahl, um einen Ölrückführ-Unterbrechungszeitpunkt festzulegen, daß eine Berechnungsein-

richtung (25) der Steuereinheit (13) die Ölverbrauchsmenge der Brennkraftmaschine (2) berechnet in Abhängigkeit von der erfaßten Motordrehzahl, den Drosselöffnungszuständen und der verstrichenen Zeit von dem letzten Umschaltvorgang des Steuerventils (8), um einen Schmieröl-Rückfluß einzurichten, und daß ein Startzeitpunkt für die Förderung von Öl an die Brennkraftmaschine von einer Zeitgebereinrichtung (27) festgesetzt wird, welche das Steuerventil (8) aus seiner Sperrstellung in seine Durchlaßstellung umschaltet, wenn die der Brennkraftmaschine zugeführte Ölmenge im wesentlichen gleich der von der Brennkraftmaschine verbrauchten Ölmenge ist.

14. Verfahren nach Anspruch 1, **dadurch gekennzeichnet**, daß eine AUS-Periode des Elektromagneten (12) konstant gehalten wird, während seine EIN-Periode gemäß den Motorbetriebszuständen variiert wird.

15. Verfahren nach Anspruch 13 oder 14, **dadurch gekennzeichnet**, daß die Zeitgebereinrichtung (27) zur Festsetzung des Startzeitpunktes für die ölförderung die Menge des von der Brennkraftmaschine (2) verbrauchten Öles von der durch die Ölpumpe (3) zugeführte Ölmenge subtrahiert und die erhaltene Differenz integriert, um den Elektromagneten (12) zu schalten, wenn der erhaltene Wert zu Null oder negativ wird.

16. Verfahren nach Anspruch 15, **dadurch gekennzeichnet**, daß die Zeitgebereinrichtung (27) zur Festsetzung eines Startzeitpunktes für die ölförderung nach der Integration der Subtraktionsergebnisse vergleicht, ob die Nicht-Lieferperiode (b), während welcher ein Rückfluß an Schmieröl zur Ansaugseite der Ölpumpe (3) eingerichtet ist, länger oder kürzer als eine vorbestimmte Periode ist, um den Elektromagneten (12) unabhängig von den Ergebnissen der Integration der Subtraktionsergebnisse auszuschalten, wenn diese Nicht-Lieferperiode (b) länger als die vorbestimmte Periode ist.

17. Verfahren nach Anspruch 3, **dadurch gekennzeichnet**, daß die AUS-Periode des Elektromagneten (12) konstant gehalten wird, während eine Ölförderstartzeitpunkt-Festsetzungseinrichtung (27) den Zeitpunkt für die Unterbrechung der Ölrückführperiode festsetzt, um das Steuerventil von seiner Sperrstellung in seine Durchlaßstellung gemäß den augenblicklichen Motorbetriebszuständen zu schalten.

18. Verfahren nach Anspruch 17, **dadurch gekennzeichnet**, daß eine Berechnungseinrichtung (24) der Steuereinheit (13) eine gewünschte Schmierölmenge der Brennkraftmaschine berechnet in Abhängigkeit von einer erfaßten Motordrehzahl, daß eine Berechnungseinrichtung (25) der Steuereinheit (13) die von der Brennkraftmaschine verbrauchte Ölmenge berechnet in Abhängigkeit von der erfaßten Motordrehzahl, den Drosselöffnungszuständen und der verstrichenen Zeit von dem letzten Umschaltvorgang des Steuerventils (8), um einen Rückfluß an Schmieröl zur Ansaugseite der Ölpumpe zu errichten, und daß eine Erfassungseinrichtung (27) eine Restmenge erfaßt zum Schalten des Steuerventils (8) von seiner Sperrstellung in seine Durchlaßstellung, wenn diese Olfördermenge und diese ölverbrauchsmenge im wesentlichen einander gleich sind, wobei diese Förder- und Verbrauchsmengen-Berechnungseinrichtungen und diese Erfassungseinrichtung für die Restmenge die Festsetzungseinrichtung bilden zum Festsetzen des ölförderstartzeitpunktes.

19. Verfahren nach mindestens einem der vorstehenden Ansprüche 1 bis 3, 9 oder 17, **dadurch gekennzeichnet**, daß die Förderperiode (a-b) variabel ist gemäß eines vorbestimmten Leistungsverhältnisses $\frac{a-b}{a}$ und/oder Leistungssteuerungsverhältnis (a), zu welchen eine Ölfördermenge an die Brennkraftmaschine (2) erhalten werden kann, die für die augenblicklichen Motorbetriebszustände, insbesondere für die augenblickliche Motordrehzahl geeignet ist.

20. Schmiersystem für eine Brennkraftmaschine (2), mit einer Schmiermittelpumpe (3), welche in einem zeitlich abgestimmten Verhältnis von dieser Brennkraftmaschine angetrieben wird, wobei diese Schmiermittelpumpe eine im wesentlichen feste Menge an Schmiermittel für jeden Zyklus ihres Betriebs fördert, mit Leitungseinrichtungen, die sich von der Schmiermittelpumpe zu der Brennkraftmaschine erstrecken zur Förderung des Schmiermittels dorthin, mit Ventileinrichtungen (8) innerhalb dieser Leitungseinrichtungen zur selektiven Steuerung des Schmiermittelflusses zu dieser Brennkraftmaschine, wobei diese Ventileinrichtungen (8) eine Durchlaßstellung haben, in welcher ein Schmiermittelfluß zu der Brennkraftmaschine ermöglicht ist, und eine Sperrstellung haben, in welcher ein Schmiermittelfluß zu der Brennkraftmaschine unterbrochen ist, und mit Steuereinrichtungen zur Steuerung dieser Ventileinrichtung zum Variieren des Leistungsverhältnisses $(\frac{a-b}{a})$ einer Förderperiode (a-b) zu einer gesamten Leistungssteuerungsperiode (a), welche diese Förderperiode (a) umfaßt, in welcher die Ventileinrichtungen (8) sich in ihrer Durchlaßstellung befinden, und welche eine Nicht-Förderperiode (b) enthält, in der diese Ventileinrichtungen sich in ihrer Sperrstellung befinden, **dadurch gekennzeichnet**, daß diese Steuereinrichtung geeignet ist, auch die Leistungssteuerungsperiode (a) zu steuern, um die der Brennkraftmaschine (2) zugeführte Schmiermittelmenge zu steuern.

21. Schmiersystem nach Anspruch 20, **dadurch gekennzeichnet**, daß die Steuereinrichtung (13) zur Betätigung der Ventileinrichtungen (8) auf die Motorbetriebszustände anspricht, insbesondere auf eine Motordrehzahl, eine Drosselstellung oder auf eine Fahrzeuggeschwindigkeit.

22. Schmiersystem nach Anspruch 20 oder 21, **dadurch gekennzeichnet**, daß die Schmiermittelpumpe (3) eine des Hubkolbentyps und von der Brennkraftmaschine (2) antreibbar ist.

23. Schmiersystem nach mindestens einem der vorstehenden Ansprüche 20 bis 22, **dadurch gekennzeichnet**, daß die Schmierölpumpe (3) mit der Brennkraftmaschine (2) über einen Förderkanal (4) verbunden ist, ein Öltank (5) an der Ansaugseite der Schmierölpumpe über einen Einführkanal (6) angeschlossen ist, ein Rückführkanal (7) den Förderkanal (4) mit dem Einführkanal (6) verbindet, um so die Schmierölpumpe (3) zu umgehen, und daß ein DreiwegeElektromagnetventil (8) vorgesehen ist, welches bei der Verbindung des Förderkanals (4) mit dem Rückführkanal (7) angeordnet ist, wobei dieses Dreiwege-Elektromagnetsteuerventil (8) ein Ventilgehäuse (9) mit einer Förderöffnung (9a), die an dem Förderkanal (4) angeschlossen ist, und mit einer Rückführöffnung (9b), die mit dem Rückführkanal (7) verbunden ist, einen in dem Ventilgehäuse (9) angeordneten Ventilkörper (10) zum Schließen entweder der Förderöffnung (9a) oder der Rückführöffnung (9b), wenn die jeweils andere geöffnet ist, wobei dieser Ventilkörper (10) von einer Druckfeder (11) in seine Ruhestellung vorgespannt ist zum Öffnen der Förderöffnung (9a), sowie eine Elektromagnetspule (12) zum Bewegen des Ventilkörpers (10) in seine aktivierte Stellung zum Öffnen der Rückführöffnung (9b), wenn diese erregt ist, umfaßt, wobei dieses Dreiwege-Elektromagnetventil (8) von einer Steuereinheit (13) gesteuert wird, welche die die Motorbetriebszustände anzeigenden Signale empfängt, um die für die Brennkraftmaschine (2) notwendige Schmierölmenge auf der Grundlage dieser Signale zu berechnen und um eine Leistungssteuerung der Erregung der Elektromagnetspule (12) des Dreiwege-Elektromagnetsteuerventils (8) gemäß den Ergebnissen dieser Signalverarbeitung durchzuführen.

Revendications

1. Procédé pour lubrifier un moteur à combustion interne à cycle à deux temps (2), dans lequel l'huile de lubrification, provenant d'une pompe à huile (3) entraînée par le moteur, selon une relation minutée, et délivrant une quantité sensiblement fixe de lubrifiant pendant chaque cycle de son fonctionnement, est délivrée à une vanne de commande (8) pour commander, de manière sélective, l'écoulement du lubrifiant vers le moteur thermique, ladite vanne de commande ayant une position d'écoulement dans laquelle un écoulement de lubrifiant vers le moteur thermique est autorisé et ayant une position de non-écoulement dans laquelle l'écoulement de lubrifiant vers le moteur thermique est empêché et dans laquelle un écoulement de retour de lubrifiant depuis la vanne de commande vers le côté aspiration de la pompe à huile est établi, ladite vanne de commande (8) étant mise en oeuvre en réponse aux conditions de fonctionnement du moteur pour faire varier le rapport cyclique

$$\left(\frac{a - b}{a}\right)$$

d'une période de délivrance (a-b) sur une période totale de commande (a) comprenant ladite période de délivrance (a-b) dans laquelle la vanne de commande (8) est dans sa position d'écoulement et une période de non-délivrance suivante ou précédente (b) dans laquelle la vanne de commande est dans sa position de non-écoulement, **caractérisé en ce que** ladite période totale de commande (a) est commandée en réponse à des conditions de fonctionnement du moteur pour commander la quantité de lubrifiant délivré au moteur (2).

2. Procédé selon la revendication 1, **caractérisé en ce que** la vanne de commande (8) est mise en oeuvre par un solénoïde et en ce qu'une unité de commande réalise une commande du rapport cyclique $\frac{a-b}{a}$ et de la période totale de commande (a) du solénoïde (12).

3. Procédé selon la revendication 2, **caractérisé en ce que** la position d'écoulement de la vanne de commande (8) est prévue pendant un état ARRET du solénoïde (12) et que la position de non-écoulement de la vanne de commande (8) est établie pendant un état activé MARCHE du solénoïde (12).

4. Procédé selon au moins l'une des revendications précédentes 1 à 3, **caractérisé en ce que** la période totale de commande (a) est raccourcie en réponse à une augmentation de vitesse du moteur et est prolongée en réponse à une diminution de la vitesse du moteur.

5. Procédé selon au moins l'une des revendications

précédentes 1 à 4, **caractérisé en ce que** la période totale de commande (a) est raccourcie en réponse à une augmentation, spécifiquement une augmentation rapide, d'un mouvement d'ouverture d'un papillon des gaz du moteur.

6. Procédé selon au moins l'une des revendications précédentes 1 à 4, **caractérisé en ce que** la quantité de lubrifiant en provenance de la pompe à huile (3) est fournie, à partir d'un orifice d'alimentation (9a) de la vanne de commande (8), au moteur (2) dans un état non excité du solénoïde (12) représentant la position d'écoulement de la vanne de commande (8) et en ce que la quantité de lubrifiant en provenance de la pompe à huile (3) est complètement renvoyée vers le coté aspiration de la pompe à huile (3) dans un état actif excité du solénoïde (12) représentant la position de non-écoulement de la vanne de commande.

7. Procédé selon au moins l'une des revendications précédentes 1 à 6, **caractérisé en ce que** le rapport cyclique $\frac{a-b}{a}$ varie en gardant la période de non-délivrance (b) constante tout en faisant varier la période de délivrance (a-b).

8. Procédé selon la revendication 8, **caractérisé en ce que** le minutage de fin de la période de délivrance (a-b) varie afin de faire varier la durée de ladite période variable.

9. Procédé selon au moins l'une des revendications précédentes 1 à 8, **caractérisé en ce que** le minutage de fin de la période de délivrance variable (a-b) est variable de sorte que le rapport cyclique $\frac{a-b}{a}$ est égal à un rapport cyclique optimal pour fournir une quantité appropriée d'huile de lubrification au moteur sous des conditions de fonctionnement du moteur données.

10. Procédé selon au moins l'une des revendications précédentes 3 à 9, **caractérisé en ce que** la période ARRET du solénoïde (12) est gardée constante tandis que la période MARCHE est rendue variable en fixant la période ARRET à une valeur assurant qu'une quantité minimale d'huile de lubrification, nécessaire pour faire fonctionner le moteur (2), est fournie à ce dernier.

11. Procédé selon au moins l'une des revendications précédentes 7 à 9, **caractérisé en ce que** la période ARRET du solénoïde (12) est variable en réponse aux conditions de fonctionnement du moteur, spécifiquement de façon échelonnée pour être variable avec une vitesse fixe selon la vitesse de rotation du moteur tandis que la période MARCHE est variable selon les conditions de fonctionnement du moteur.

12. Procédé selon au moins l'une des revendications précédentes 7 à 11, **caractérisé en ce que** la période totale de commande (a) est modifiée selon le rapport cyclique approprie $\frac{a-b}{a}$ à des conditions instantanées de fonctionnement de moteur.

13. Procédé selon au moins l'une des revendications précédentes 1 à 3, **caractérisé en ce que** des moyens de calcul (24) d'une unité de commande (13) calculent une quantité souhaitée d'huile de lubrification en réponse à la vitesse détectée de rotation du moteur pour déterminer un minutage d'interruption de retour d'huile, des moyens de calcul (25) de l'unité de commande (13) calculent la quantité de consommation d'huile dans le moteur (2) en réponse à la vitesse détectée de rotation du moteur, aux conditions d'ouverture du papillon des gaz et au temps écoulé depuis le dernier changement de la vanne de commande (8) pour établir un écoulement de retour d'huile de lubrification et en ce qu'un minutage de début, pour fournir de l'huile au moteur, est fixé par des moyens formant minuterie (27) commutant la vanne de commande (8) de sa position de non-écoulement à sa position d'écoulement lorsque la quantité d'huile fournie au moteur est sensiblement égale à la quantité de consommation d'huile dans le moteur.

14. Procédé selon la revendication 1, **caractérisé en ce qu**'une période ARRET du solénoïde (12) est gardée constante tandis que sa période MARCHE varie selon les conditions de fonctionnement du moteur.

15. Procédé selon les revendications 13 ou 14, **caractérisé en ce que** les moyens formant minuterie (27), pour fixer le minutage de début d'alimentation en huile, soustraient la quantité de consommation d'huile dans le moteur (2) de la quantité d'huile fournie dans la pompe à huile (3) et intègrent la différence obtenue pour commuter le solénoïde (12) lorsque la valeur résultante devient nulle ou négative.

16. Procédé selon la revendication 15, **caractérisé en ce que** les moyens formant minuterie (27), pour fixer le minutage de début de l'alimentation en huile, après intégration des résultats de soustraction, effectuent une comparaison pour savoir si la période de non-délivrance (b), pendant laquelle un écoulement de retour d'huile de lubrification vers le côté aspiration de la pompe à huile (3) est établi, est plus longue ou plus courte qu'une période prédéterminée afin de désactiver le solénoïde (12) sans tenir compte des résultats de l'intégration des résultats de soustraction lorsque ladite période de non-délivrance (b) est plus longue que ladite période prédéterminée.

17. Procédé selon la revendication 3, **caractérisé en ce que** la période ARRET du solénoïde (12) est gardée constante tandis que des moyens de fixation de minutage de début d'alimentation en huile (27) fixent le minutage pour interrompre la période de retour d'huile pour commuter la vanne de commande de sa position de non-écoulement à son état d'écoulement selon les conditions instantanées de fonctionnement du moteur.

18. Procédé selon la revendication 17, **caractérisé en ce que** des moyens de calcul (24) d'une unité de commande (13) calculent une quantité souhaitée d'huile de lubrification du côté moteur en réponse à une vitesse détectée de rotation du moteur, des moyens de calcul (25) de l'unité de commande (13) calculent la quantité de consommation d'huile dans le moteur en réponse à la vitesse détectée du moteur, aux conditions d'ouverture du papillon des gaz et au temps écoulé depuis le dernier changement d'état de la vanne de commande (8) pour établir un écoulement de retour d'huile de lubrification vers le côté aspiration de la pompe à huile, et des moyens de détection (27) pour détecter une quantité résiduelle pour commuter la vanne de commande (8) de son état de non-écoulement à son état d'écoulement lorsque ladite quantité d'alimentation en huile et ladite quantité de consommation d'huile sont sensiblement égales, lesdits moyens de calcul de quantités d'alimentation et de consommation et lesdits moyens de détection de la quantité résiduelle établissant les moyens de fixation pour fixer le minutage de début d'alimentation en huile.

19. Procédé selon au moins l'une des revendications précédentes 1 à 3, 9 ou 17, **caractérisé en ce que** la période de délivrance (a-b) est variable selon un rapport cyclique prédéterminé $\frac{a-b}{a}$ et/ou une période totale de commande (a) à laquelle une quantité d'alimentation en huile fournie au moteur (2), appropriée pour les conditions instantanées de fonctionnement du moteur, spécifiquement la vitesse instantanée de rotation du moteur, peut être obtenue.

20. Système de lubrification pour un moteur à combustion interne (2) comprenant une pompe de lubrifiant (3) entraînée par ledit moteur, selon une relation minutée, ladite pompe de lubrifiant délivrant une quantité sensiblement fixe de lubrifiant pendant chaque cycle de son fonctionnement, des moyens formant conduite s'étendant depuis ladite pompe de lubrifiant vers ledit moteur pour délivrer du lubrifiant à ce dernier, des moyens formant vanne (8) dans lesdits moyens formant conduite pour commander, de manière sélective, l'écoulement du lubrifiant vers ledit moteur, lesdits moyens formant vanne ayant une position d'écoulement dans laquelle un écoulement de lubrifiant vers ledit moteur est autorisé et ayant une position de non-écoulement dans laquelle l'écoulement de lubrifiant vers ledit moteur est interrompu, et des moyens de commande pour commander lesdits moyens formant vanne pour varier le rapport cyclique

$$\left(\frac{a - b}{a}\right)$$

d'une période de délivrance (a-b) pour une période totale de commande (a) comprenant ladite période de délivrance (a-b), dans laquelle les moyens formant vanne (8) sont dans leur position d'écoulement et une période de non-délivrance (b), dans laquelle lesdits moyens formant vanne sont dans leur position de non-écoulement, **caractérisé en ce que** lesdits moyens de commande sont conçus pour commander également la période de commande à pleine capacité (a) pour commander la quantité de lubrifiant délivré audit moteur (2).

21. Système de lubrification selon la revendication 20, **caractérisé en ce que** les moyens de commande (13) pour mettre en oeuvre les moyens formant vanne (8) sont sensibles aux conditions de fonctionnement du moteur, particulièrement à une vitesse de rotation du moteur, une position du papillon des gaz ou une vitesse du véhicule.

22. Système de lubrification selon les revendications 20 ou 21, **caractérisé en ce que** la pompe de lubrification (3) est du type à mouvement alternatif, entraînée par le moteur (2).

23. Système de lubrification selon au moins l'une des revendications précédentes 20 à 22, **caractérisé en ce que** la pompe à huile de lubrification (3) est reliée au moteur (2) par l'intermédiaire d'un passage d'alimentation (4), un réservoir d'huile (5) est relié au côté aspiration de la pompe à huile de lubrification (2) par l'intermédiaire d'un passage d'introduction (6), un passage de retour (7) relie le passage d'alimentation (4) au passage d'introduction (6) de façon à court-circuiter la pompe à huile de lubrification (3) et une électrovanne à trois voies (8) est prévue, laquelle est disposée au niveau de la connexion du passage d'alimentation (4) avec le passage de retour (7), ladite électrovanne de commande à trois voies (8) étant constituée d'une enveloppe de vanne (9) ayant un orifice d'alimentation (9a) communiquant avec le passage d'alimentation (4) et un orifice de retour (9b) communiquant avec le passage de retour (7), un corps de vanne (10) disposé dans l'enveloppe de vanne (9) pour fermer l'un ou l'autre de l'orifice d'alimentation (9a) et de l'orifice de retour (9b) lorsque l'autre est ouvert, ledit corps de vanne (10) étant préchargé par un ressort de poussée (11) dans sa position de repos pour ouvrir l'orifice d'alimentation (9a) ; et une bobine de solénoïde (12) pour déplacer le corps de vanne (10) vers sa position activée pour ouvrir l'orifice de retour (9b) quand elle est excitée, ladite électrovanne à trois voies (8) étant commandée par une unité de commande (13) qui reçoit des signaux indiquant les conditions de fonctionnement du moteur pour calculer la quantité d'huile de lubrification nécessaire pour le moteur (2) sur la base de ces signaux, commandant l'excitation de la bobine de solénoïde (12) de l'électrovanne de commande à trois voies (8) selon les résultats dudit traitement de signal.

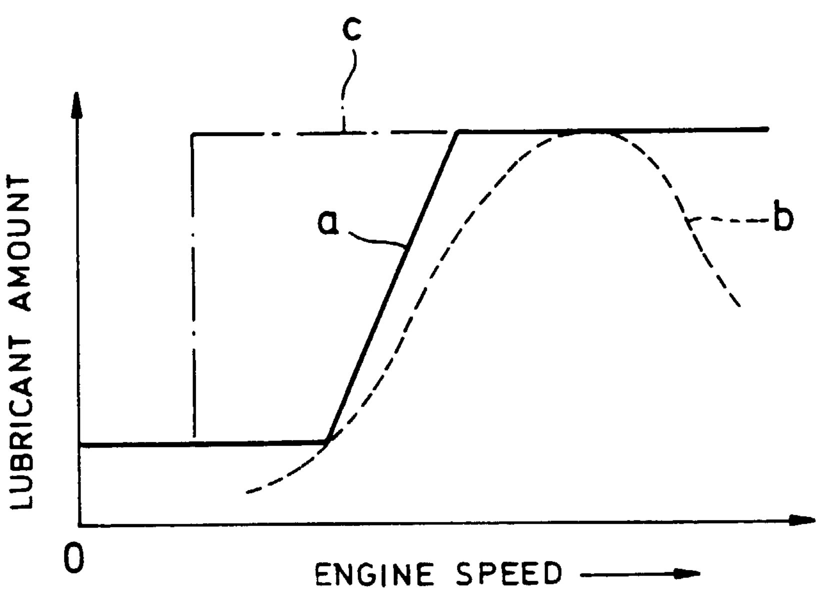

FIG.1

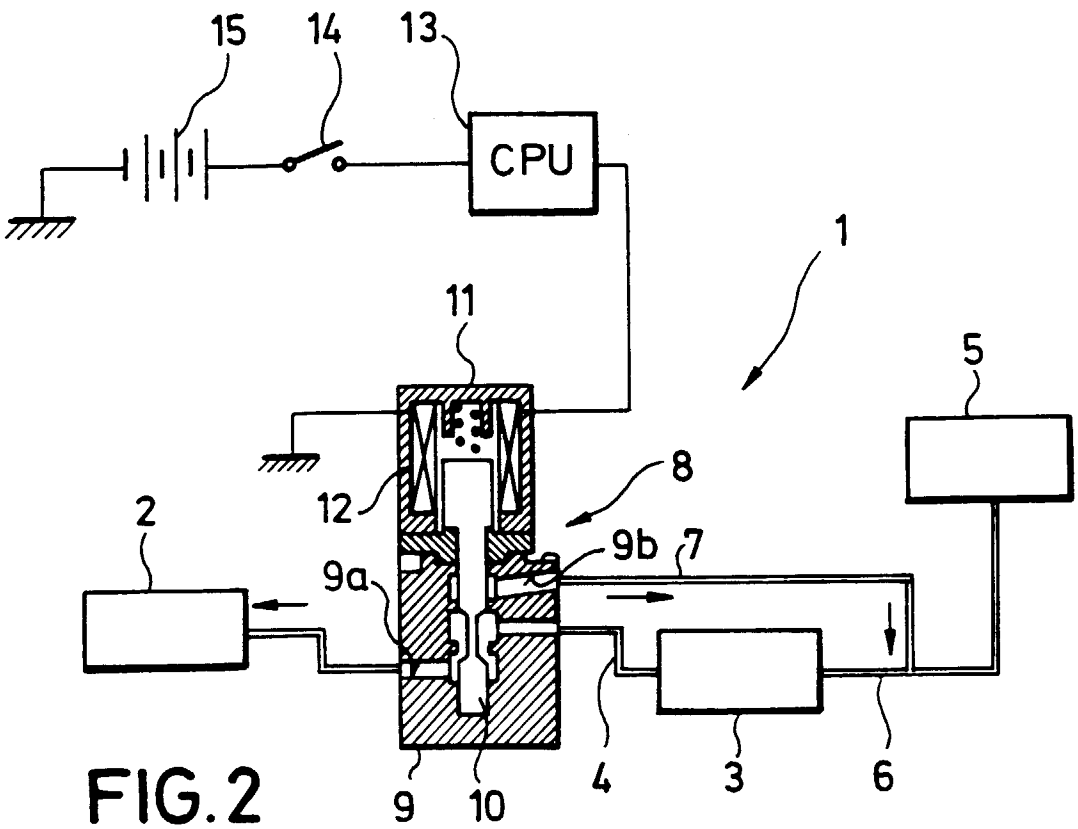

FIG.2

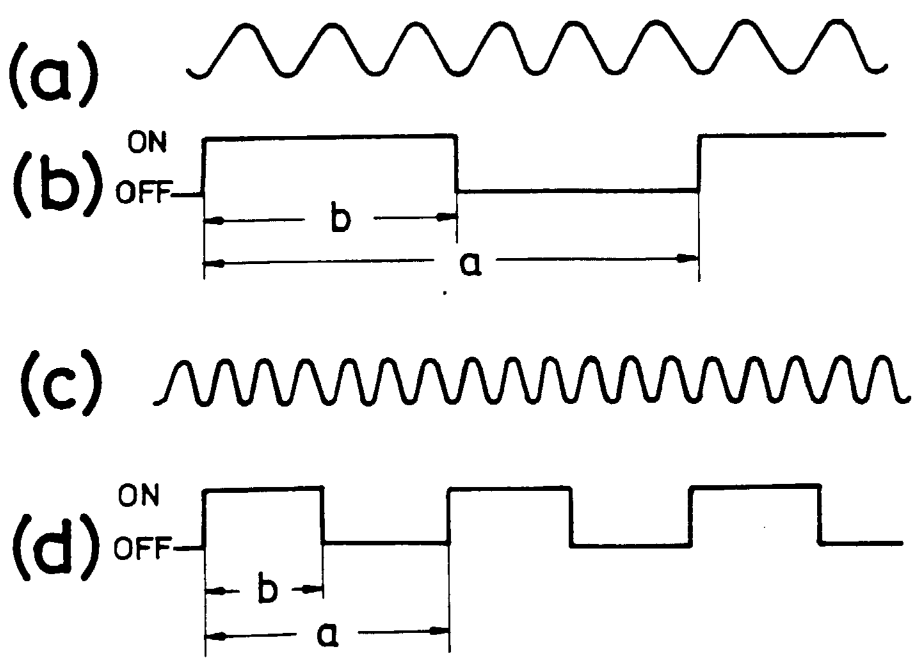

FIG.3

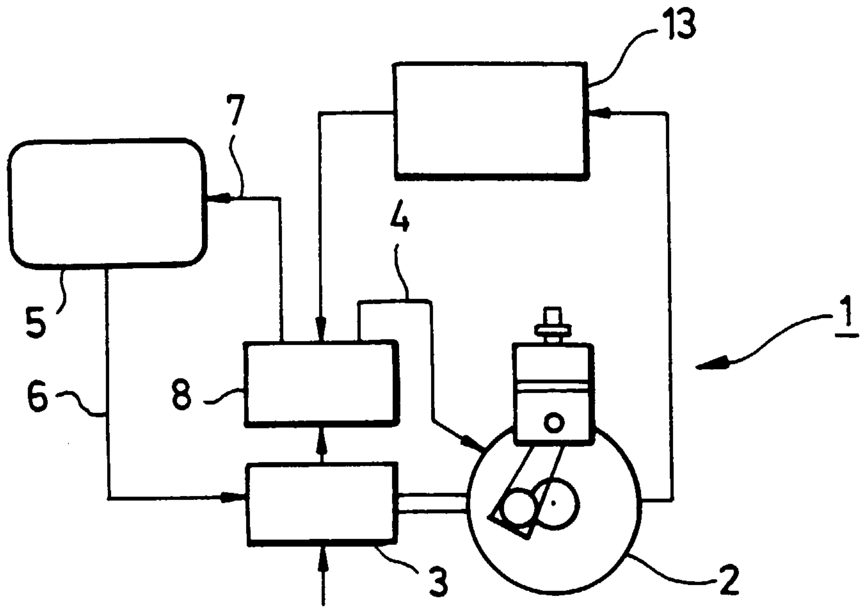

FIG.4

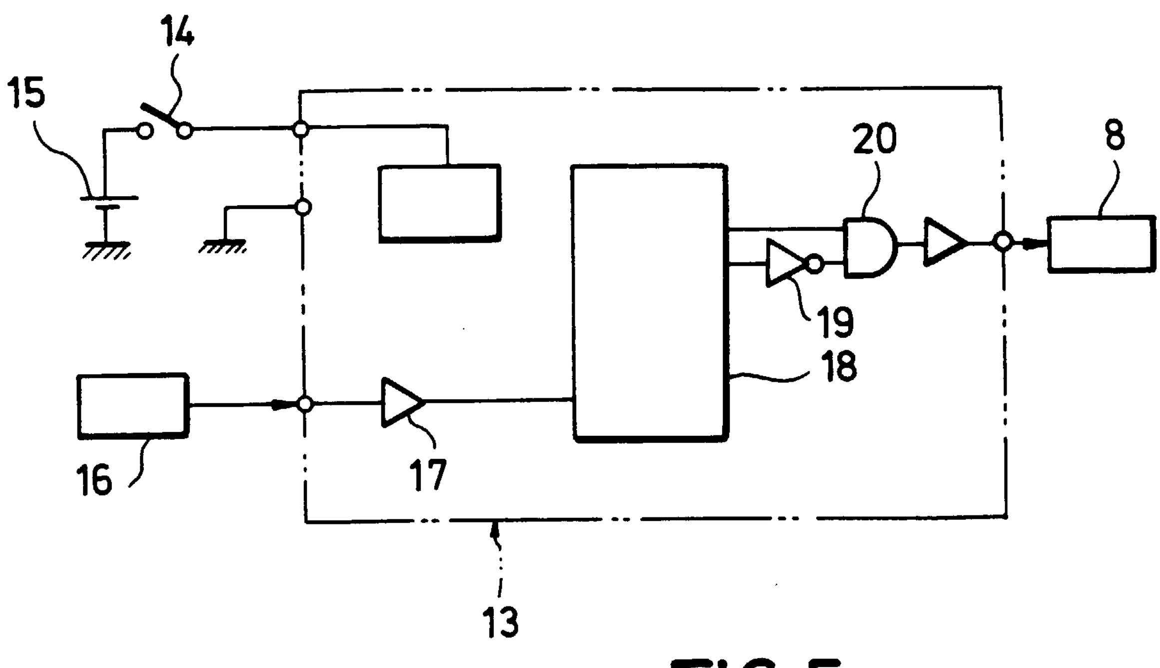

FIG.5

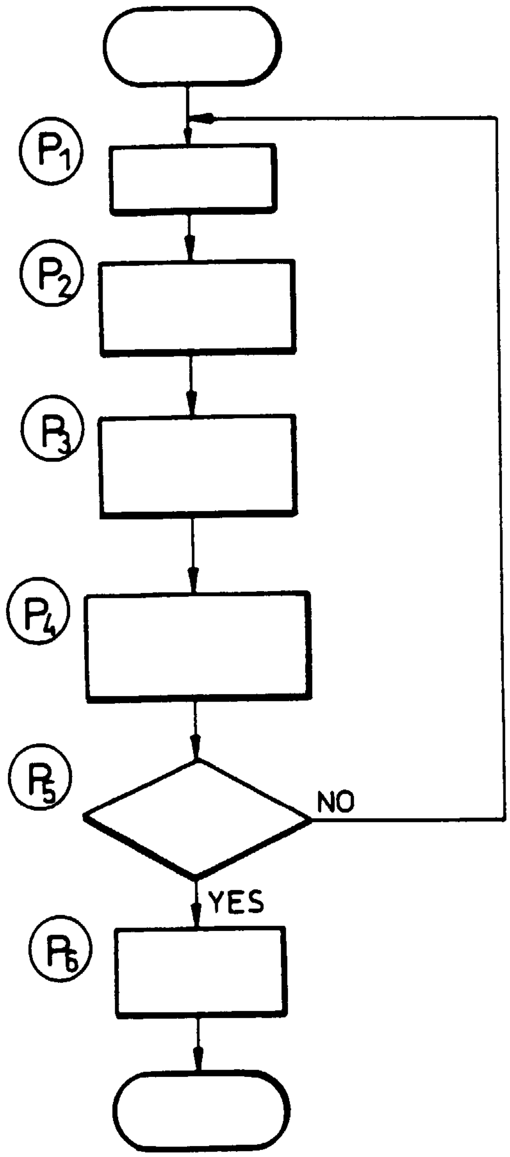

FIG.6

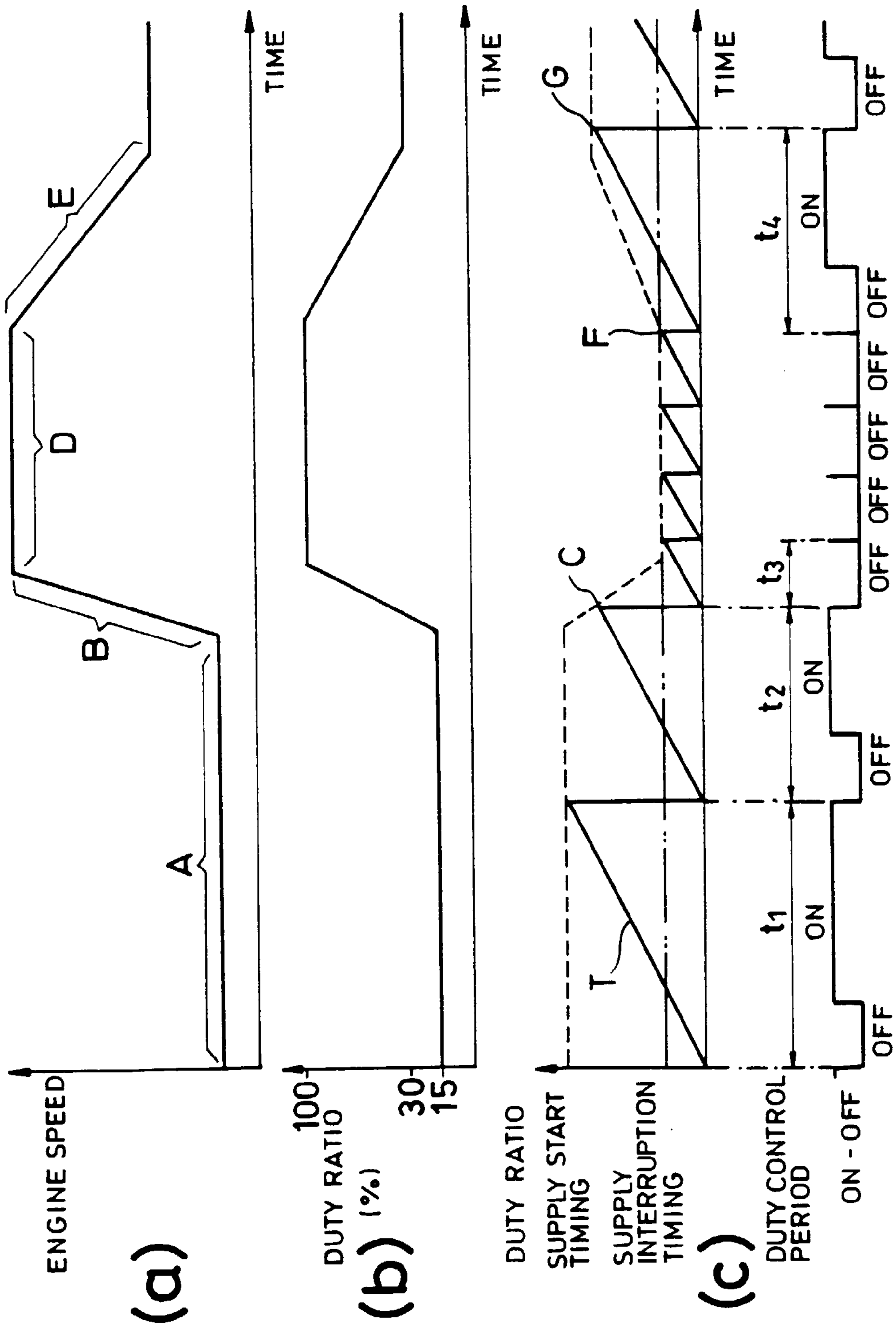
(a)
ENGINE SPEED
TIME
A
B
D
E
(b)
DUTY RATIO (%)
100
30
15
TIME
(c)
DUTY RATIO
SUPPLY START TIMING
SUPPLY INTERRUPTION TIMING
DUTY CONTROL PERIOD
ON - OFF
T
C
F
G
TIME
t1
t2
t3
t4
OFF
ON
OFF
ON
OFF
OFF
OFF
OFF
OFF
ON
OFF

FIG.7

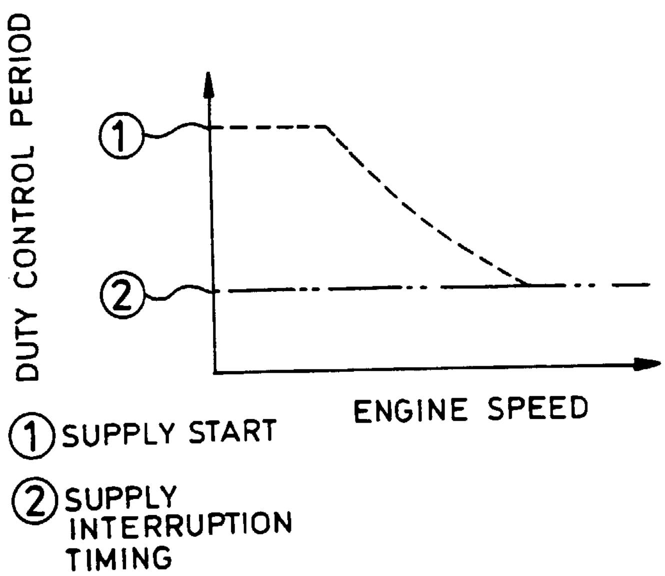
DUTY CONTROL PERIOD
1
2
ENGINE SPEED
1 SUPPLY START
2 SUPPLY INTERRUPTION TIMING

FIG.8

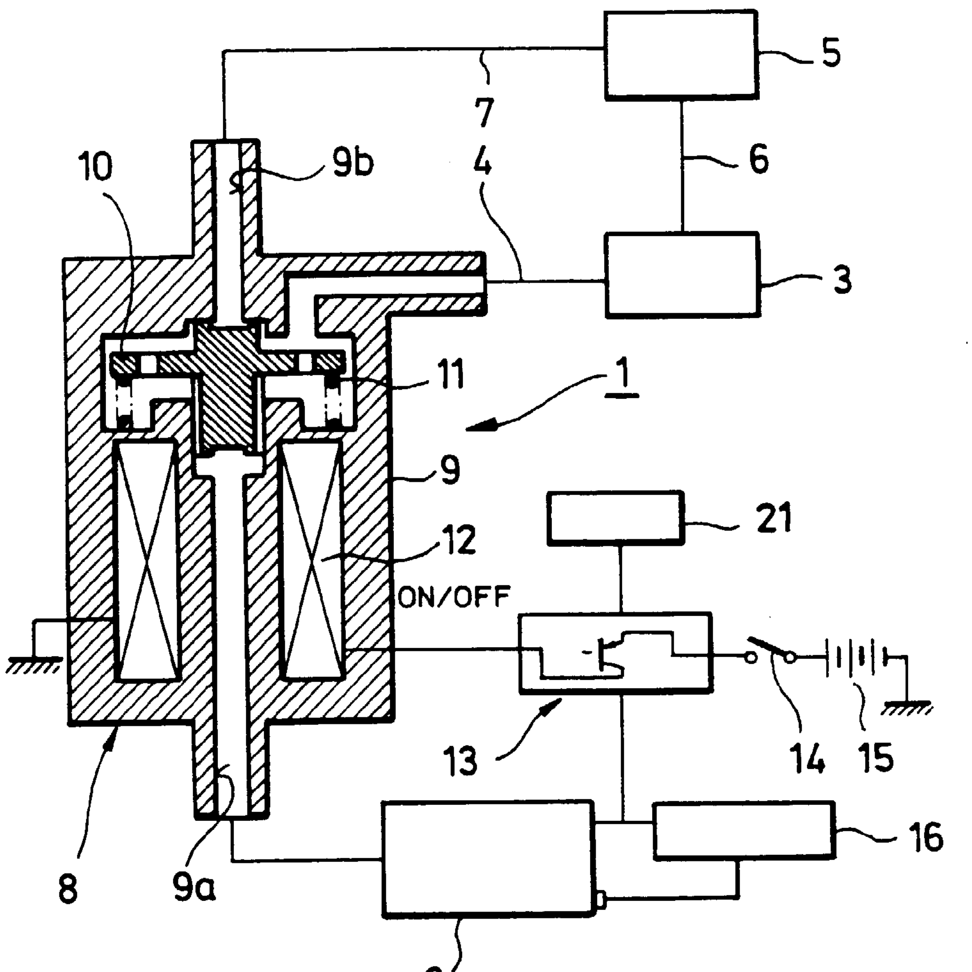
5
7
6
4
3
10
9b
11
1
9
21
12
ON/OFF
13
14
15
16
8
9a
2

FIG.9

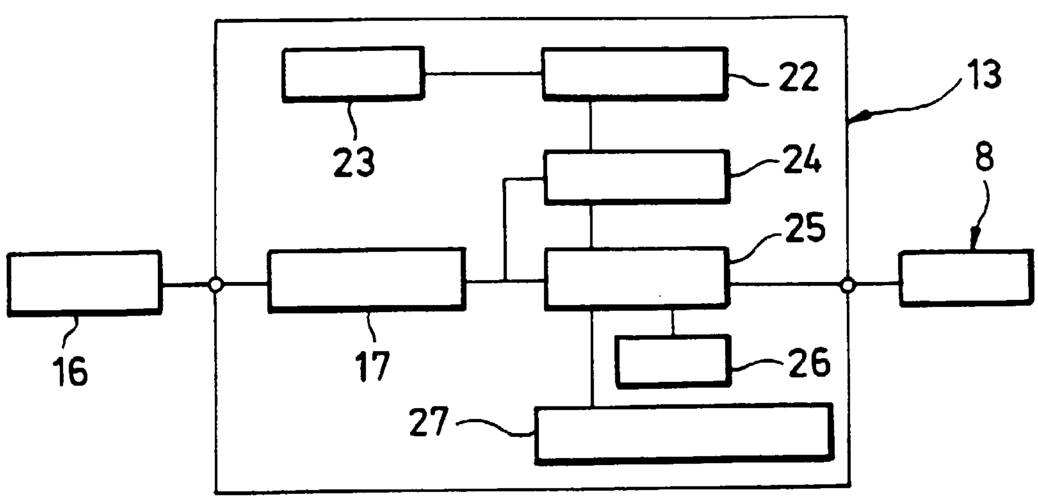
22
13
23
24
8
25
16
17
26
27

FIG.10

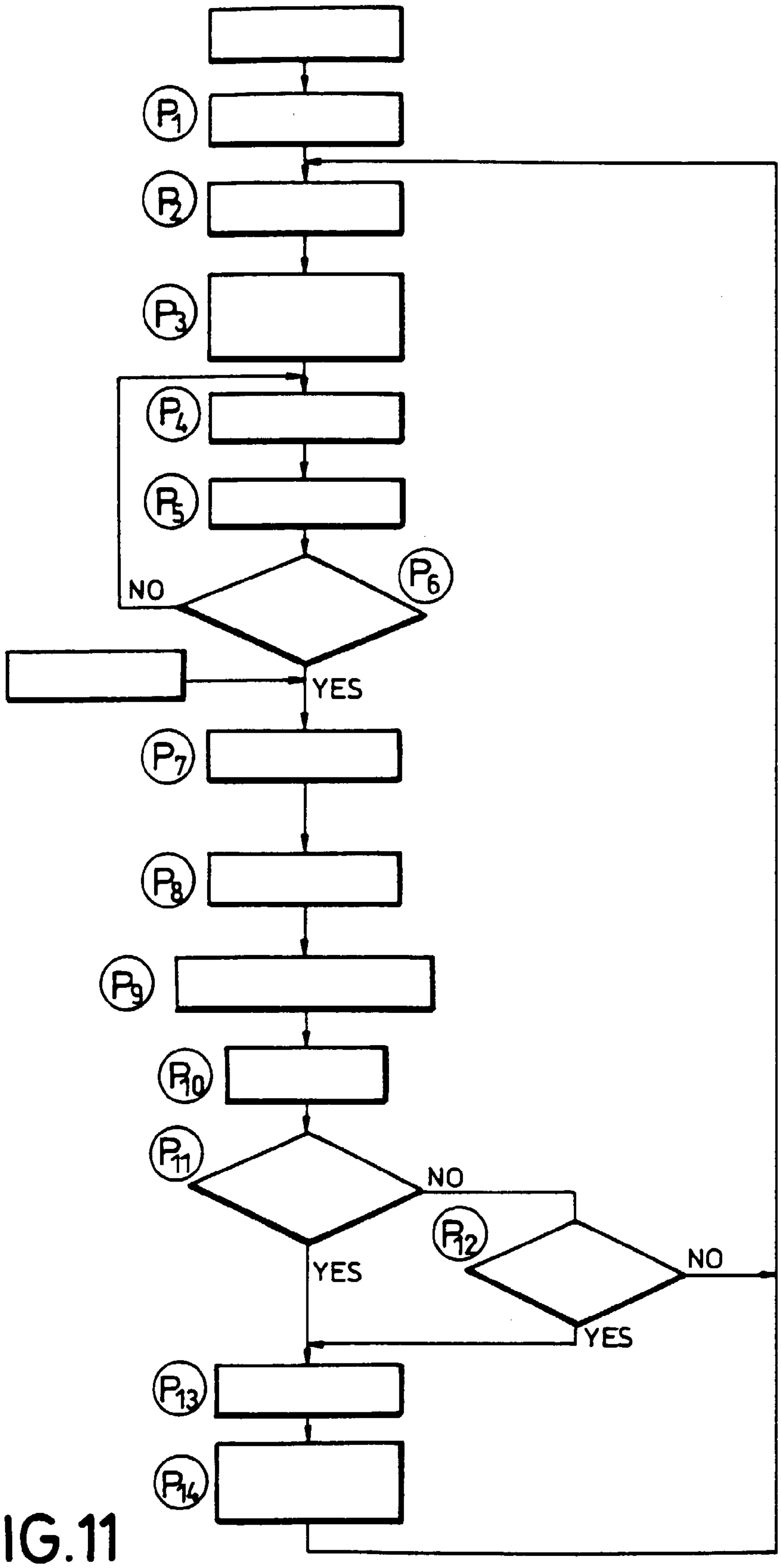

FIG.11

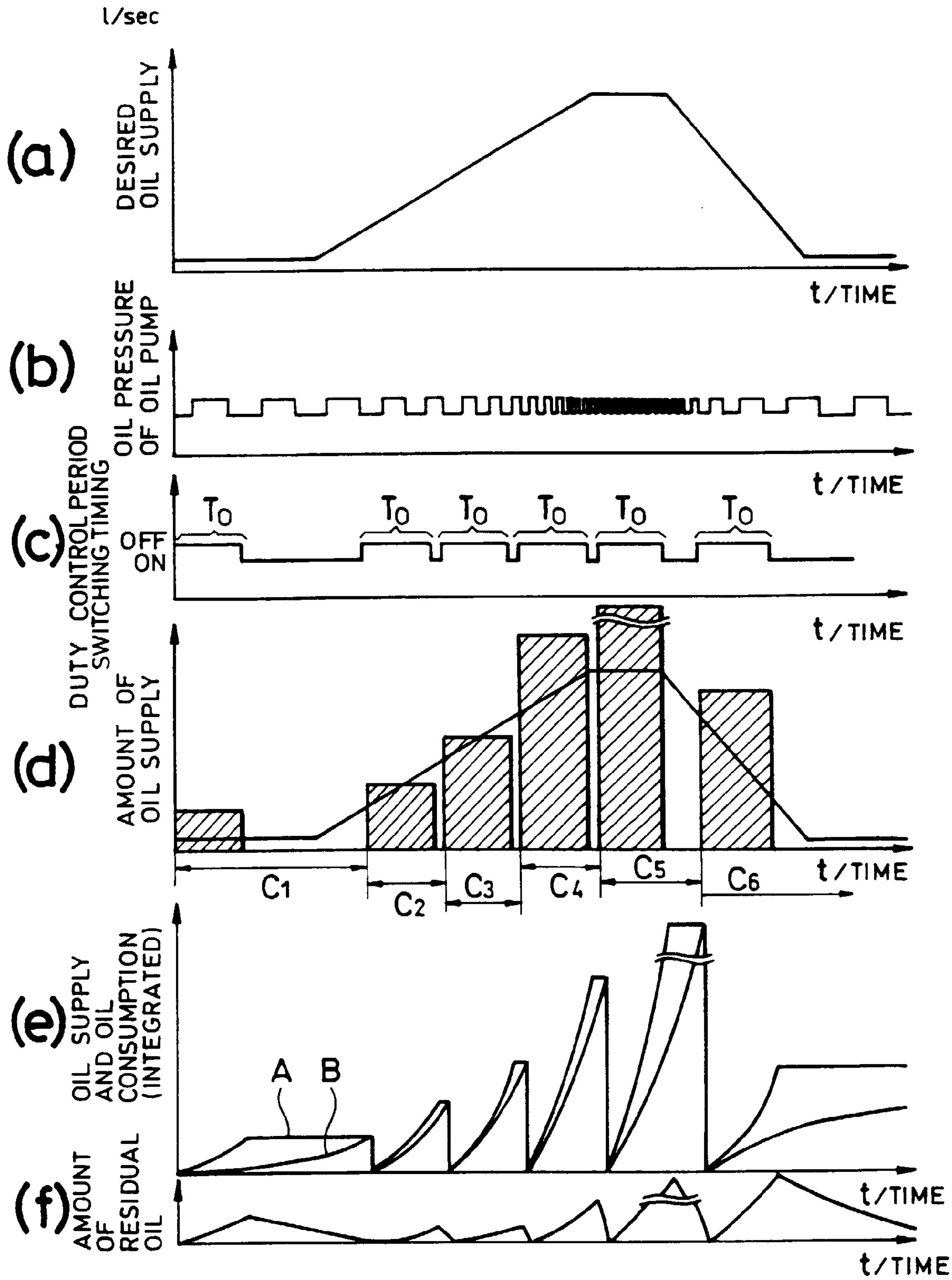
l/sec
(a)
DESIRED OIL SUPPLY
t/TIME
(b)
OIL PRESSURE OF OIL PUMP
t/TIME
(c)
DUTY CONTROL PERIOD SWITCHING TIMING
OFF
ON
T0
T0
T0
T0
T0
T0
t/TIME
(d)
AMOUNT OF OIL SUPPLY
C1
C2
C3
C4
C5
C6
t/TIME
(e)
OIL SUPPLY AND OIL CONSUMPTION (INTEGRATED)
A
B
t/TIME
(f)
AMOUNT OF RESIDUAL OIL
t/TIME

FIG.12

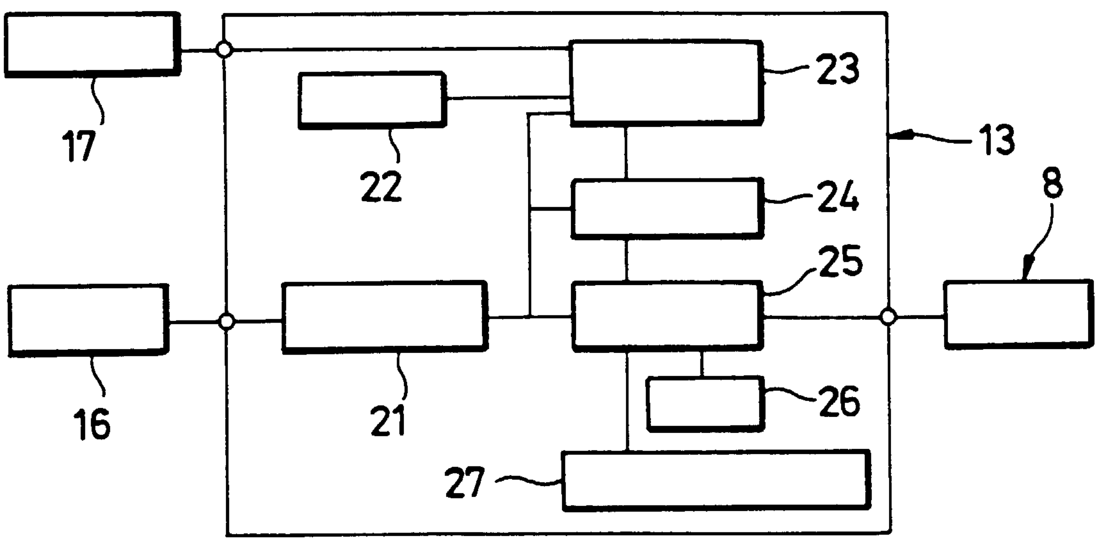

FIG.13

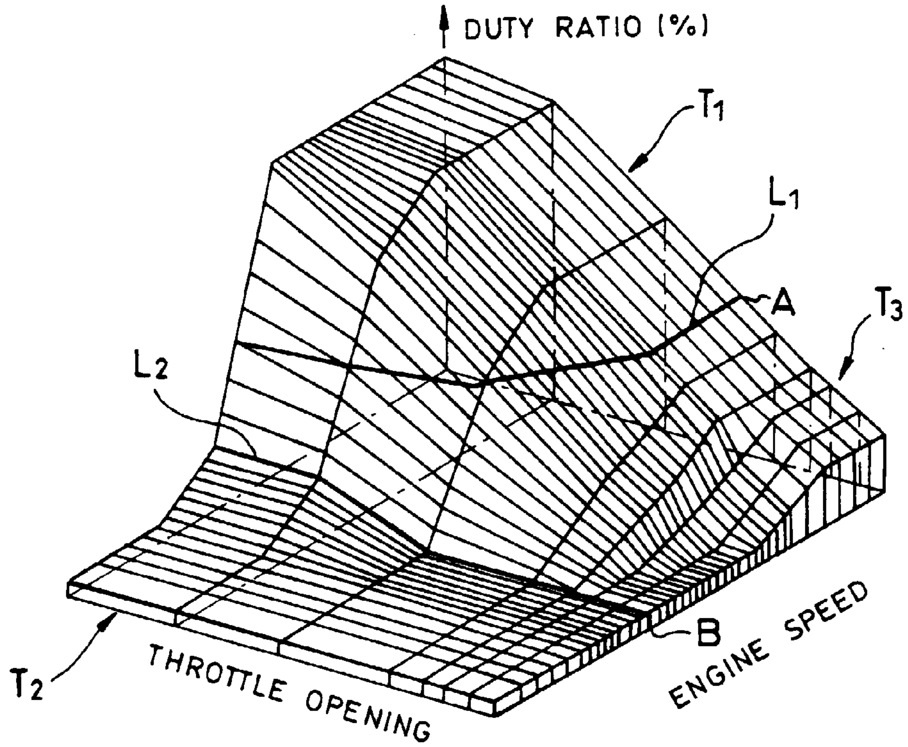
DUTY RATIO (%)
T1
L1
A
T3
L2
T2
THROTTLE OPENING
B
ENGINE SPEED

FIG.14

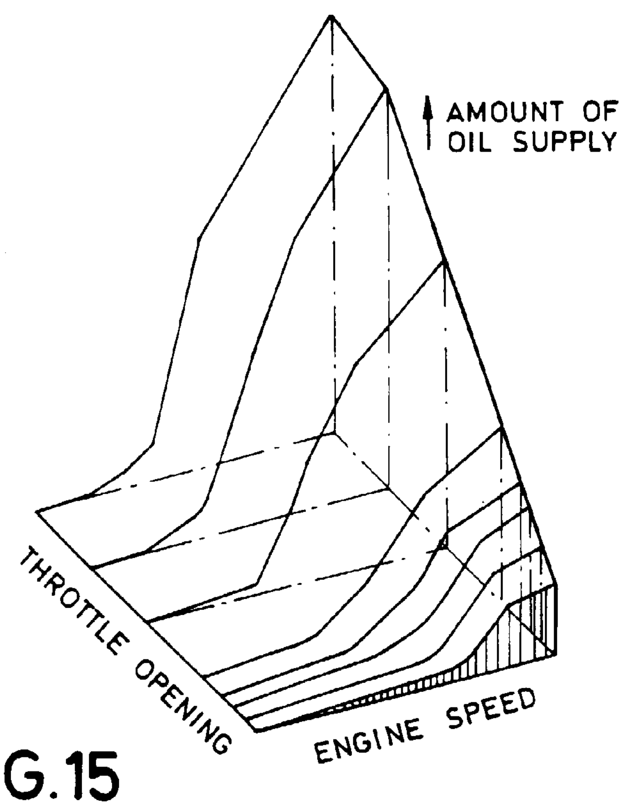
AMOUNT OF
OIL SUPPLY
THROTTLE OPENING
ENGINE SPEED

FIG.15

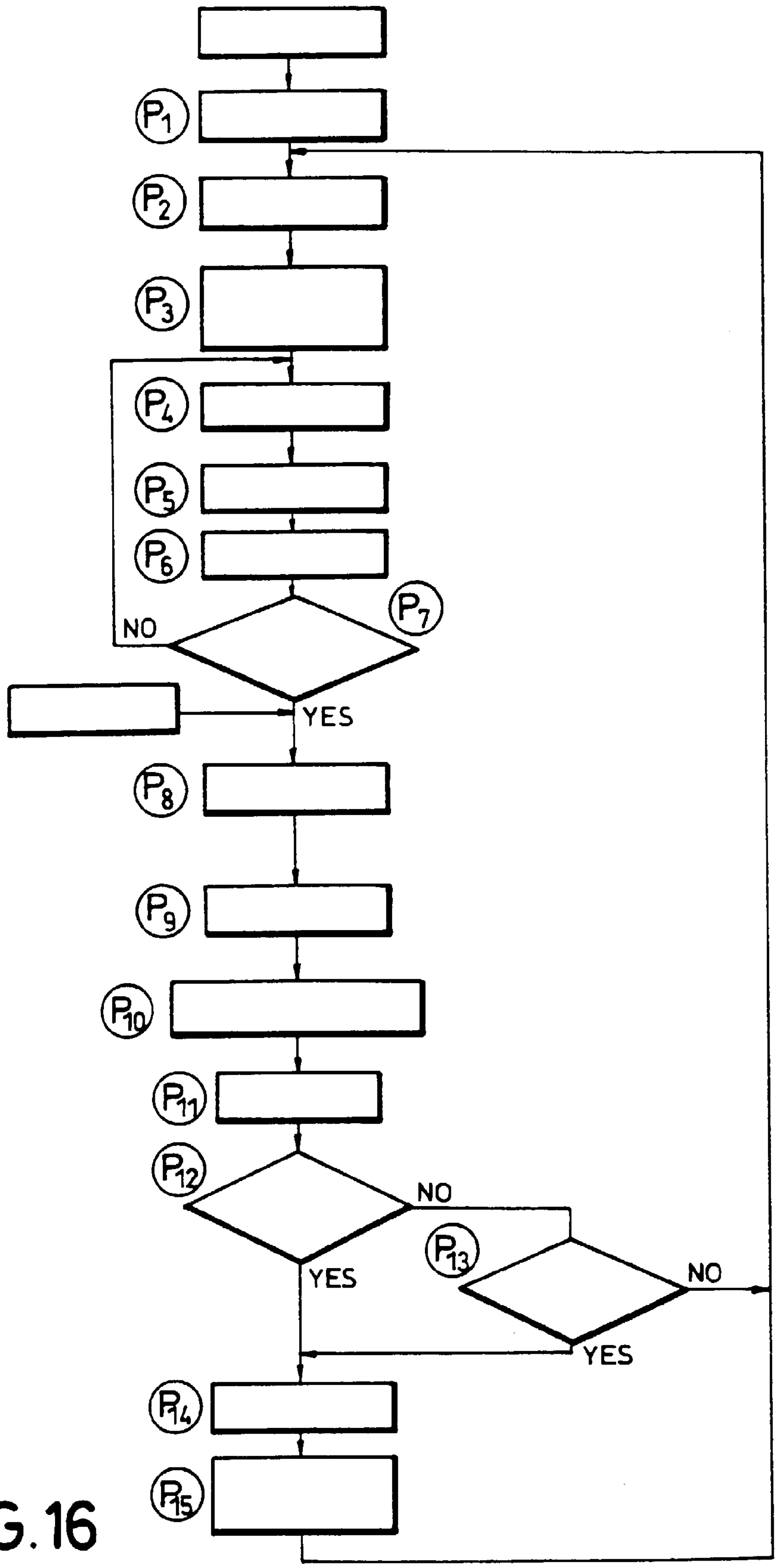
P1
P2
P3
P4
P5
P6
P7
NO
YES
P8
P9
P10
P11
P12
NO
YES
P13
NO
YES
P14
P15

FIG. 16

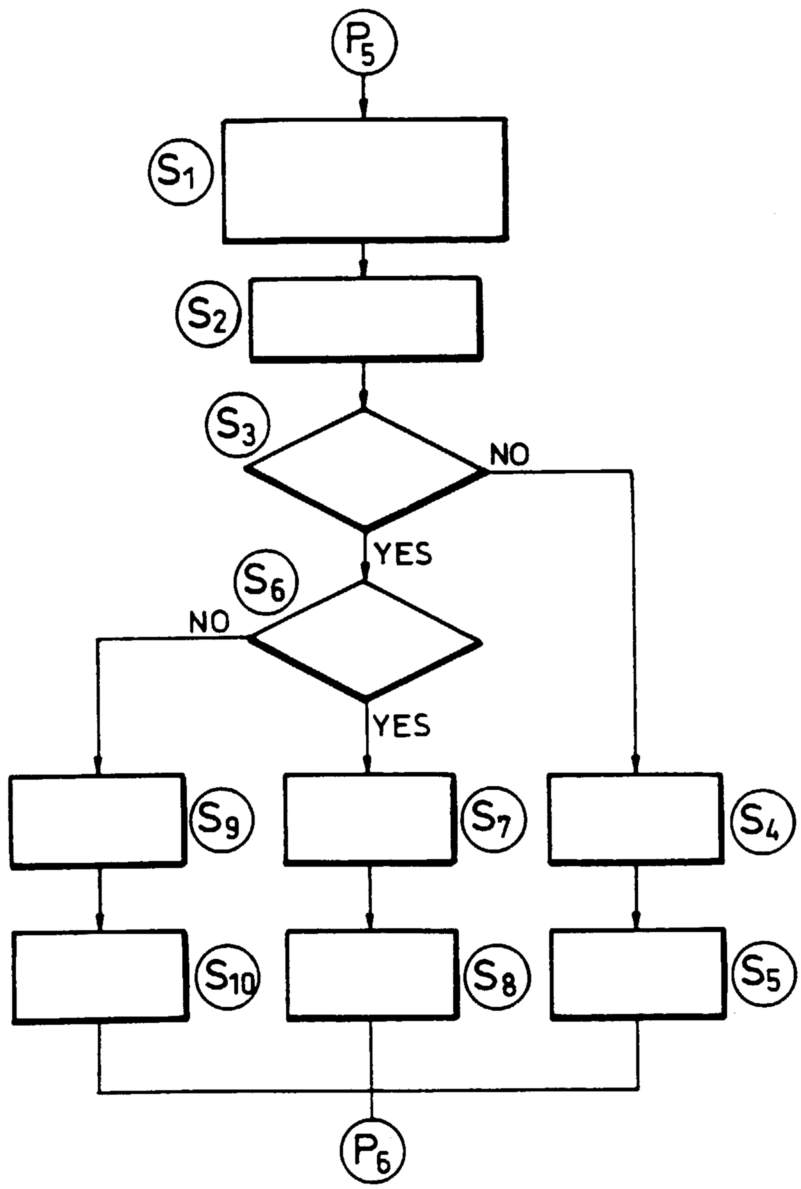

FIG.17

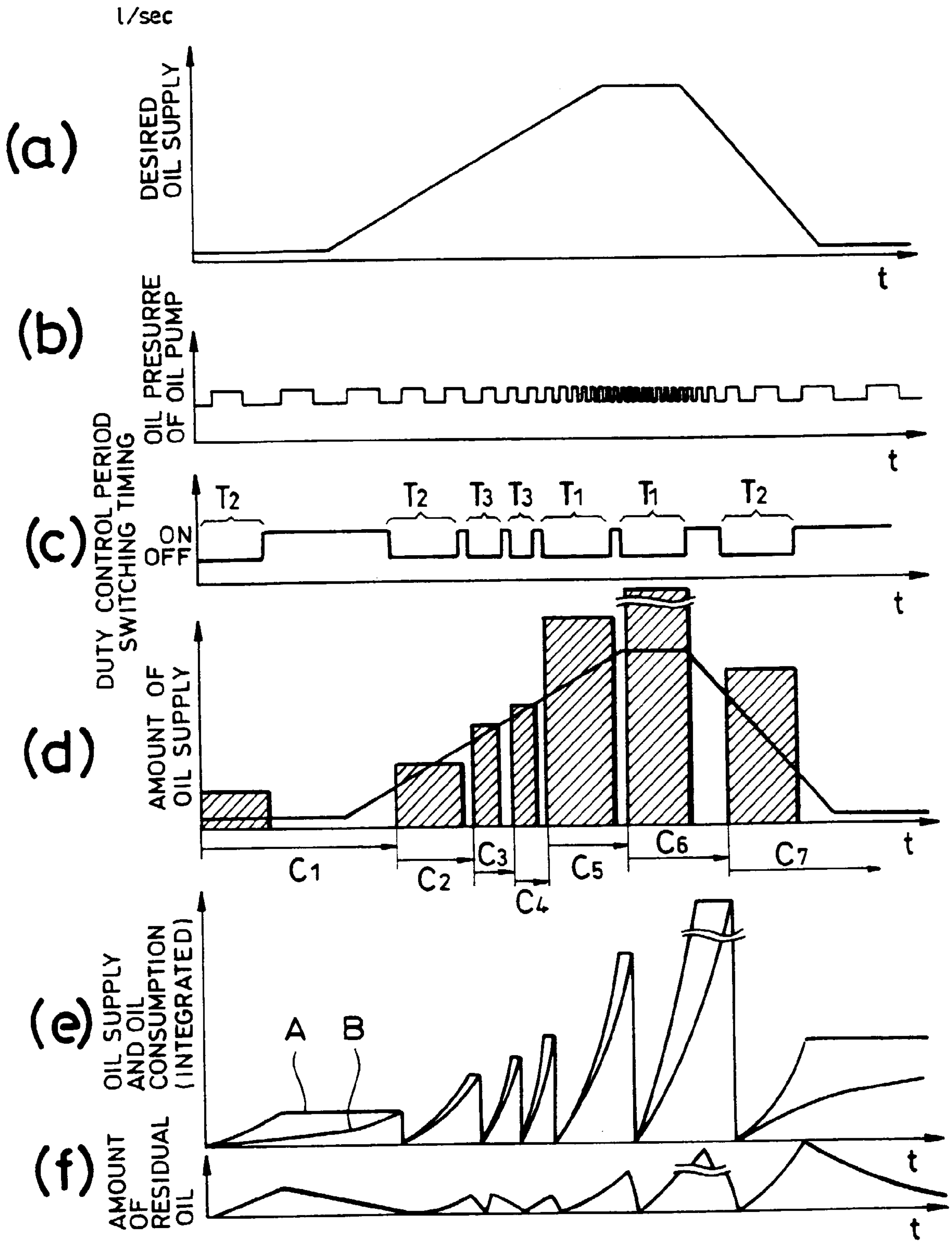
l/sec
(a)
DESIRED OIL SUPPLY
t
(b)
OIL PRESURRE OF OIL PUMP
t
(c)
DUTY CONTROL PERIOD SWITCHING TIMING
ON
OFF
T2
T2
T3
T3
T1
T1
T2
t
(d)
AMOUNT OF OIL SUPPLY
C1
C2
C3
C4
C5
C6
C7
t
(e)
OIL SUPPLY AND OIL CONSUMPTION (INTEGRATED)
A
B
t
(f)
AMOUNT OF RESIDUAL OIL
t

FIG.18

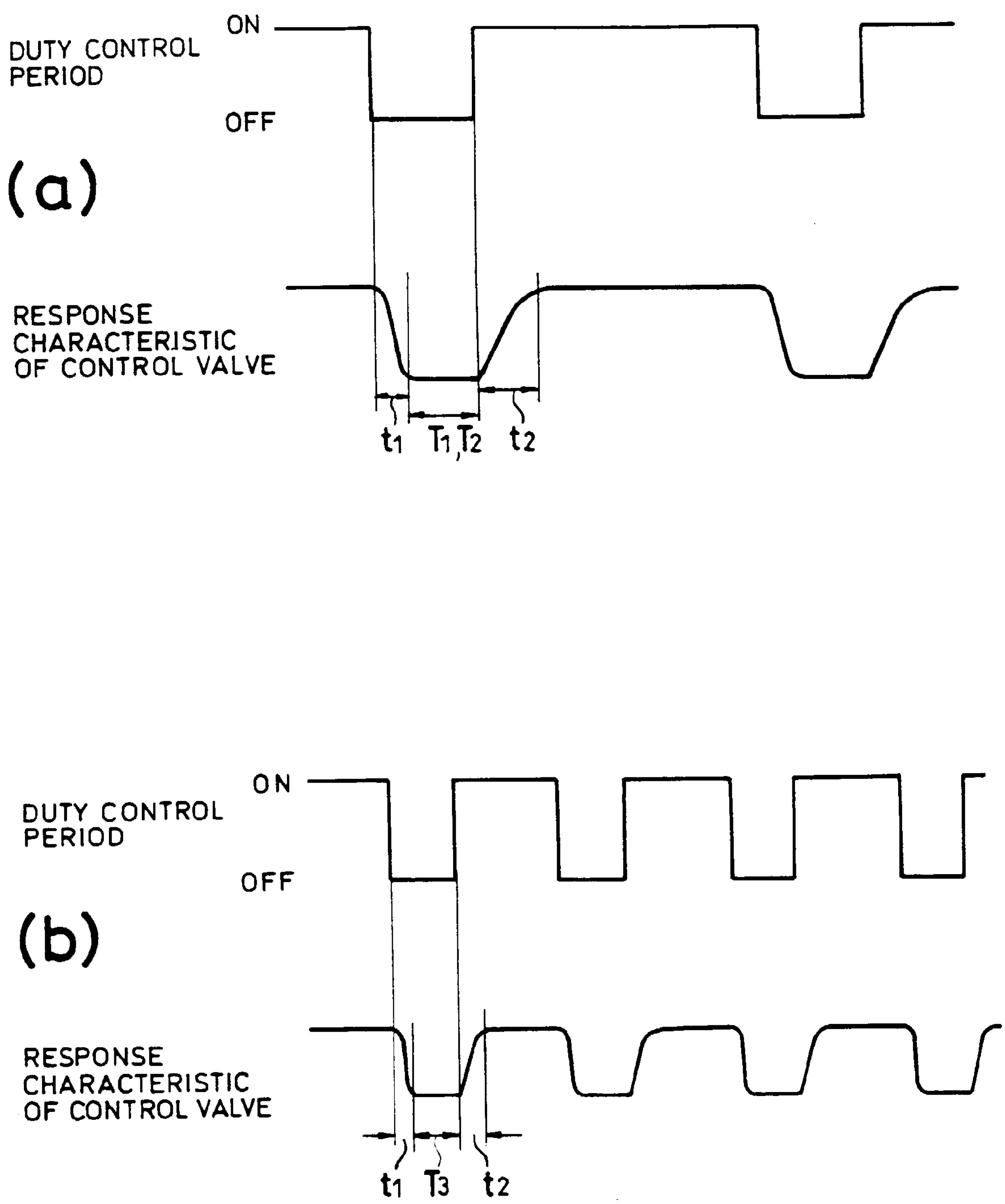
ON
DUTY CONTROL
PERIOD
OFF
(a)
RESPONSE
CHARACTERISTIC
OF CONTROL VALVE
t1
T1, T2
t2
ON
DUTY CONTROL
PERIOD
OFF
(b)
RESPONSE
CHARACTERISTIC
OF CONTROL VALVE
t1
T3
t2

FIG. 19

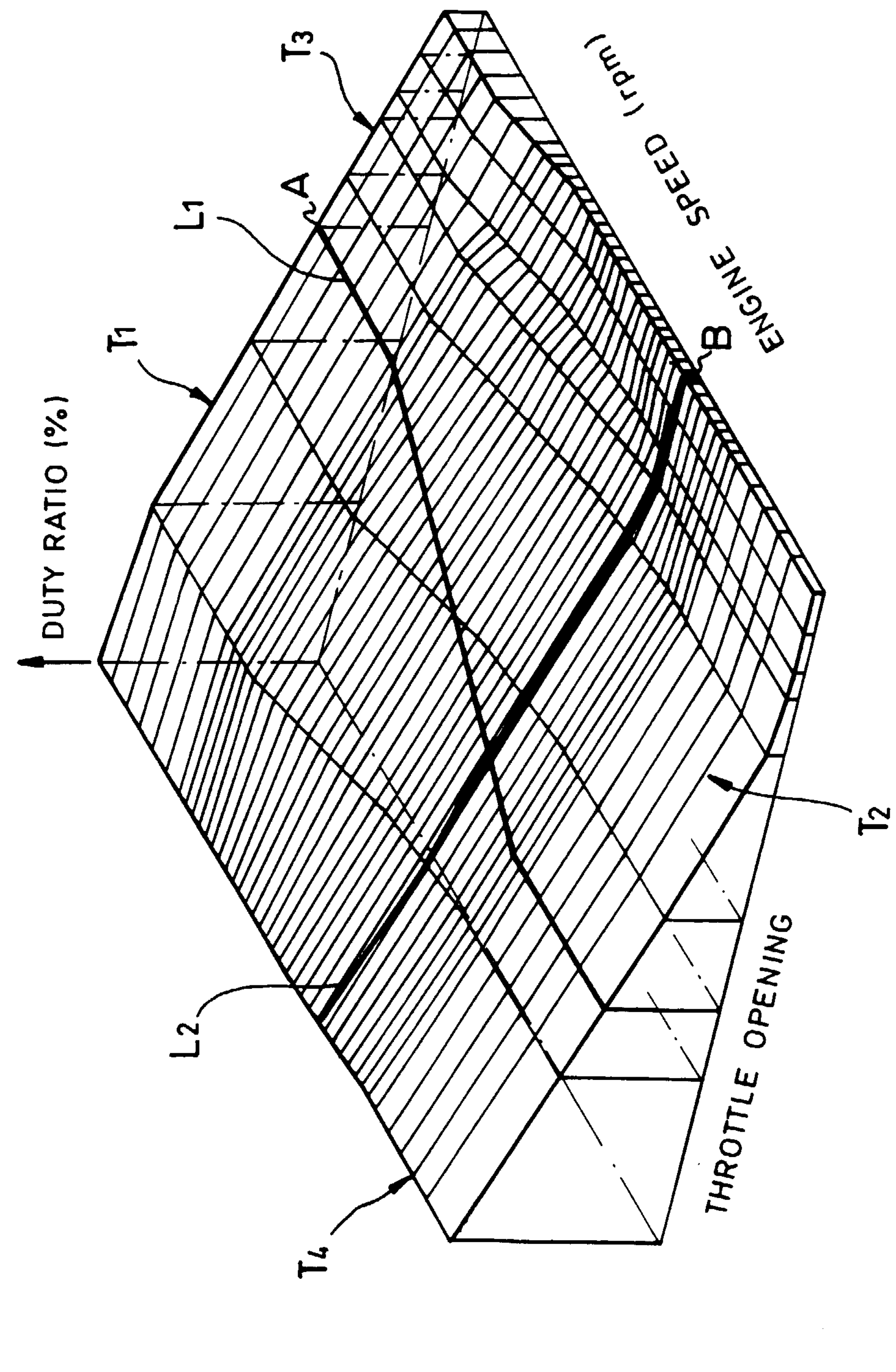
DUTY RATIO (%)
T1
T3
L1
A
B
ENGINE SPEED (rpm)
T2
THROTTLE OPENING
L2
T4

FIG. 20

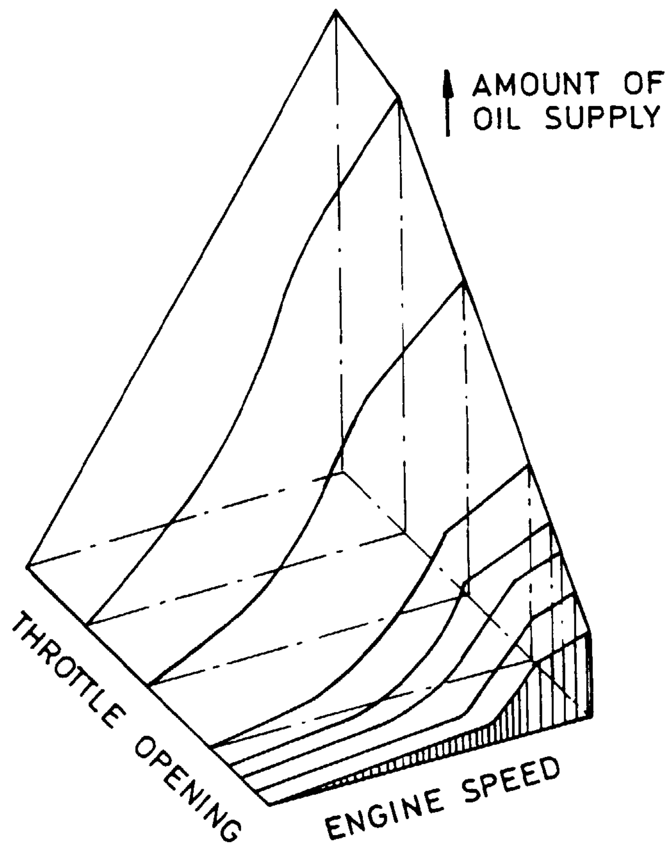

FIG. 21

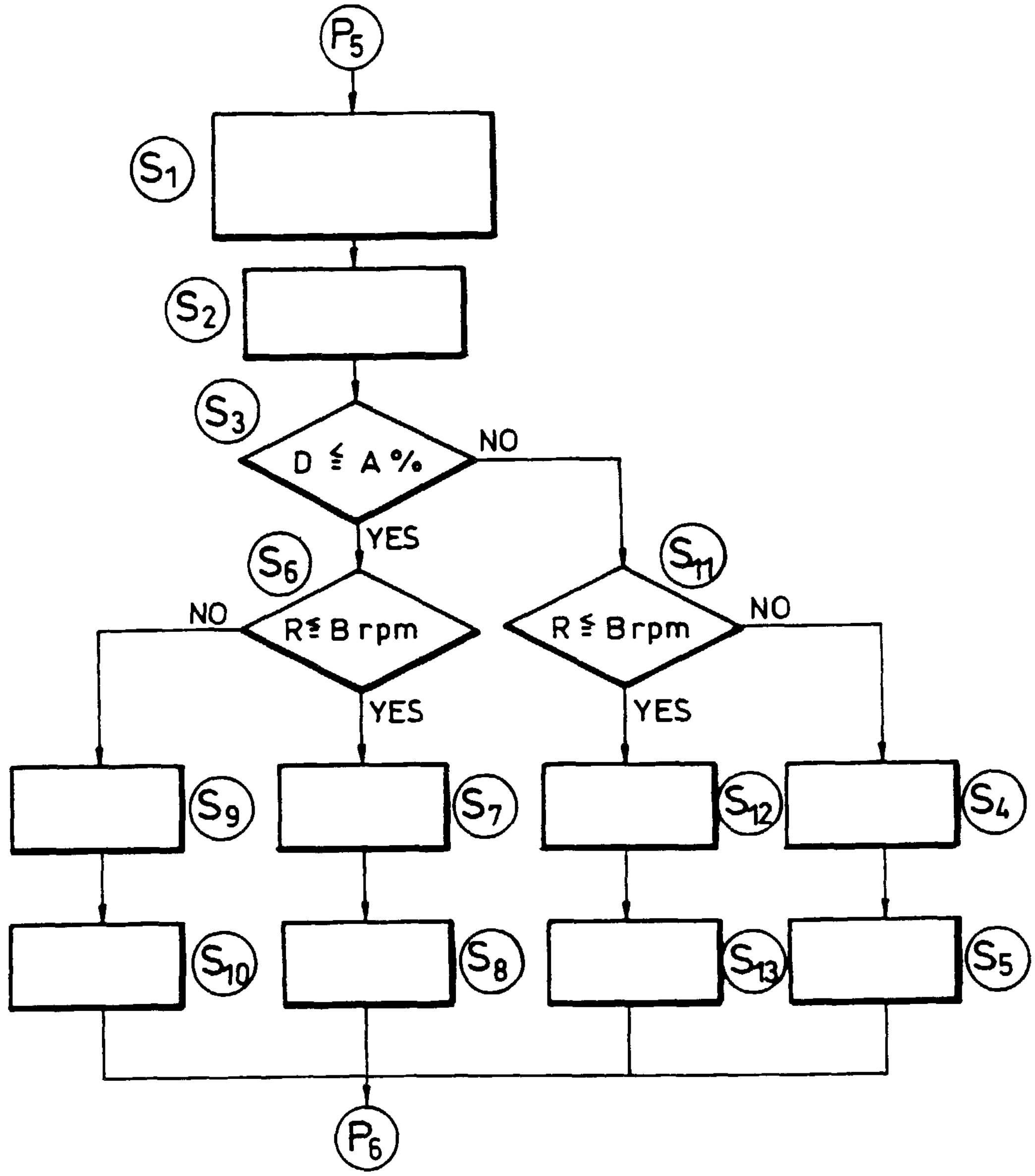
P5
S1
S2
S3
D ≦ A %
NO
YES
S6
S11
R ≦ B rpm
NO
YES
R ≦ B rpm
NO
YES
S9
S7
S12
S4
S10
S8
S13
S5
P6

FIG.22