

METHOD AND APPARATUS FOR LUBRICATING CYLINDER SURFACES IN LARGE DIESEL ENGINES

Field of the Invention

The present invention concerns a method for lubricating the cylinder faces in large diesel engines, particularly marine engines, including at least one lubricating apparatus with one or more reciprocating pumps connected with and each feeding more separate lubricating points disposed in the cylinder linings, a central electronic control of the stroke of the reciprocating pump is established and that the control includes activation of an actuator which is connected to an adjustable stop for the stroke of the piston.

Moreover the invention concerns a system for lubricating the cylinder faces in large diesel engines, particularly marine engines, including at least one lubricating apparatus with a number of reciprocating pumps which are connected with and each feeds more separate lubricating points disposed in the cylinder linings, an electronic control unit which is connected with a regulating means for the stroke adjusting device of the reciprocating pump, which regulating means is controlled electronically and wherein the regulating means includes an actuator which is connected to an adjustable stop for the stroke of the piston.

Background of the Invention

A lubricating system as mentioned by way of introduction has been described in WO 0235068 and WO02095196. In the disclosure thereof it is envisaged that controlling of the reciprocating pump for a separate lubrication point may occur centrally from a computer. Thus, the computer may control a number of reciprocating pumps, each of which functions as a dosing pump for one single lubrication point. However there is no disclosure that the control of one of the reciprocating pumps effects the regulation of more dosing pistons for delivering lubricating oil to the lubricating points.

The lubricating apparatuses are traditionally designed as pumping units which are mounted in close association with respective cylinders, and which are connected with a feeding reservoir for lubricating oil and with lubricating points in the form of oil injection nozzles at different points on the cylinder wall. Each pump unit includes a plurality of reciprocating pumps that feed various lubricating points with oil, and

which are driven by a common rotating control shaft with cams applied thereon. At the rotation of the shaft, the cams with pressing heads act on respective axially displacing pistons which are spring biased in direction towards the control shaft, so that the pistons at the rotation of the shaft will perform reciprocating movements for activating the pistons of the reciprocating pumps.

For many years, lubricating apparatuses have operated under the condition that the discharge pressure from the reciprocating pumps did not have to be very large. Hereby, it has been necessary to operate with injection or pump pressures of the magnitude 10 bar in connection with nozzles without atomisation.

In recent years it has been proposed to increase the efficiency of the lubrication by injecting the oil through pressurised atomising nozzles for achieving oil mist lubrication during the upwards movement of the piston. However, hereby the oil is applied a far higher pressure for ensuring fine atomisation through atomising nozzles, e.g. a pressure up to 100 bar or more.

It is a fixed standard that the oil is to be injected into the cylinder during the upwards return stroke of the engine piston, i.e. under the compression process, however before the subsequent power stroke by the ignited combustion.

Lubricating points will thus, as mentioned in the present application, include oil injecting nozzles and/or pressurised atomising nozzles.

In both systems, the control shaft is driven through a direct or indirect mechanical coupling with the crankshaft of the engine, whereby it is possible to provide power for the activation of pumps and at the same time to achieve synchronisation between the crankshaft of the engine and the control shaft of the lubricating apparatus.

A pump unit may e.g. include a box-shaped apparatus housing, from where connecting pipes extend to the lubricating points on the associated engine cylinder, e.g. in a number of 6-24.

The pistons are traditionally operated by means of activation cams/rocker arms on a through-going control shaft which is rotated synchronously with the crankshaft of the engine. The pistons are spring biased towards the activation cams. There is provided a set screw defining the extreme position of an associated activation cam. The set screws may be operated manually for determining individual operative strokes of the pistons and thereby the associated yield of the individual reciprocating pumps.

Furthermore, there is an increasing demand for a flexible and easy adjusting of the controlled feeding cylinder lubrication oil portion for the immediate demand of the engine depending on diverse measurable engine parameters. All these adjustments are preferably to be controlled centrally.

Since the cylinder lubricating oil is dosed with one portion per engine revolution, the only possibility of adjusting the dosage is to change the stroke of the pumps.

As system for this purpose is described e.g. in DK patent application 4998/85. This system is operated by a cam disk mechanism for adjusting the pump stroke in dependence on the engine load. Changing this dependence may only be effected by changing the cam disks with other cam disks with a different transfer function.

Furthermore, the well-known mechanical lubricator can only to some extent vary the stroke automatically and thus it is difficult to obtain any stroke and to have the stroke adjustment step less.

Another system is also known, which includes lubricating unit using a central actuating piston which is mounted in a bore acting as a hydraulic cylinder in a housing, and which is driven by lubricating oil fed to a hydraulic chamber in the hydraulic cylinder in which the actuating piston is disposed. The lubricating oil is supplied through a control valve that includes a valve sleeve which may connect the hydraulic chamber with a drain line leading lubricating oil back to storage tank/lubricating apparatus or a pressurised line connected with the pressure side of the storage tank. The hydraulic chamber is connected with a number of dosing cylinders containing dosing pistons for delivering lubricating oil to the lubricating points.

Each of the dosing pistons is actuated by the actuator piston for feeding a lubricating oil portion to the lubricating points. The oil portion is determined by the stroke which is adjusted by a manually adjustable stop determining the stroke of the actuator piston and thereby also individual operational strokes of the dosing pistons and thereby the associated yields of the individual dosing pumps.

A proposal for regulating has been presented in that the lubricating oil portion from a specific pump stroke and to a specific lubricating point is returned to the lubricating apparatus, as an electronic controlled redirecting of the lubricating oil portion between lubricating apparatus and the lubricating points is established. This system has appeared to function satisfactorily, but there may be systems where it is wanted to avoid bypass conducting the lubricating oil back to storage tank/lubricating apparatus.

In connection with traditional cylinder wall lubrication, it has hitherto been the practice to use simple spring-biased check valves that can resist the internal pressure in the cylinder, but which yield to a slightly higher external injection pressure. However, in connection with pressurised atomised injection, it is desirable and necessary that the valve system opens only at a much higher oil pressure in order that the oil injection can assume the character of a pressurised atomising injection right from the beginning. We are hereby speaking of a pressure differential factor of up to several hundreds percent.

Object of the Invention

It is the purpose of the present invention to indicate a system and a method whereby it is possible to establish the cylinder lubrication with an automatic stepless or stepwise control of the stroke of the pump piston from an algorithm, whereby it is possible to achieve a flexible central automatic control of the feeding to individual lubricating points without any need of bypassing lubricating oil and returning it to storage tank/lubricating apparatus. Especially it is desired to achieve that a number of dosing cylinders containing dosing pistons for delivering lubricating oil to the lubricating points are activated by the central control.

Description of the Invention

The control is electronic and may include control of a hydraulic system which is used for the adjustment which is performed centrally and automatically.

5 According to the present invention, this is achieved by a method of the kind mentioned in the introduction which is peculiar in that the lubricating oil portion from a given pump stroke to effect the regulation of one or more dosing pistons for delivering lubricating oil to more lubricating points is regulated, that said actuator has a position without regulation for maximum controlled feeding of oil and that the lubricating oil
10 portion is regulated according to customised regulating algorithms contained in an electronic control unit whereby said actuator steplessly or variably in steps may increase or reduce the controlled feeding of oil to a situation without any controlled feeding of oil.

15 The system according to the invention is peculiar in that the electronic control unit is arranged to effect the regulation of one or more dosing pistons for delivering lubricating oil to and that the regulating means has a position without regulation for maximum controlled feeding of oil and that the electronic control unit contains customised regulating algorithms for regulation the lubricating oil portion for
20 increasing or reducing the controlled feeding of lubricating oil steplessly or variably in steps to a situation without any controlled feeding of oil.

The regulating means may be an electronic unit, a pneumatic unit or a hydraulic unit which is controlled by an electronic control unit.

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When the method according to the invention involves that the control includes activation of an actuator which is connected to an adjustable stop for the stroke of the piston, and which has an initial position without regulation for maximum controlled feeding of oil and which steplessly or variably in steps may reduce the controlled
30 feeding of oil to a situation without any controlled feeding of oil, then a system is provided which is very simple and reliable. The actuator may be a rotatable or translational actuator. The actuator is thus capable of performing a downwards

regulation and an upwards regulation, depending on the direction of the rotation/translation.

5 With a method and a system according to the invention, it is possible to regulate the lubricating oil portion in a central and automatic way according to different regulating principles which are determined by an electronic control, where algorithms may regulate the lubricating oil portion discharged by the reciprocating pump. It is possible to control the supply to the lubricating points alternately and in arbitrary sequence in one cylinder and/or in different cylinders by suitable algorithms in the electronic
10 control unit. Hereby it becomes possible to perform reduction of the lubricating oil portion injected into the cylinder/cylinders. The regulation of the lubricating points may be effected individually or in groups.

15 As the electronic control is used for regulating a lubrication oil portion from the lubricating apparatus to one or more of the lubricating points in one or more of the cylinders, a relatively simple solution is provided. By this solution, a stepless adjusting of the stroke and thereby of the lubricating oil portion fed to each cylinder in a single pump stroke for the lubricating apparatus may be attained in an electronically controlled way.

20 It is thus possible in a pump stroke of the reciprocating pump in the lubricating apparatus to perform regulation of the oil portion to one or more lubricating points in all cylinders or part of the cylinders, and that by a subsequent pump stroke in the lubricating apparatus downward regulation of the oil portion to other lubricating
25 points in the cylinders is performed. Hence, cyclical regulation of the oil supply of the various lubricating points of the cylinder or cylinders may be performed in one cycle.

The system according to the invention may be used for traditional lubrication and for so-called SIP lubrication. Also, the system according to the invention may be used for
30 regulating the stroke of a reciprocating pump which is connected to one or more lubricating points, irrespectively whether such a reciprocating pump is feeding lubricating oil directly to the lubricating points or whether the reciprocating pump is acting via a number of associated dosing pumps. The advantage of the invention and

possibilities of saving lubricating oil will be equally attractive regardless of the lubrication principle.

5 With the system according to the invention it thus becomes possible to regulate the flow at a given number of lubricating points. The number of lubricating points with possibility of flow regulation depends on how flexible a user wants the regulation. With the system according to the invention, automatic shifting between lubricating points, where flow regulation is performed, is ensured.

10 A system according to the invention may either be integrated in the lubrication apparatus or be mounted as a separate unit which is associated with existing or new lubricating apparatuses. The system according to the invention is thus advantageous in that it may be retrofitted in existing installations, irrespectively whether these prior art lubricating apparatuses are constructed in one or the other of the above mentioned
15 ways.

The flow regulation is controlled by the electronic control so that the amount of lubricating oil to the individual lubricating points is regulated depending on actual need and load level. In principle, it may be said that the regulation is performed by a
20 stepless or stepwise adjusting of the stroke of the reciprocating pump, either up or down. This stepless or stepwise quantity adjustment is effected in a simple way by setting or adjusting the stroke of the reciprocating pumps. By setting to the stroke to 0 (zero), it is possible to skip a lubricating stroke.

25 According to the invention, a programming of the electronic control may be performed. As an illustrative example may be mentioned a lubricating apparatus which is intended for feeding ten lubricating points. A 10% reduction may thus be effected in that a lubricating point is skipped in each succeeding cycle. After 10 cycles, each of the lubricating points would have been skipped. Regardless of this skipping,
30 by using the system according to the invention, lubrication of every cylinder is performed in each cycle. This lubrication will, however, not necessarily occur at every lubrication point of the cylinder.

Standard programming may be programmed into the electronic control unit, or customer-engineered regulation options may be put into the control program. Regulation adapted to different customer and/or operational requirements may thus be performed in a simple way.

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According to a further embodiment, the method according to the invention is peculiar in that that the lubricating oil portion is alternately regulated between the various lubricating points in different cylinders which are lubricated by using one or more lubricating apparatuses. According to specific embodiments, it is possible to use the
10 flow regulation for controlling one or more lubricating apparatuses, and each of these lubricating apparatuses may be used for feeding a number of lubricating points in one or more cylinders. The invention is thus not limited to using one lubricating apparatus per cylinder and flow regulation only regulating a single lubricating apparatus.

15 The invention is particularly advantageous when running in very low engine load ranges as, compared with engine lubrication without applying the invention, a saving of the amount of lubricating oil will be attained in relation to a traditional cylinder lubrication only based on the engine speed.

20 According to a further embodiment, the method according to the invention is peculiar in that changing the stroke of the reciprocating pump is performed at a time between lubricating strokes of the lubricating apparatus, and is preferably initiated by an index signal for completed controlled feeding of lubricating oil from the lubricating apparatus. Hereby is achieved a very simple construction. By using an index signal for
25 completed feeding of lubricating oil, it will only be required to perform adjustment of the stroke between succeeding lubricating strokes. For example, at 100 revolutions per minute there may be 600 milliseconds between the lubricating strokes. This will be ample time for adjusting the stroke, even when subtracting the time used for activating the stroke adjusting device of the reciprocating pump.

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Regulation may thus be effected independently of engine revolutions, e.g. based on the index signal from the lubricating apparatus. For controlling flow regulation, different
parameters may thus be used, e.g. actual engine load, signals from lubricating

apparatus, pressure conditions, load conditions, customer-specific parameters, e.g. results of analyses of scrape-down, or other parameters. The flow regulation may thus be controlled according to regulating principles, e.g. engine speed (RPM), mean effective pressure (MEP), or engine power (BHP).

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According to a further embodiment, the method and system according to the invention are peculiar in that a pump stroke is used for feeding –up to 6 or more lubricating points in a cylinder lining. The system may thus be used for regulating the stroke of a reciprocating pump which is connected to more lubricating points, irrespectively
 10 whether such a reciprocating pump is feeding lubricating oil directly to the lubricating points or whether the reciprocating pump is acting via a series of associated dosing pumps.

15 A system according to the present invention may, as mentioned, be used in connection with various traditional lubricating principles. It may thus be used in connection with traditional lubricating apparatuses or in connection with pressure atomiser nozzles.

Description of the drawing

The invention will then be explained in more detail with reference to the accompanying drawing, where

- 20 Fig. 1 shows a schematic drawing of an embodiment of a system according to the invention;
- Fig. 2 shows a sectional view of an embodiment of a conventionally designed lubricating apparatus modified to form a part of a system according to the invention;
- 25 Fig. 3 shows a longitudinal section of the lubricating apparatus shown in Fig. 2;
- Fig. 4 shows a schematic drawing of a second embodiment of a system according to the invention;
- Fig. 5 shows a longitudinal section through an embodiment of a cylinder lubricating unit which may form part of a system according to the invention; and
- 30 Fig. 6 shows a sectional view through a basic embodiment of a further embodiment of a system according to the invention.
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Detailed Description of the Invention

In the Figures of the drawing, identical or corresponding elements will be provided the same designations. No detailed explanation of such details will thus be given in connection with each Figure.

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Fig. 1 shows an installation or system for lubricating cylinder faces 1 in cylinders 2 in large diesel engines. The shown installation includes two lubricating apparatuses 3 that each has a number of piston pumps indicated by 4. Via connecting lines 5 (of which only one is illustrated for each lubricating apparatus), each of the piston pumps are connected with a lubricating point 6 disposed in the cylinder wall 7 for lubricating the cylinder surface 1 of the cylinder wall. The installation furthermore includes a flow regulating means in the shape of a flow regulator 8 which will be explained in more detail with reference to Figs. 2 and 3.

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Furthermore, the installation includes an electronic control unit 9 which is connected with the flow regulators 8 and the lubricating apparatuses 3. As indicated by 10, the control unit can receive an index signal from the lubricating apparatuses 3.

The lubricating apparatus 3 shown in Figs. 2 and 3 has a box-shaped apparatus housing 11 which on a front wall 12 carries a row of reciprocating pump units 13, of which only one is shown in Fig. 2. The unit has a valve housing 14 with a lower inlet for lubricating oil, an intermediate section for accommodating a piston 15 projecting into the housing 11, and an upper outlet for the reciprocating pump 4 thus formed. Via a flow indicator 16, the outlet is connected to an upper connecting stub 17, and from the entire row of these stubs connecting pipes extend to the lubricating points on the associated engine cylinder, e.g. in a number of 6 – 24.

The pistons 15 are actuated for pressing in by means of actuation cams 18 on a through-going control shaft 19 which is rotated synchronously with the crankshaft of the engine, and which is seated in bearing cases 20. The pistons are not actuated directly, but via thrust pads 21 on respective rocker arms 22 which are pivoting about a fixed journal 23 with eccentric end-journals 24 and have upward extensions 25 that interact at the top with respective set screws 26 projecting inwards from the front wall.

The pistons 15 are spring-loaded in direction inwards against the thrust pads 21 which they will thus keep pressed inwards until respective upper arm ends abut on the set screws 26. Hereby, for each pump unit the initial position will be determined from which each of the thrust pads 21 will be pressed outwards at the passage of the
 5 associated actuating tappet 18.

In operation, in the shown situation there will be a certain distance between the arm part 25 and the set screw 26, so that the thrust pad 21 during the tappet passage will be pressed outwards for operating the piston 15 and will go back to the said initial
 10 position after this passage under the action of the spring force of the piston. The set screws can hereby be operated for determining individual operational strokes of the pistons and thereby the associated yields of the individual pump units.

The set screw 26 is connected with the flow regulator 8 containing an electronically
 15 controlled regulating means in the form of a step motor or similar regulating means, which can be utilised for rotating the set screw 26 for regulating the stroke of the reciprocating pump 4. For each of the reciprocating pumps 4, thus there is associated a regulating means, of which only one is illustrated by 27, but the flow regulator 8 will contain a number of regulating means 27 at most corresponding to the number of
 20 reciprocating pumps 4. Via a connection 28, each regulating means 27 is connected with the electronic control unit 9. As a result of signals from the electronic control unit 9, the electronically controlled regulating means may thus be used for setting the stroke of the associated reciprocating pump 4. This may occur steplessly variably and regardless of the setting of the remaining reciprocating pumps.

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In Figs. 4 and 5 is seen a system of the type which in principle is known from the description of DK patent 173 512.

Fig. 4 shows a cylinder lubricating system where two cylinders 2 are shown. Each of
 30 the cylinders 2 are provided with four lubricating points 6 provided with injection units 6'. Each of the lubricating units 6' are connected via connecting lines 29 with a central lubricating unit 30 which is connected with a control valve 31. Via the line 32, the control valve 31 is connected with an electronic control unit 9. Furthermore, there

is illustrated a pressure control unit 33 which also via lines 34, 35 is connected with the control unit 9, and which via lubricating oil supply lines 36, 37 are connected with the cylinder lubricating units 30.

5 The cylinder lubricating units 30 are shown more clearly in Fig. 5.

The cross-section in Fig. 5 shows that a central cylinder lubricating unit 30 is provided with a supply gate 38 for lubricating oil and a discharge gate 39 for lubricating oil. The control valve 31 is connected with a valve 40 regulating oil supply and discharge. The
 10 cylinder lubricating unit 30 comprises an actuator piston 41 provided with flanges 42. Each of the flanges 42 engage dosing pistons 43 feeding lubricating oil via gates 44 and via the connecting lines 29 to the lubricating points 6, as shown on Fig. 4.

The unit 30 has an adjustable stop element 45 determining the travel of the actuator
 15 piston 41. The stop element 45 determines the stroke of the actuator piston 41 and thereby also the dosing pistons 43 that act as dosing pumps.

A compression spring 46 pre-loads the actuator piston 41 in direction of the starting position. The adjustable stop element 45 is screwed into a thread 47 in the end part 48
 20 of the unit. Screwing in the adjustable stop element 45 will thus limit the stroke of the actuator piston 41 and thereby the portion of lubricating oil discharged from the dosing pistons 43. The adjustable stop element 45 thus functions as adjusting device for the stroke of the reciprocating pump. The adjustable stop element 45 is connected with an electronically controlled regulating means 49 which in principle is constructed
 25 as the above mentioned regulating means 27. Via wires 50, the regulating means 49 is connected with the central electronic control unit 9. Electronic control of the stroke of the reciprocating pump will thus be possible so that in a flexible way it is possible to achieve a central and stepless control of the dosing to be performed at the individual lubricating points 6.

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As there may be achieved a stepless/stepwise central control of the dosing, it will be possible to adapt the amount of lubricating oil to lubricating oil portion desired

discharged by a single pump stroke, and thus there will be no need for return flow to storage tank or lubricating apparatus.

5 The cross-section in Fig. 6 shows that a central cylinder lubricating unit 51 is provided with a supply gate 38 for lubricating oil and a discharge gate 39 for lubricating oil. The cylinder lubricating unit 51 includes an actuator piston 52 having a set screw 53 which engages a rotatable flow regulator 8. When activating the flow regulator 8, the actuator piston 52 will be displaced to the right or to the left, and thereby an end plate 54 will influence the position of dosing pistons 55 in cylinder borings 56. Springs 57 keep the dosing pistons 55 to the left and define within the cylinder borings 56 a volume 58
10 which determines the lubrication oil portion wanted to be delivered to injection units 59 at the lubrication points 6.

The flow regulator 8 is connected with the central electronic control unit 9. Electronic
15 control of the stroke of the dosing pistons 55 will thus be possible so that in a flexible way it is possible to achieve a central and stepless control of the dosing (the volume 58) to be performed at the individual lubricating points 6.

The above embodiments are just non-limiting examples of the invention. The
20 invention is thus not limited to the shown embodiments but is only limited by the subsequent patent claims.

Claims

1. A method for lubricating the cylinder faces in large diesel engines, including at least one lubricating apparatus with reciprocating pumps connected with and each feeding separate lubricating points disposed in the cylinder linings, wherein the lubricating oil portion from a given pump stroke is regulated, as a central electronic control of the stroke of the reciprocating pump is established, wherein each of the reciprocating pump comprises a single actuator piston acting on a number of associated dosing pistons which are respectively connected with and feeds said lubricating points, whereby the lubricating oil is fed to the lubricating points as a group which are connected to the dosing pistons driven by the single actuator piston, and wherein the control includes activation of an actuator which is connected to an adjustable stop for the stroke of the actuator piston characterised in that said actuator has a position for maximum feeding of the lubricating oil and a position for zero feeding of the lubricating oil so that the feeding of the lubricating oil is steplessly or variably in steps increased or reduced between the maximum feeding and the zero feeding, and so that the lubricating oil fed to the respective groups of lubricating points to be lubricated in the respective cylinders is controlled alternately by an algorithm contained in the central electronic control whereby a lubricating stroke in a succeeding cycle can be skipped.
 2. Method according to claim 1, characterised in that the controlled feeding of oil from the lubricating apparatus is adjusted so that lubrication without regulating of any lubricating oil portion causes that no under-lubrication occurs by the lubrication of the cylinders.
 3. Method according to claim 1 or 2, characterized in that change of the stroke of the reciprocating pump is performed at a time between lubricating strokes of the lubricating apparatus, and is preferably initiated by an index signal for completed controlled feeding of lubricating oil from the lubricating apparatus.
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4. Method according to any preceding claim, characterised in that a pump stroke is used for feeding –up to 6 or more lubricating points in a cylinder lining.

5. A system for lubricating the cylinder faces in large diesel engines, including at least one lubricating apparatus with reciprocating pumps connected with and each feeding separate lubricating points disposed in the cylinder linings, wherein each of the reciprocating pumps comprises a single actuator piston acting on a number of associated dosing pistons each of which is connected with and feeding said lubricating points disposed, whereby the lubricating oil is fed to the lubricating points as a group which are connected to the dosing pistons driven by the single actuator piston, an electronic control unit which is arranged to effect the regulation of dosing pistons for delivering lubricating oil and which is connected with a regulating means for the stroke adjusting device of the reciprocating pump, which regulating means is controlled electronically and wherein the regulating means includes an actuator which is connected to an adjustable stop for the stroke of the piston, characterised in that said actuator has a position for maximum feeding of the lubricating oil and a position for zero feeding of the lubricating oil so that the feeding of the lubricating oil is steplessly or variably in steps increased or reduced between the maximum feeding and the zero feeding, and so that the lubricating oil fed to the respective groups of lubricating points to be lubricated in the respective cylinders is controlled alternately by an algorithm contained in the electronic control unit whereby a lubricating stroke in a succeeding cycle can be skipped.

6. System according to claim 5, characterised in that each reciprocating pump is connected with -up to 6 or more lubricating points in a cylinder wall.
