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(54) **Cylinder lubricating apparatus**

(57) A cylinder lubricating apparatus (20A - 20E) comprises injectors (12a - 12n) mounted on a cylinder (11a - 11n) of an engine and injects lubrication oil into the inside of the cylinder, and a pump (14) forcibly feeding the oil to the injectors, and is characterized by further comprising an oil storage means (15) storing the pressurized oil from the pump, branched feeding means (16a - 16n) branched from the storage means and connected with the injectors, a normally-closed type remote control valve (17a - 17n) provided in each of the branched oil feeding means, and a control means (19) remotely controlling a valve open timing and valve open holding time of each valves.

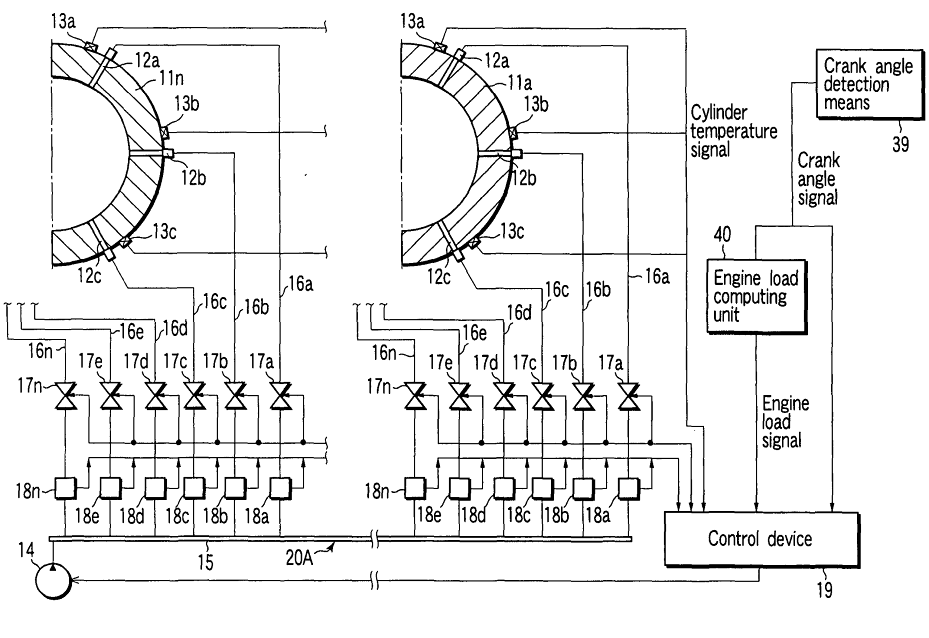

FIG. 1

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Description

[0001] The present invention relates to a cylinder lubricating apparatus, which forcibly injects lubrication oil into the inside of a cylinder of an internal combustion engine.

[0002] Such cylinder lubricating apparatuses as described above are now used in for example large diesel engines, particularly those for ships.

[0003] An example of the cylinder lubricating apparatus is disclosed in the microfilm (pages 1 - 3, FIGS. 1 and 2) of Japanese Utility Model Application No. 56-71004 (Japanese Utility Model Application KOKAI Publication No. 59-175619). In the conventional cylinder lubricating apparatus disclosed in this document, a cam shaft is rotated by the power from a crank shaft of an internal combustion engine, a cam of the cum shaft presses one end of a rocker arm so that the rocker arm is moved rotationally in one direction, the one end of the rotationally moved rocker arm presses a plunger of a plunger pump against the urging force of a spring, the plunger forcibly feeds lubrication oil to an injector with a check valve, and the injector injects the lubrication oil into the inside of a cylinder of the internal combustion engine. Then, the plunger together with the rocker arm is returned to its original position by the urging force of the spring. The rocker arm and the plunger are held at their original positions against the urging force of the spring by a contact of the other end of the rocker arm with an oil injection amount adjusting screw at the original position. In this conventional apparatus, the rocking range of the rocker arm can be adjusted by adjusting a moving amount of the oil injection amount adjusting screw, and, as a result of this adjustment, the amount of the injected oil controlled by a reciprocating distance of the plunger per one operation of the injector can be adjusted.

[0004] The conventional cylinder lubricating apparatus, described in the above document is provided one for one cylinder of the large diesel engine. Therefore, a large diesel engine having a plurality of cylinders have the same number of the above-mentioned conventional cylinder lubricating apparatuses as the number of the cylinders.

[0005] FIG. 11 shows a schematic configuration of a conventional large diesel engine 1 having a plurality of conventional cylinder lubricating apparatuses 3 described in the above-mentioned document.

[0006] As shown in FIG. 11, the conventional large diesel engine 1 having a plurality of cylinders 2 comprises the same number of above-mentioned conventional cylinder lubricating apparatuses 3 as the number of cylinders 2. The plural cylinders 2 of the large diesel engine 1 are arranged linearly, and the plural cylinder lubricating apparatuses 3 are also arranged linearly and in parallel to the plural cylinders 2. Cam shafts 4 of the cylinder lubricating apparatuses 3 are aligned each another. The cam shafts 4 are connected by shaft couplings 6, and a part of the rotating force of a not-shown crank shaft of the large diesel engine 1 is transmitted from a not-shown exhaust valve drive cam shaft to the free end of the cam shaft 4 of the cylinder lubricating apparatus 3 located at one end of the linearly arranged cylinder lubricating apparatuses 3, through a well known power transmission means 7 like a chain or a series of gears. In FIG. 11, a reference numeral 5 denotes a part of the plurality of cams provided in each cam shaft 4, and 3a denotes a housing which houses the above described structural elements of the cylinder lubricating apparatus 3, such as the above-mentioned not-shown rocker arms, the above-mentioned not-shown plunger pumps, the above-mentioned not-shown urging means, and the above-mentioned not-shown injectors with check valves.

[0007] In the conventional large diesel engine 1 comprising the plurality of conventional cylinder lubricating apparatuses 3 configured as described above, it is a troublesome work to arrange the plurality of cylinder lubricating apparatuses 3 so that the centers of the cam shafts 4 are aligned.

[0008] Further, twist is likely to occur between the cam shafts 4 coupled by the shaft coupling 6. Therefore, it is difficult to adjust the operations of the cylinder lubricating apparatuses 3 so that each of the cylinder lubricating apparatuses 3 injects lubrication oil into the inside of the cylinder 2 corresponding thereto at an optimum timing responding to the movement of a not-shown piston in the corresponding cylinder 2.

[0009] More further, in order to adjust the oil injection amount per one operation of the injector in each cylinder lubricating apparatus 3, it is necessary to adjust the rotating amount of the oil injection amount adjusting screw in each cylinder lubricating apparatus 3. Thus, adjustments of the oil injection amounts in all of the cylinder lubricating apparatuses 3 are complicated.

[0010] In addition, the optimum oil injection amount changes when the load of the large diesel engine 1 changes, but it is difficult to change the oil injection amount to the optimum one in the conventional cylinder lubricating apparatus 3 using the oil injection amount adjusting screw.

[0011] In these circumstances, the conventional cylinder lubricating apparatus 3 consumes inevitably more lubrication oil than the optimum oil injection amount.

[0012] The present invention has been derived under the above-mentioned circumstances, and an object of the present invention is to provide a cylinder lubricating apparatus which can be easily installed in a large diesel engine having a plurality of cylinders, and can easily and speedily control an oil injection amount into the large diesel engine in response to an operating situation of the diesel engine.

[0013] In order to achieve the above described object of the present invention, a cylinder lubricating apparatus according to the present invention, comprises a plurality of injectors which are mounted on a cylinder of an internal combustion engine and inject lubrication oil into the inside of the cylinder, and a lubrication oil pump which forcibly feeds the lubrication oil to the injectors, the cylinder lubricating apparatus being characterized by further comprising

a pressurized oil storage means which is communicated with a discharge port of the lubrication oil pump and stores the lubrication oil pressurized by the lubrication oil pump,

a plurality of branched oil feeding means which are branched from the pressurized oil storage means and are connected with the plurality of injectors,

a normally-closed type remote control open/close valve which is provided in each of the branched oil feeding means, and

a control means which remotely controls a valve open timing and a valve open holding time of each of the remote control open/close valves.

[0014] This summary of the invention does not necessarily describe all necessary features so that the invention may also be a sub-combination of these described features.

[0015] The invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 schematically shows a configuration of a cylinder lubricating apparatus according to a first embodiment of the present invention;

FIG. 2 shows an electro magnetically operated open/close valve (a solenoid-operated valve in the embodiment) provided in the cylinder lubricating apparatus of FIG. 1, by using a graphical symbol thereof, the electro magnetically operated open/close valve being a kind of the remote control open/close valve;

FIG. 3 schematically shows a longitudinal sectional view of an oil amount limiter provided in the cylinder lubricating apparatus of FIG. 1;

FIG. 4 is a time chart showing a relationship between an operation of the electro magnetically operated open/close valve (the solenoid-operated valve in the embodiment) of FIG. 2 and a crank angle signal, with a time passage;

FIG. 5 schematically shows a configuration of a cylinder lubricating apparatus according to a second embodiment of the present invention;

FIG. 6 shows electro magnetically operated open/close valves (solenoid-operated valves in the embodiment) provided in the cylinder lubricating apparatus of FIG. 5 and arranged in parallel to each other, by using graphical symbols thereof;

FIG. 7 schematically shows a configuration of a cylinder lubricating apparatus according to a third embodiment of the present invention;

FIG. 8A schematically shows a longitudinal sectional view of an example of an electro magnetically operated open/close valve (a solenoid-operated switching valve in the embodiment) built-in type injector provided in the cylinder lubricating apparatus of FIG. 7;

FIG. 8B schematically shows a longitudinal sectional view of another example of an electro magnetically operated open/close valve (a solenoid-operated switching valve in the embodiment) built-in type injector provided in the cylinder lubricating apparatus of FIG. 7;

FIG. 9 schematically shows a configuration of a cylinder lubricating apparatus according to a fourth embodiment of the present invention;

FIG. 10 schematically shows a configuration of a cylinder lubricating apparatus according to a fifth embodiment of the present invention; and

FIG. 11 schematically shows a large diesel engine having a plurality of cylinders, which is provided with a plurality of conventional cylinder lubricating apparatuses.

[0016] Hereinafter, a cylinder lubricating apparatus 20A according to the first embodiment of the present invention will be explained in details with reference to the attached FIG. 1 to FIG. 4.

[0017] FIG. 1 shows only a part of each of two cylinders 11a and 11n located at both ends of an arrangement of a plurality of cylinders 11a - 11n of a large diesel engine for a ship. The cylinder lubricating apparatus 20A according to the first embodiment has a plurality of injectors 12a - 12n attached on each of the plurality of cylinders 11a - 11n of the large diesel engine for a ship. The injectors 12a - 12n are arranged at predetermined positions on each of the cylinders 11a - 11n. These predetermined positions are arranged with equal intervals in the circumferential direction of a not-shown cylinder liner of each cylinder at an equal height level from the bottom of the cylinder liner, for example a 1/3 height level of the total height of the cylinder liner. In this embodiment, for example six injectors are provided, and only three injectors 12a, 12b, and 12c out of them are shown in FIG. 1.

[0018] Each of the injectors may be either a check valve type (open type) or an inward-open type (closed type) capable of injecting lubrication oil at a higher speed than a lubrication oil injection speed of the check valve type. It is also permitted to mix the check valve type injectors and the inward-open type injectors.

[0019] The check valve type (open type) injector has an oil chamber, an injection port communicated with one end of the oil chamber, and a tapered valve seat formed on a part of the inner surface of the oil chamber at the other end of the oil chamber, in a forward end portion of a slender nozzle body. An oil leading pass opened at the center of the valve seat extends toward a middle portion of the nozzle body. At the other end of the oil chamber, a valve body, for example a steel ball, and a coil spring for sitting the valve body on the valve seat are provided.

[0020] In this injector, when the pressure of a high-pressurized lubrication oil led to the other end of the oil chamber through the oil leading pass becomes larger than the urging force of the coil spring, the valve body leaves from the valve seat, and, as a result of this, the high-pressurized lubrication oil flows into the oil chamber and then is ejected from the injection port. This ejection is stopped when the pressure of the high-pressurized lubrication oil flowing into the lubrication oil leading pass drops.

[0021] An inward-open valve type (closed type) injector of an automatically open/close system which is a kind of the inward-open valve type (closed type) injector has an oil chamber, an injection port communicated with one end of the oil chamber, and a tapered valve seat formed on a part of the inner surface of the oil chamber at the one end of the oil chamber, in a forward end portion of a slender nozzle body. The nozzle body is further provided with a needle reciprocally movable in its longitudinal direction, whose one end has a tapered surface which is brought into contact with or left from the valve seat of the nozzle body and is exposed to the oil chamber. The nozzle body is more further provided with a coil spring which urges the needle so that the tapered surface at its one end comes into contact with the valve seat of the nozzle body, and an oil leading pass which extends from the outside of the nozzle body to the oil chamber with keeping away from the needle.

[0022] In this injector, when the pressure of a high-pressurized lubrication oil led into the oil chamber through the oil leading pass and loaded on the tapered surface of the one end of the needle becomes larger than the urging force of the coil spring, the needle leaves from the valve seat, and, as a result of this, the high-pressurized lubrication oil is ejected from the injection port. This ejection is stopped when the pressure of the high-pressurized lubrication oil flowing in the lubricating oil leading pass drops.

[0023] Each injection port of the injectors 12a - 12n attached on each of the cylinders 11a - 11n may be either a single-port type which has only one port at its forward end, the only one port directing inward in the radius direction of each of the cylinders 11a - 11n, or a multi-port type whose forward end is branched into multiple ports inclined toward the inner circumferential surface of each of the cylinders 11a - 11n from the radius direction of each of the cylinders 11a - 11n.

[0024] On the outer circumferential surface of each of the cylinders 11a - 11n, a plurality of temperature sensors 13a - 13n (only three temperature sensors 13a - 13c are shown in FIG. 1, and the others are not shown) are provided. The number of temperature sensors 13a - 13n on each cylinder is preferably the same as the number of injectors 12a - 12n on each cylinder. And, it is preferable that the temperature sensors 13a - 13n are arranged adjacent to the injectors 12a - 12n on each cylinder. Each of the temperature sensors 13a - 13n outputs an electric signal (a cylinder temperature detection signal) corresponding to a temperature measured by each of them.

[0025] In addition to the injectors 12a - 12n attached on each of the cylinders 11a - 11n of the large diesel engine for a ship, as described above, the cylinder lubricating apparatus 20 according to the first embodiment further comprises a lubrication oil pump 14 which pressurizes the lubrication oil to be fed to the injectors 12a - 12n; a pressurized oil storage means 15 which communicates with the discharge port of the lubrication oil pump 14 and stores the lubrication oil pressurized by the lubrication oil pump 14; a plurality of branched oil feeding means 16a - 16n which are branched from the pressurized oil storage means 15 and are connected with the injectors 12a - 12n mounted on each of the cylinders 11a - 11n; normally-closed type remote control open/close valves 17a - 17n which are provided in the branched oil feeding means 16a - 16n, respectively; and an electronic control means 19 which remotely controls a valve open timing and a valve open holding time of each of these remote control valves 17a - 17n. Oil amount limiters 18a - 18n are interposed in the branched oil feeding means 16a - 16n between the pressurized oil storage means 15 and the remote control valves 17a - 17n.

[0026] In this embodiment, a solenoid-operated switching valve which is a kind of an electro magnetically operated open/close valve is used for the remote control valve.

[0027] The lubrication oil pump 14 is preferably a constant volume type hydraulic pump which feeds a constant volume of pressurized lubrication oil in only one direction, and is driven by a not-shown electric motor or by a rotation force taken from the large diesel engine for a ship.

[0028] The pressurized oil storage means 15 includes a pipe, extends along the plurality of cylinders 11a - 11n of the large diesel engine for a ship, and is called as a common rail. The pressurized oil storage means 15 holds the lubrication oil discharged from the discharge port of the lubrication oil pump 14 at a predetermined pressure.

[0029] A combination of the lubrication oil pump 14 and the pressurized oil storage means 15 can be arranged to correspond to each of the cylinders 11a - 11n. If the cylinders 11a - 11n are divided into several groups, the combination can also be arranged for each one of the groups.

[0030] Further, it is also possible to provide a combination of one lubrication oil pump 14 with a plurality of pressurized oil storage means 15 arranged to correspond to the cylinders 11a - 11n respectively, or a combination of one lubrication oil pump 14 with a plurality of pressurized oil storage means 15 arranged for each group of the cylinders 11a - 11n.

[0031] A 2-port/2-position switching valve shown schematically in FIG. 2 can be preferably used as each of the solenoid-operated switching valves 17a - 17n.

[0032] Each of the oil amount limiters 18a - 18n has the same structure, and regulates the amount of lubrication oil fed to each of the injectors 12a - 12n. FIG. 3 schematically shows the structure of the oil amount limiter 18a.

[0033] The oil amount limiter 18a includes a housing 31. The housing 31 is provided with a first housing element 31a, a second housing element 31b, and a transparent window element 31c between the first and second housing elements 31a and 31b. The first housing element 31a, the transparent window element 31c, and the second housing element 31b are aligned with each other. A blind hole is formed in an end-face of the first housing element 31a located adjacent to the transparent window element 31c, and a center hole being concentric with the blind hole is formed in the transparent window element 31c. An opening of the center hole located adjacent to the second housing element 31b is closed by the second housing element 31b, and the blind hole of the first housing element 31a and the center hole of the transparent window element 31c form an oil chamber 34 of the housing 31.

[0034] An oil inlet 35 is formed in the closed end portion of the first housing element 31a, and the oil inlet 35 connects an upstream part of the branched oil feeding means 16a located adjacent to the pressurized oil storage means 15 with the oil chamber 34. The diameter of the oil inlet 35 is smaller than that of the oil chamber 34. An oil outlet 36 is formed in the second housing element 31b, and the oil outlet 36 connects the oil chamber 34 to a downstream part of the branched oil feeding means 16a located adjacent to the solenoid-operated switching valve 17a. The diameter of the oil outlet 36 is smaller than that of the oil chamber 34, and an opening of the oil outlet 36 in the oil chamber 34 forms as a tapered valve seat 36a.

[0035] A shuttle 32 is contained in the oil chamber 34 to be slidable in the longitudinal direction of the oil chamber 34. The shuttle 32 is made of magnetic material such as steel, and is configured to have a stepped-cylindrical shape. The shuttle 32 includes a throttle passage 37 penetrating in its longitudinal direction. The throttle passage 37 has a first part 37a having the same diameter as that of the oil inlet 35, and a second part 37b communicating with the first part 37a and having the smaller diameter than that of the first part 37a. The first part 37a extends from one end-face of the shuttle 32 facing the oil inlet 35 of the oil chamber 34 and having a large diameter, to the proximity of the other end-face of the shuttle 32 facing the oil outlet 36 of the oil chamber 34 and having a small diameter. The second part 37b extends from the inner end of the first part 37a to the other end-face of the shuttle 32.

[0036] A periphery 32a of the other end-face of the shuttle 32 having the small diameter is chamfered to have a tapered surface to be brought into contact with and left from the tapered valve seat 36a at the opening of the oil outlet 36 in the oil chamber 34.

[0037] The oil chamber 34 further contains an urging means 33 which urges the shuttle 32 toward a first position adjacent to the oil inlet 35. In this embodiment, the urging means 33 has a coil spring wound around a small diameter part of the outer circumferential surface of the shuttle 32 located near to the second housing element 31b. Both ends of the coil spring contact the periphery of the valve seat 36a on the oil chamber side end-face of the second housing element 31b and a step 32b of the outer circumferential surface of the shuttle 32.

[0038] The oil amount limiter 18a is provided with a lift sensor 38 to detect a movement of the shuttle 32. The lift sensor 38 is preferably a proximity type magnetic sensor. The lift sensor 38 detects a change in a magnetic field caused by the movement of a shoulder 32c of a large diameter part of the shuttle 32, when the shuttle 32 leaves from a first position (a state shown in FIG. 4) adjacent to the oil inlet 35 against the urging force of the coil spring 33, and moves to a second position where the periphery 32b of the small diameter other end-face of the shuttle 32 sits on the valve seat 32a of the oil outlet 36. A shuttle movement detection signal from the lift sensor 38 is inputted to the control device 19.

[0039] The control device 19 may be, for example, a microcomputer, and controls an operation of the lubrication oil pump 14 and the valve open timing and valve open holding time of each of the solenoid-operated switching valves 17a - 17n, based on various input data. The various input data to the control device 19 includes the shuttle movement detection signal from the lift sensor 38 of each of the oil amount limiters 18a - 18n shown in FIG. 3, the cylinder temperature detection signal from each of the temperature sensors 13a - 13n shown in FIG. 1, and the crank angle signal and engine load signal from the large diesel engine for a ship.

[0040] The crank angle signal is detected by a crank angle detection means 39 shown in FIG. 1. The crank angle detection means 39 is provided with a plurality of parts to be detected such as projections and magnets, mounted on the crank shaft of the large diesel engine for a ship so that the parts to be detected correspond to the cylinders of the engine, and a plurality of proximity switches which detect passage of the parts to be detected. The crank angle detection means 39 generates a detected part detection pulse, that is the crank angle signal (refer to FIG. 3), for one or several times per one rotation of the crank shaft, and supplies the crank angle signal to the control device 19.

[0041] The crank angle signal is also sent to an engine load computing unit 40. The engine load computing unit 40 computes a rotation speed of the crank from the crank angle signal, and also computes a load state in the large diesel engine for a ship from this rotation speed, and supplies the control device 19 with an engine load signal corresponding to the computed load state.

[0042] Next, an operation of the cylinder lubricating apparatus 20 of the first embodiment configured as described above, will be explained in detail.

[0043] When the large diesel engine for a ship is operated and the crank shaft is rotated, the crank angle signal is sent from the crank angle detection means 39 to the control device 19 and the engine load computing unit 40. The engine load computing unit 40 supplies the control device 19 with the engine load signal computed from the input crank angle signal. The control device 19 is also supplied with the cylinder temperature signals from the temperature sensors 13a - 13n of each of the cylinders 11a - 11n of the large diesel engine for a ship.

[0044] When a predetermined time t1 (refer to FIG. 4) passes after the rising of the crank angle signal, the control device 19 excites the solenoid-operated switching valves 17a - 17n mounted on one of the cylinders 11a - 11n from which the crank angle signal is supplied, and opens these solenoid-operated switching valves 17a - 17n. The valve open holding time t2 (refer to FIG. 4) to hold the solenoid-operated switching valves 17a - 17n in the valve open state is determined and controlled by the control device 19 based on the engine load signal and the cylinder temperature signals.

[0045] That is, the control device 19 controls the valve open timing t1 (refer to FIG. 4) and the valve open holding time t2 (refer to FIG. 4) of each of the solenoid-operated switching valves 17a - 17n of each of the cylinders 11a - 11n, based on the crank angle signal, engine load signal and cylinder temperature signals corresponding to each of the cylinders. As a result of this, the cylinder lubricating apparatus 20A of the first embodiment can inject an appropriate amount of lubrication oil in real time to the predetermined parts of the cylinders corresponding to the injectors 12a - 12n, in accordance with the operating condition of the large diesel engine for a ship, during the operation of the large diesel engine for a ship installed with the cylinder lubricating apparatus 20A.

[0046] For example, the control device 19 controls the valve open holding time t2 (refer to FIG. 4) of each of the solenoid-operated switching valves 17a - 17n of each of the cylinders 11a - 11n, in accordance with the increase and decrease of the load of the large diesel engine for a ship, which can be known from the engine load signal. As a result of this, the amount of the lubrication oil injected by the injectors 12a - 12n corresponding to the solenoid-operated switching valves 17a - 17n into the cylinder corresponding to the injectors 12a - 12n is increased or decreased.

[0047] Further, the control device 19 controls the valve open holding time t2 (refer to FIG. 4) of each of the solenoid-operated switching valves 17a - 17n of each of the cylinders 11a - 11n, in accordance with the rise and fall of the cylinder temperature signal from each of the temperature sensors 13a - 13n of each of the cylinders 11a - 11n. As a result of this, the amount of the lubrication oil injected by the injectors 12a - 12n corresponding to the solenoid-operated switching valves 17a - 17n into the cylinder corresponding to the injectors 12a - 12n is also increased or decreased.

[0048] That is, it is possible to increase the amount of lubrication oil injected by the injector adjacent to the temperature sensor which detects a high temperature, more than the amount of lubrication oil injected by the injector adjacent to the temperature sensor which detects a low temperature. And, this means that the operation of each of the injectors 12a - 12n can be controlled to increase or decrease the amount of lubrication oil injected by each of the injectors 12a - 12n, in accordance with the cylinder temperature detected by one of the temperature sensors 13a - 13n located adjacent to each of the injectors 12a - 12n.

[0049] When one of the solenoid-operated switching valves 17a - 17n is opened, the pressurized lubrication oil flows from the pressurized oil storage means 15 into the oil inlet 35 of one of the oil amount limiters 18a - 18n corresponding to the one of the solenoid-operated switching valves 17a - 17n through the upstream part of one of the branched oil feeding means 16a - 16n corresponding thereto. The pressurized lubrication oil flown into the oil inlet 35 is led into the throttle pass 37 of the shuttle 32, and applies the step between the first part 37a and the second part 37b in the throttle pass 37 to move the shuttle 32 from the first position (shown in FIG. 3) where the shuttle 32 adjoins the oil inlet 35, to the second position where the tapered periphery 32a of the small diameter other end-face of the shuttle 32 sits on the tapered valve seat 36a of the oil outlet 36, against the urging force of the urging means 33.

[0050] The throttle pass 37 of the shuttle 32 regulates the flow rate of the pressurized lubrication oil flowing from the pressurized oil storage means 15 into one of the injectors 12a - 12n through one of the solenoid-operated switching valves 17a - 17n corresponding to one of the oil amount limiters 18a - 18n. Therefore, even if one of the solenoid-operated switching valves 17a - 17n corresponding to one of the oil amount limiters 18a - 18n fails and is held in its open state, excess amount of lubrication oil will not flow into the cylinder corresponding to the failed solenoid-operated switching valve.

[0051] The lift sensor 38 detects the above-mentioned movement of the shuttle 32, and sends the detection signal to the control device 19.

[0052] The movement of the shuttle 32 can also be confirmed by visual inspection through the transparent window element 31c of the housing 31.

[0053] When one of the solenoid-operated switching valves 17a - 17n corresponding to one of the oil amount limiters 18a - 18n is closed and the flow of the pressurized lubrication oil from the pressurized oil storage means 15 into the throttle pass 37 of the shuttle 32 of the one of the oil amount limiters 18a - 18n through the oil inlet 35 thereof is stopped, the shuttle 32 is returned from the second position where the tapered periphery 32a of the small diameter other end-face sits on the tapered valve seat 36a of the oil outlet 36, to the first position (shown in FIG. 3) adjacent to the oil inlet 35, by the urging force of the urging means 33.

[0054] By the detection signal from the lift sensor 38, the control device 19 can know whether each of the solenoid-operated switching valves 17a - 17n operates normally as instructed by the control device 19.

[0055] The cylinder lubricating apparatus 20A according to the first embodiment and configured as described above is easy to install in an internal combustion engine as compared with the conventional cylinder lubricating apparatus shown in FIG. 11, and can control the valve open timing and valve open holding time of each of the injectors 12a - 12n, always exactly, and easily by the remote operation, regardless of whether the internal combustion engine corresponding to the lubricating apparatus 20A is operating or stopping.

[0056] Next, a cylinder lubricating apparatus 20B according to a second embodiment of the present invention will be explained in detail with reference to FIG. 5 and FIG. 6.

[0057] Most structural elements of the cylinder lubricating apparatus 20B according to the second embodiment of the present invention are the same as those of the cylinder lubricating apparatus 20A according to the first embodiment and explained with reference to FIG. 1 - FIG. 4. Therefore, in the structural elements of the cylinder lubricating apparatus 20B according to the second embodiment, the same structural elements of the cylinder lubricating apparatus 20B of the cylinder lubricating apparatus 20B as those of the cylinder lubricating apparatus 20A according to the first embodiment are denoted by the same reference numerals as those denoting the same structural elements of the cylinder lubricating apparatus 20A, and detailed descriptions of these structural elements will be omitted.

[0058] In the cylinder lubricating apparatus 20B according to the second embodiment, a plurality of solenoid-operated switching valves 17a, - or 17n are provided in a parallel manner to each of the plurality of branched oil feeding means 16a - 16n. In FIG. 5 and FIG. 6, for example, two solenoid valves 17a, - or 17n are provided in the parallel manner.

[0059] The other configuration of the cylinder lubricating apparatus 20B according to the second embodiment, excepting the above described configuration about the provision of the solenoid-operated switching valves 17a, - or 17n in the parallel manner, is the same as that of the cylinder lubricating apparatus 20A according to the first embodiment. Therefore, the cylinder lubricating apparatus 20B according to the second embodiment provides the same functions and technical advantages as those provided by the cylinder lubricating apparatus 20A according to the first embodiment. In addition, in the cylinder lubricating apparatus 20B according to the second embodiment, since the plurality of solenoid valves 17a, - or 17n are provided in the parallel manner to each of the plurality of branched oil feeding means 16a - 16n, the apparatus 20B can be normally operated even if one of the solenoid-operated switching vales 17a, - or 17n provided in the parallel manner fails.

[0060] This is important for a cylinder lubricating apparatus installed in a large diesel engine for a ship which is used in the ocean for a long period.

[0061] Next, a cylinder lubricating apparatus 20C according to a third embodiment of the present invention will be explained in detail with reference to FIG. 7, FIG. 8A and FIG. 8B.

[0062] Most structural elements of the cylinder lubricating apparatus 20C according to the third embodiment of the present invention are the same as those of the cylinder lubricating apparatus 20A according to the first embodiment and explained with reference to FIG. 1 - FIG. 4. Therefore, in the structural elements of the cylinder lubricating apparatus 20C according to the third embodiment, the same structural elements of the cylinder lubricating apparatus 20C as those of the cylinder lubricating apparatus 20A according to the first embodiment are denoted by the same reference numerals as those denoting the same structural elements of the cylinder lubricating apparatus 20A, and detailed descriptions of these structural elements will be omitted.

[0063] In the cylinder lubricating apparatus 20C according to the third embodiment shown in FIG. 7, each solenoid-operated switching valve 17a, - or 17n is built in each injector 12a, - or 12n corresponding thereto. The structures of the injectors 12a - 12n containing the solenoid-operated switching valves 17a - 17n are the same as to each other.

[0064] FIG. 8A shows one injector 12a as a representative of the injectors 12a - 12n containing the solenoid-operated switching valves 17a - 17n. The injector 12a containing the solenoid-operated switching valve 17a shown in FIG. 8A is a pilot type which is a kind of the inward-open type (closed type) of the automatically open/close system.

[0065] The pilot type injector 12a includes an oil chamber 42, an injection port 43 communicated with the oil chamber 42, and a valve seat 44 provided at one end of the injection port 43 facing the oil chamber 42, in a forward end portion of a slender nozzle body 41. In a middle portion of the nozzle body 41, a slender guide hole 41a extending from the oil chamber 42 to a way to a base end portion of the nozzle body 41 is formed. And, a needle 45 is contained in the guide hole 41a so that the needle 45 can be reciprocally movable in the longitudinal direction of the guide hole 41a. A forward end part 45a of the needle 45 is formed to have a tapered surface which corresponds to the valve seat 44 of the injection port 43, and the tapered forward end part 45a is exposed in the oil chamber 42. In the middle portion of the nozzle body 41, a pilot passage 46 is further provided to extend along the guide hole 41a from the oil chamber 42 to the way to the base end portion of the nozzle body 41. An inner end of the pilot passage 46 is communicated with a space between an inner end of the guide hole 41a and an inner end of the needle 45 in the guide hole 41a. The inner end of the pilot passage 46 is further communicated with the branched oil feeding means 16a corresponding to the injector 12a. A solenoid-operated switching valve 17a is build in the base end portion of the nozzle body 41, and is aligned with the guide hole 41a. The solenoid-operated switching valve 17a includes an oil chamber 52 which is communicated with the inner end of the guide hole 41a through an oil outlet 51 of a small diameter and is further communicated with an oil passage 56 extending from a not-shown oil tank through a stepped oil passage 49 of a large diameter.

[0066] A valve body 48 is contained in the oil chamber 52 so that the valve body 48 is reciprocally movable along the longitudinal center line of the nozzle body 41 between the oil outlet 51 and the stepped oil passage 49. A magnetic coil 47 surrounds the oil chamber 52 in the base end portion of the nozzle body 41, and the valve body 48 functions as an armature to be driven by the magnetic coil 47 to make the reciprocal movement thereof.

[0067] The operation of the magnetic coil 47 is controlled by the control device 19.

[0068] An oil-lead passage 48a is formed in the valve body 48a. The oil-lead passage 48a extends from one end of the valve body 48a facing the oil passage 49 to a proximity of the other end thereof facing the oil outlet 51, and opens in the outer circumferential surface of the valve body 48a at the proximity of the other end thereof.

[0069] An urging means, a compressed coil spring in this embodiment, 50 is arranged between the one end of the valve body 48a and the step of the oil passage 49. The urging force of the urging means 50 urges the valve body 48a toward the oil outlet 51 so that the one end of the valve body 48a contacts and closes the oil outlet 51. At this time, a gap G is produced between the other end of the valve body 48a and one end of the oil chamber 52 which faces the other end of the valve body 48a and in which the oil passage 49 opens.

[0070] In the pilot type injector 12a configured as described above, the valve body 48 is moved to leave from the oil outlet 51 against the urging force of the urging means 50 when the magnetic coil 47 of the solenoid-operated switching valve 17a is energized. As a result of this, the pressurized lubrication oil from the branched oil feeding means 16a corresponding to the injector 12a flows into the oil passage 56 through the throttle 46a, the oil outlet 51, the oil chamber 52, the oil-lead passage 48a of the valve body 48, and the stepped oil passage 49.

[0071] At this time, the pressure of the pressurized lubrication oil flowing from the branched oil feeding means 16a into the oil passage 56 through the throttle 46a, the oil outlet 51, the oil chamber 52, the oil-lead passage 48a of the valve body 48, and the stepped oil passage 49 is lowered when the lubrication oil passing through the throttle 46a. And, a difference is generated between a pressure applied to the tapered forward end portion 45a of the needle 45 by the pressurized lubrication oil in the oil chamber 42 and a pressure applied to the inner end of the needle 45 by the depressurized lubrication oil as described above. The pressure difference moves the needle 45 so that the tapered forward end portion 45a of the needle 45 leaves from the tapered valve seat 44 of the injection port 43, and then the pressurized lubrication oil in the oil chamber 42 is injected into the cylinder 11a,-or 11n corresponding to the injector 12a, through the injection port 43.

[0072] When the energizing of the magnetic coil 47 of the solenoid-operated switching valve 17a is stopped, the valve body 48 is moved by the urging force of the urging means 50 to close the oil outlet 51. As a result of this, the needle 45 in the guide hole 41a is moved back to close the injection port 43 by a difference between the pressure of the no-depressurized lubrication oil applied to the inner end of the needle 45 and the pressure of the pressurized lubrication oil applied to the tapered forward end portion 45a of the needle 45 in the oil chamber 42 while the pressurized lubrication oil is injected from the oil chamber 42 through the injection port 43 and the pressure of the pressurized lubrication oil in the oil chamber 42 is lowered.

[0073] The pilot type injector 12a can be operated speedily, and this is the technical advantage of the pilot type injector 12a.

[0074] FIG. 8B shows an inward-open type (closed type) injector 12a of a direct drive system in which an solenoid-operated switching valve 17a is build, and the injector 12a shown in FIG. 8B can be used in place of the pilot type injector 12a shown in FIG. 8A in the cylinder lubricating apparatus 20C according to the third embodiment shown in FIG. 7.

[0075] In the inward-open type (closed type) injector 12a of the direct drive system, an oil chamber 42', an injection port 43' communicated with the oil chamber 42', and a valve seat 44' formed on an opening of the injection port 43' in the oil chamber 42' are provided in a slender nozzle body 41'.

[0076] A slender guide hole 41'a is formed in a middle portion of the nozzle body 41' so that the guide hole 41'a extends from the oil chamber 42' to a way to a base end portion of the nozzle body 41'. A needle 55 is contained in the guide hole 41'a so that the needle 55 can be reciprocally movable in a longitudinal direction of the guide hole 41'a. A forward end portion 55a of the needle 55 is formed to have a tapered surface corresponding to the tapered valve seat 44' of the injection port 43', and the tapered forward end portion 55a is exposed in the oil chamber 42'.

[0077] The solenoid-operated switching valve 17a is build in the middle portion of the nozzle body 41'. The solenoid-operated switching valve 17a includes a magnetic coil 47' surrounding an inner end part of the guide hole 41', and the needle 55 functions as an armature to be driven by the magnetic coil 47' to make the reciprocal movement thereof.

[0078] The operation of the magnetic coil 47' is controlled by the control device 19.

[0079] An oil-lead passage 55b is formed in the needle 55. The oil-lead passage 55b extends from the forward end portion 55a of the needle 55 exposed in the oil chamber 42' to a base end of the needle 55 facing an inner end of the guide hole 41'a.

[0080] A stepped oil inlet 49' communicating with the branched oil feeding means 16a corresponding to the injector 12a is formed in a base end portion of the nozzle body 41', and the oil inlet 49' opens in the inner end of the guide hole 41'a.

[0081] An urging means, a compressed coil spring in this embodiment, 50' is arranged between the base end of the needle 55 and the step in the oil inlet 49'. The urging force of the urging means 50' urges the needle 55 toward the injection port 43' so that the tapered forward end portion 55a of the needle 55 contacts the valve seat 44' of the injection port 43' and closes the injection port 43'. At this time, a gap G is produced between the base end of the needle 55 and the inner end of the guide hole 41'.

[0082] In the inward-open type (closed type) injector 12a of the direct drive system configured as described above, the needle 55 is moved to leave from the valve seat 44' of the injection port 43' against the urging force of the urging means 50' when the magnetic coil 47' of the solenoid-operated switching valve 17a is energized. As a result of this, the pressurized lubrication oil from the branched oil feeding means 16a corresponding to the injector 12a is injected from the injection port 43' through the oil inlet 49', the oil leading passage 56b of the needle 55, and the oil chamber 42'.

[0083] When the energizing of the magnetic coil 47' of the solenoid-operated switching valve 17a is stopped, the needle 55 is moved by the urging force of the urging means 50' to make the tapered forward end portion 55a of the needle 55 contact the valve seat 44' of the injection port 43' as shown in FIG. 8B and close the injection port 43'.

[0084] The injector 12a of the direct drive system configured as described above, can be operated more speedily in comparison with the check-valve type injector 12a as described above, but its operation speed is lower than that of the pilot type injector 12a as described above. However, a structure of the injector 12a of the direct drive system is more simple than that of the pilot type injector 12a, and its manufacturing cost is lower than that of the pilot type injector 12a.

[0085] The other configuration of the cylinder lubricating apparatus 20C according to the third embodiment, excepting the above described configuration about the solenoid-operated switching valves 17a - 17n build in the injectors 12a - 12n, is the same as that of the cylinder lubricating apparatus 20A according to the first embodiment. Therefore, the cylinder lubricating apparatus 20C according to the third embodiment provides the same functions and technical advantages as those provided by the cylinder lubricating apparatus 20A according to the first embodiment. In addition, since, in the cylinder lubricating apparatus 20C according to the third embodiment, the solenoid valves 17a - 17n are build in the injectors 12a - 12n corresponding to the solenoid valves 17a - 17n, a time difference produced between the operation of each of the solenoid valves 17a - 17n and that of the injectors 12a - 12n corresponding to each of the solenoid valves 17a - 17n by a passage resistance generated while the lubrication oil flows from each of the solenoid valves 17a - 17n to each of the injectors 12a - 12n corresponding thereto and by a viscosity resistance of the lubrication oil, is shortened, in comparison with the cylinder lubricating apparatus 20A according to the first embodiment in which the solenoid valves 17a - 17n are not build in the injectors 12a - 12n corresponding to the solenoid valves 17a - 17n. This means that a responsibility of a cylinder lubrication operation of the cylinder lubricating apparatus 20C according to the third embodiment is superior to that of the cylinder lubricating apparatus 20A according to the first embodiment, and that the cylinder lubricating apparatus 20C according to the third embodiment can control the cylinder lubrication operation more precisely than the cylinder lubricating apparatus 20A according to the first embodiment.

[0086] Next, a cylinder lubricating apparatus 20D according to a fourth embodiment of the present invention will be explained in detail with reference to FIG. 9.

[0087] In structural elements of the cylinder lubricating apparatus 20D according to the fourth embodiment and shown in FIG. 9, the same structural elements of the cylinder lubricating apparatus 20D as those of the cylinder lubricating apparatus 20A according to the first embodiment are denoted by the same reference numerals as those denoting the same structural elements of the cylinder lubricating apparatus 20A, and detailed descriptions of these structural elements will be omitted.

[0088] In the cylinder lubricating apparatus 20D according to the fourth embodiment shown in FIG. 9, each of a plurality of branched oil feeding means 16 for a plurality of injectors 12a - 12n includes one upstream-side branched oil feeding pipe UBP for communicating a pressurized oil storage means 15 with a solenoid-operated switching valve 17 corresponding to each of the plurality of branched oil feeding means 16, and a plurality of downstream-side branched oil feeding pipes LBP for communicating the corresponding solenoid-operated switching valve 17 with the plurality of injectors 12a - 12n corresponding thereto.

[0089] In the embodiment shown in FIG. 9, two branched oil feeding means 16 are provided to each of a plurality of cylinders 11a - 11n. A half of a plurality of injectors 12a - 12n (six injectors are shown in FIG. 9) attached on each of the cylinders 11a - 11n are connected with a half of the downstream-side branched oil feeding pipes LBP branched from one upstream-side branched oil feeding pipe UBP of one branched oil feeding means 16 at the solenoid-operated switching valve 17, and another half of the plurality of injectors 12a - 12n (six injectors are shown in FIG. 9) are connected with another half of the downstream-side branched oil feeding pipes LBP branched from the other upstream-side branched oil feeding pipe UBP of the other branched oil feeding means 16 at the solenoid-operated switching valve 17.

[0090] An oil amount limiter 18 is provided in each of the upstream-side branched oil feeding pipes UBP of the branched oil feeding means 16.

[0091] A structure of the solenoid-operated switching valve 17 and that of the oil amount limiter 18, which are used in this embodiment, are the same as that of each solenoid-operated switching valve 17a, - or 17n and that of each oil amount limiter 18a, - or 18n, which are used in the cylinder lubricating apparatus 20A of the first embodiment described above.

[0092] The other configuration of the cylinder lubricating apparatus 20D according to the fourth embodiment, excepting the above described configuration about the branched oil feeding means 16, is the same as that of the cylinder lubricating apparatus 20A according to the first embodiment.

[0093] Since the cylinder lubricating apparatus 20D according to the fourth embodiment operates the same number of injectors 12a - 12n as that of the injectors 12a - 12n used in the first embodiment by a fewer solenoid-operated switching valves 17 and a fewer oil amount limiter 18 than those used in the first embodiment, a manufacturing cost of the cylinder lubricating apparatus 20D is cheaper than that of the cylinder lubricating apparatus 20A. But, the cylinder lubricating apparatus 20D according to the fourth embodiment can not so precisely control an oil injection amount as the cylinder lubricating apparatus 20A according to the first embodiment can control the oil injection amount.

[0094] However, the cylinder lubricating apparatus 20D according to the fourth embodiment is easy to install in an internal combustion engine as compared with the conventional cylinder lubricating apparatus 3 described above with reference to FIG. 11, and can control the valve open timing and valve open holding time of each of the injectors 12a - 12n, always exactly, and easily by the remote operation, regardless of whether the internal combustion engine corresponding to the lubricating apparatus 20D is operating or stopping.

[0095] Next, a cylinder lubricating apparatus 20E according to a fifth embodiment of the present invention will be explained in detail with reference to FIG. 10.

[0096] Most structural elements of the cylinder lubricating apparatus 20E according to the fifth embodiment and shown in FIG. 10 are the same as those of the cylinder lubricating apparatus 20D according to the fourth embodiment and shown in FIG. 9. Therefore, the same structural elements of the cylinder lubricating apparatus 20E as those of the cylinder lubricating apparatus 20D according to the fourth embodiment and shown in FIG. 9 and as those of the cylinder lubricating apparatus 20A according to the first embodiment and shown in FIGS. 1 to 4 are denoted by the same reference numerals as those denoting the same structural elements of the cylinder lubricating apparatuses 20A and 20D, and detailed descriptions of these structural elements will be omitted.

[0097] The cylinder lubricating apparatus 20E according to the fifth embodiment and shown in FIG. 10 is different from the cylinder lubricating apparatus 20D according to the fourth embodiment and described above with reference to FIG. 9 in a following configuration.

[0098] That is, throttles 61 and 62 are provided in a plurality of downstream-side branched oil feeding pipes LBP excepting the longest one. These throttles 61 and 62 function to make a pressure loss of each of the downstream-side branched oil feeding pipes LBP excepting the longest one between a solenoid-operated switching valve 17 corresponding to the downstream-side branched oil feeding pipes LBP and the injectors 12a - 12c, or 12d - 12n corresponding thereto, equal substantially to that of the longest downstream-side branched oil feeding pipe LBP.

[0099] For example, in a case that one branched oil feeding means 16 includes three downstream-side branched oil feeding pipes LBP as shown in FIG. 10, one 62 of two throttles 61 and 62 provided in the shortest one of two downstream-side branched oil feeding pipes LBP excepting the longest one in the three downstream-side branched oil feeding pipes LBP extending from the solenoid-operated switching valve 17 corresponding to the downstream-side branched oil feeding pipes LBP and the injectors 12a - 12c, or 12d - 12n corresponding thereto, is smaller in a cross sectional area than that another throttle 61 provided in the secondary short one of the two downstream-side branched oil feeding pipes LBP excepting the longest one.

[0100] The cylinder lubricating apparatus 20E according to the fifth embodiment and configured as described above can inevitably provide the same functions and technical advantages as those provided by the cylinder lubricating apparatus 20D according to the fourth embodiment and described above with reference to FIG. 9. In addition, in comparison with the cylinder lubricating apparatus 20D according to the fourth embodiment and described above with reference to FIG. 9, in which throttles 61 and 62 are not provided in the plurality of downstream-side branched oil feeding pipes LBP corresponding to one branched oil feeding means 16, excepting the longest downstream-side branched oil feeding pipe LBP, the cylinder lubricating apparatus 20E of the fifth embodiment can make each of the plurality of injectors 12a - 12c or 12d - 12n corresponding to one branched oil feeding means 16 inject an equal amount of lubrication oil to each other by one solenoid-operated switching valve 17 corresponding to the one branched oil feeding means 16.

[0101] This invention is not limited to the configurations of the cylinder lubricating apparatuses 20A to 20E according to the first to fifth embodiments described above with reference to FIGS. 1 to 10. For example, in each of the first to fifth embodiments, the oil amount limiters 18 or 18a - 18n can be omitted. In a case where the oil amount limiters 18 or 18a - 18n are used, these can be provided in not only upstream sides of the branched oil feeding means 16 or 16a - 16n with respect to the solenoid-operated switching valve 17 or 17a - 17n but also downstream sides of the branched oil feeding means 16 or 16a - 16n with respect to the solenoid-operated switching valve 17 or 17a - 17n. In a case where the oil amount limiters 18 or 18a - 18n are omitted, a valve body lift sensor or a needle lift sensor can be provided in each of the injectors 12a - 12n so that the lift sensor detects a lift distance of a valve body or needle and generates a signal being useful to inspect an oil injection operation of each of the injectors 12a - 12n and to control the oil injection operation.

Claims

1. A cylinder lubricating apparatus (20A - 20E) comprising a plurality of injectors (12a - 12n) which are mounted on a cylinder (11a - 11n) of an internal combustion engine and inject lubrication oil into the inside of the cylinder, and a lubrication oil pump (14) which forcibly feeds the lubrication oil to the injectors, the cylinder lubricating apparatus being **characterized by** further comprising:

    a pressurized oil storage means (15) which is communicated with a discharge port of the lubrication oil pump (14) and stores the lubrication oil pressurized by the lubrication oil pump;
    a plurality of branched oil feeding means (16a - 16n) which are branched from the pressurized oil storage means and are connected with the plurality of injectors (12a - 12n);
    a normally-closed type remote control open/close valve (17a - 17n) which is provided in each of the branched oil feeding means; and
    a control means (19) which remotely controls a valve open timing and a valve open holding time of each of the remote control open/close valves.

2. A cylinder lubricating apparatus according to claim 1, **characterized in that** the plurality of remote control open/close valves (17a - 17n) are provided in each of the plurality of branched oil feeding means (16a - 16n) in a parallel manner.

3. A cylinder lubricating apparatus according to claim 1, **characterized in that** the remote control open/close valves (17a - 17n) are built in the injectors (12a - 12n) corresponding to the remote control open/close valves.

4. A cylinder lubricating apparatus according to claim 1, **characterized in that** each of the plurality of branched oil feeding means (16a - 16n) includes:

    one upstream side branched oil feeding pipe (UBP) which communicates the remote control open/close valve (17a - 17n) corresponding to each of the branched oil feeding means (16a - 16n) with the pressurized oil storage means (15); and
    a plurality of downstream side branched oil feeding pipes (LBP) which are branched from the corresponding remote control open/close valve (17a - 17n) and communicated with a plurality of injectors (12a - 12c or 12d - 12n) corresponding to the downstream side branched oil feeding pipes (LBP).

5. A cylinder lubricating apparatus according to claim 4, **characterized in that** the plurality of downstream side branched oil feeding pipes (LBP) have a plurality of lengths;
    throttles (61, 62) are provided in the plurality of downstream side oil feeding pipes (LBP) excepting the longest one; and
    the throttles (61, 62) function to make a pressure loss of each of the downstream-side branched oil feeding pipes (LBP) excepting the longest one between the remote control open/close valve (17a - 17n) corresponding to each of the downstream-side branched oil feeding pipes (LBP) and the injectors (12a - 12c or 12d - 12n) corresponding thereto equal substantially to that of the longest downstream-side branched oil feeding pipe (LBP).

6. A cylinder lubricating apparatus according to any one of claims 1 - 5, **characterized in that** each of the plurality of branched oil feeding means (16, 16a - 16n) includes an oil amount limiter (18, 18a - 18n), and the oil amount limiter (18, 18a - 18n) regulates a flow rate of the pressurized lubrication oil supplied from the pressurized oil storage means (15) to the remote control open/close valve (17a - 17n).

7. A cylinder lubricating apparatus according to claim 6, **characterized in that** each of the plurality of branched oil feeding means (16, 16a - 16n) includes the oil amount limiter (18, 18a - 18n) between the remote control open/close valve (17a - 17n) and the pressurized oil storage means (15).

8. A cylinder lubricating apparatus according to claim 6 or 7, **characterized in that** the oil amount limiter (18, 18a - 18n) includes:

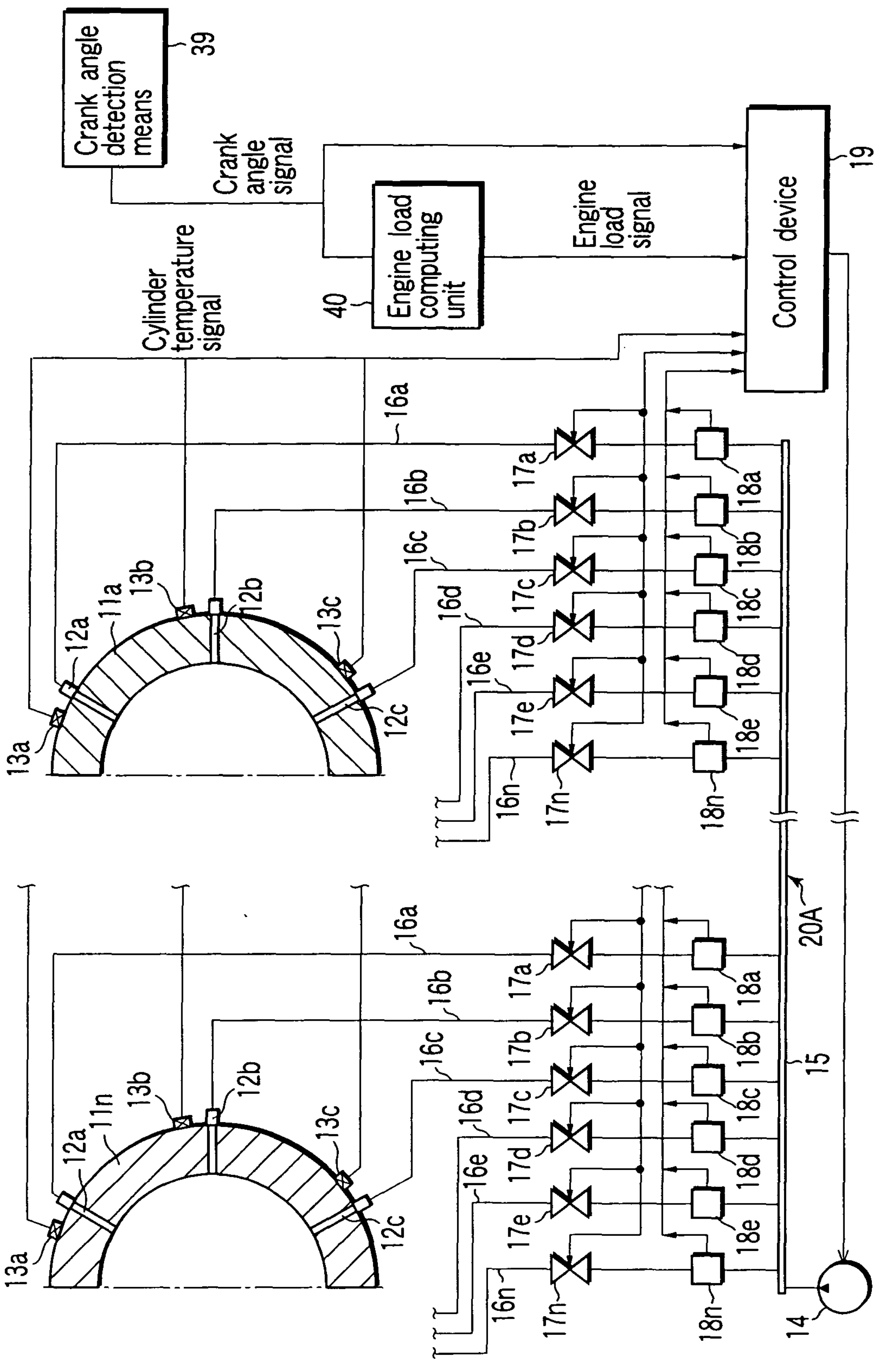
    a housing (31) which has an oil chamber (34), an oil inlet (35) communicated with the oil chamber, and an oil outlet (36) connected with the oil chamber;

a shuttle (32) which is arranged in the oil chamber (34), is movable between a first position adjacent to the oil inlet (35) and a second position being away from the oil inlet (35), and has a throttle passage (37) communicated with the oil inlet (35) and oil outlet (36) through the oil chamber (34);
an urging means (33) which urges the shuttle (32) toward the second position; and
a movement sensor (38) which detects a movement of the shuttle (32).

9. A cylinder lubricating apparatus according to any one of claims 1 - 8, **characterized in that** the control means (19) remotely controls a valve open timing (t1) and valve open holding time (t2) of each of the remote control open/close valves (17, 17a - 17n), based on a crank angle detection signal from a crank angle detection means (39) which detects a crank angle of the internal combustion engine.

10. A cylinder lubricating apparatus according to any one of claims 1 - 9, **characterized in that** the control means (19) remotely controls a valve open holding time (t2) of each of the remote control open/close valves (17, 17a - 17n), based on an engine load signal from an engine load detection means which detects a magnitude of load applied to the internal combustion engine.

11. A cylinder lubricating apparatus according to any one of claims 1 - 10, **characterized in that** the control means (19) remotely controls a valve open holding time (t2) of each of the remote control open/close valves (17, 17a - 17n), based on cylinder temperature signals from a plurality of temperature sensors (13a - 13n) arranged on the cylinder (11a - 11n) of the internal combustion engine to separate from each other along a circumferential direction of the cylinder.


Crank angle detection means
39
Crank angle signal
Engine load computing unit
40
Engine load signal
Control device
19
Cylinder temperature signal
13a
12a
11a
13b
12b
13c
12c
16a
16b
16c
16d
16e
16n
17a
17b
17c
17d
17e
17n
18a
18b
18c
18d
18e
18n
11n
20A
15
14

F I G. 1

FIG. 2

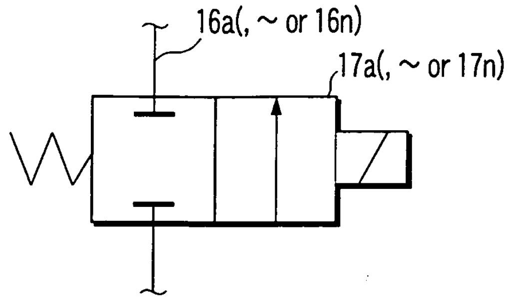


FIG. 3

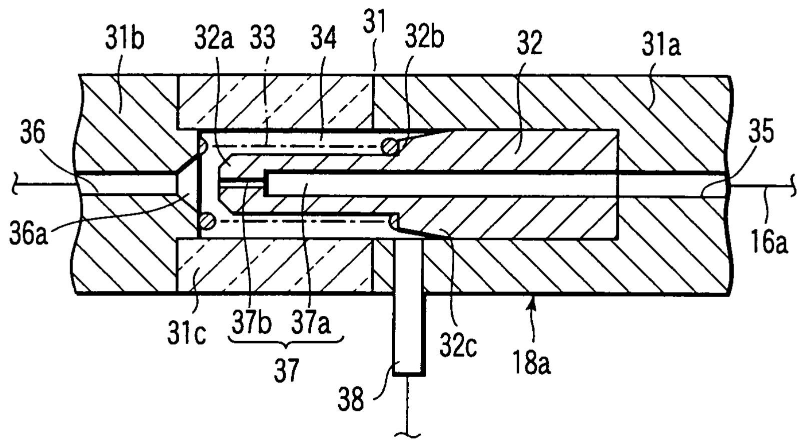


FIG. 4

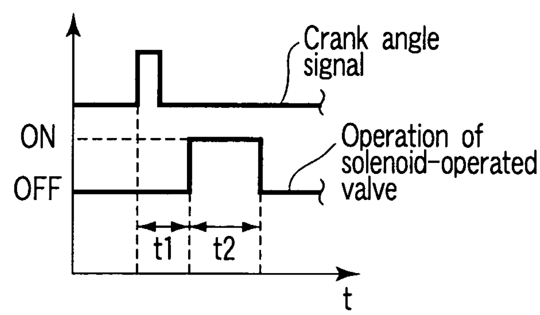
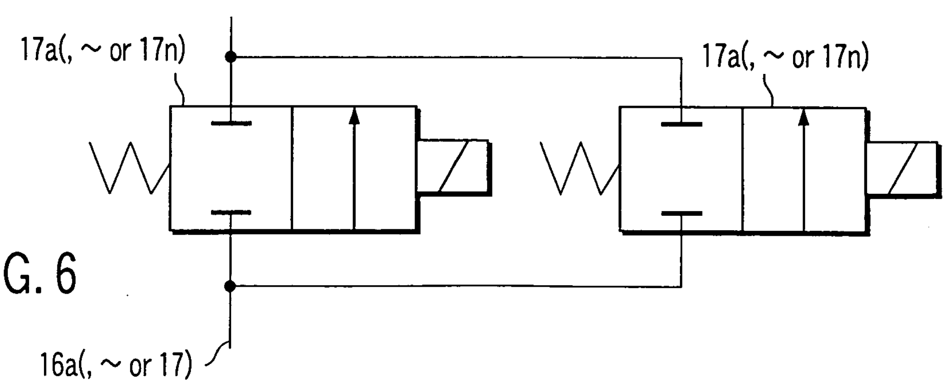


FIG. 6



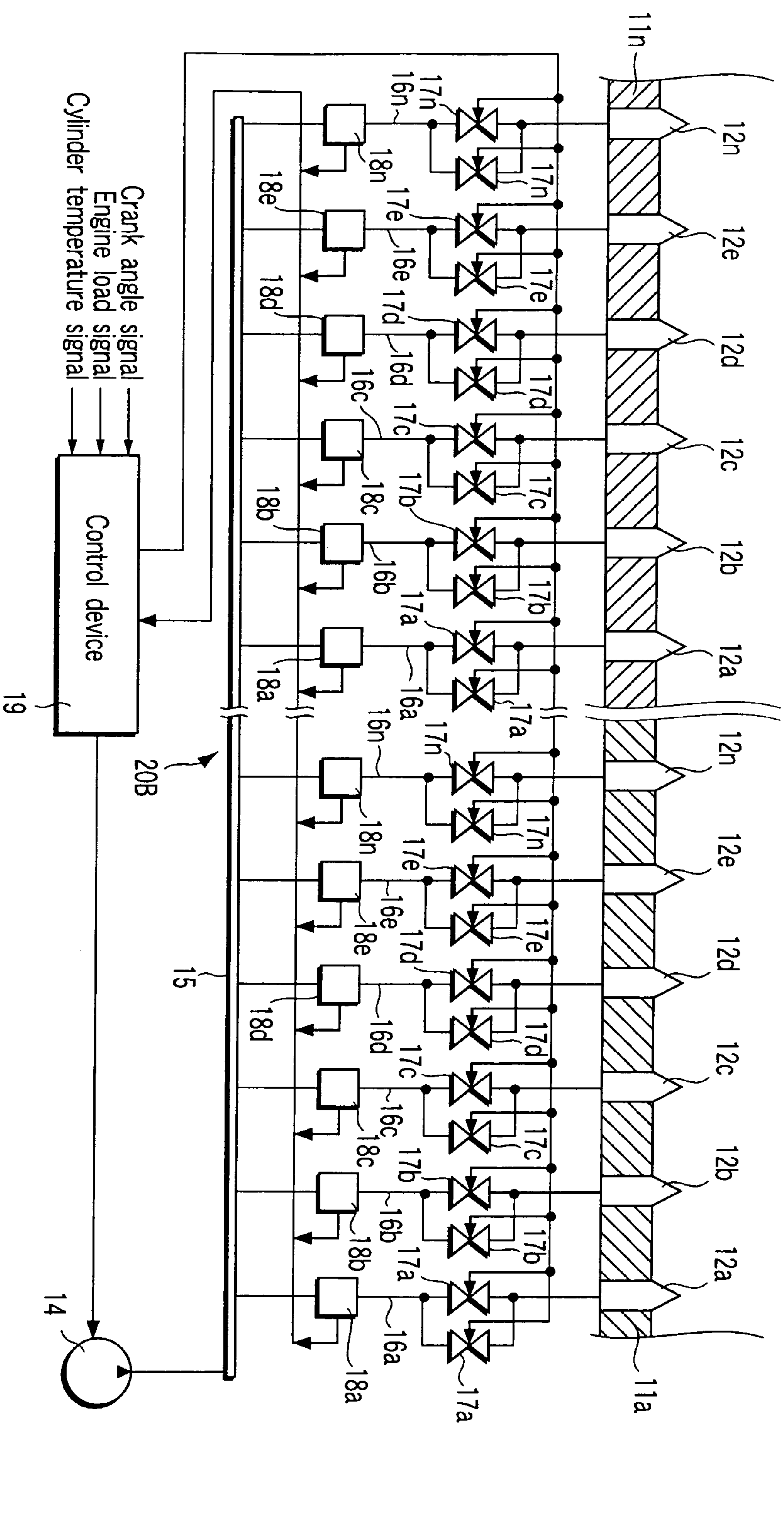

Crank angle signal
Engine load signal
Cylinder temperature signal
Control device
19
14
15
20B
11n
11a
12n
12e
12d
12c
12b
12a
16n
16e
16d
16c
16b
16a
17n
17e
17d
17c
17b
17a
18n
18e
18d
18c
18b
18a

FIG. 5

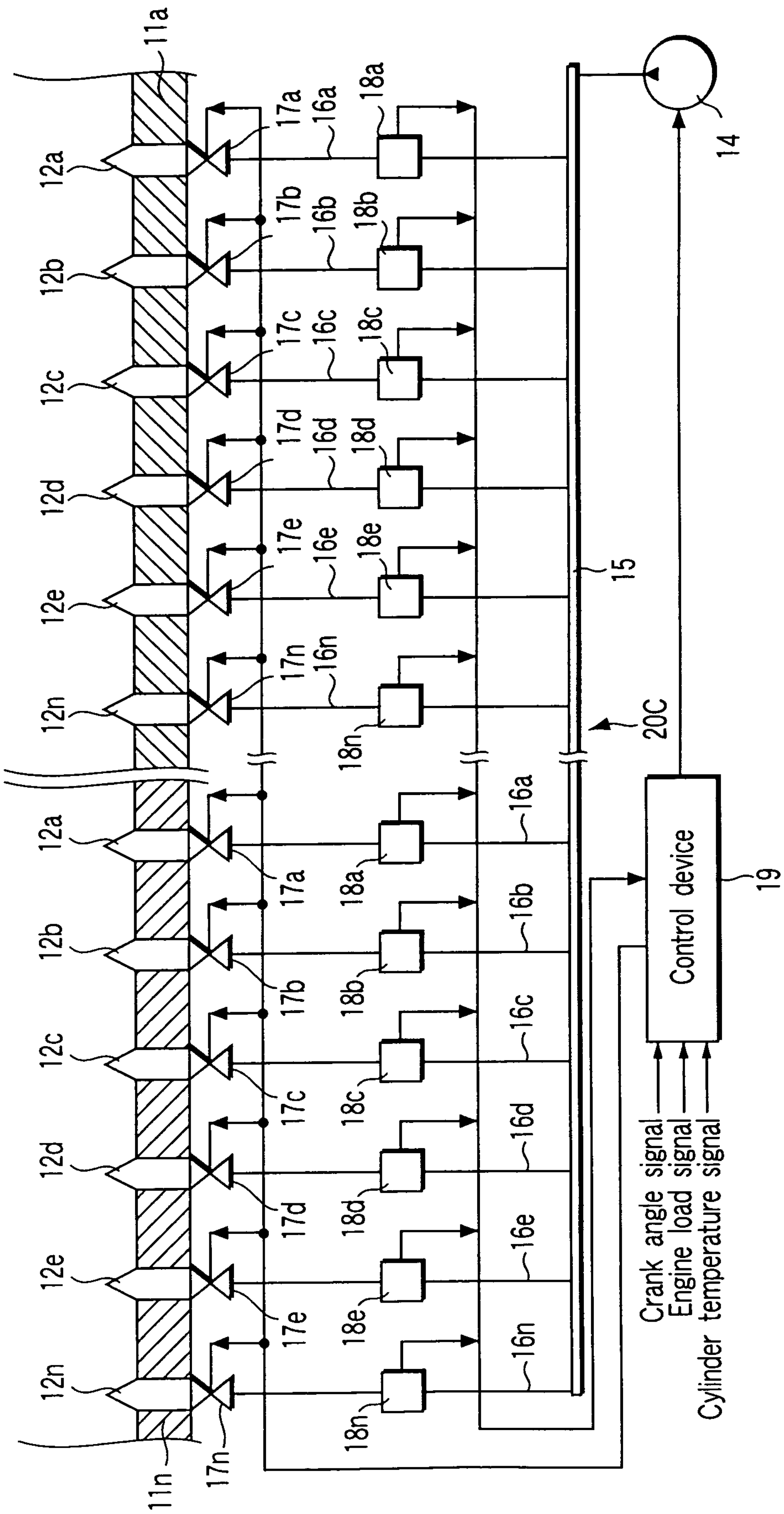
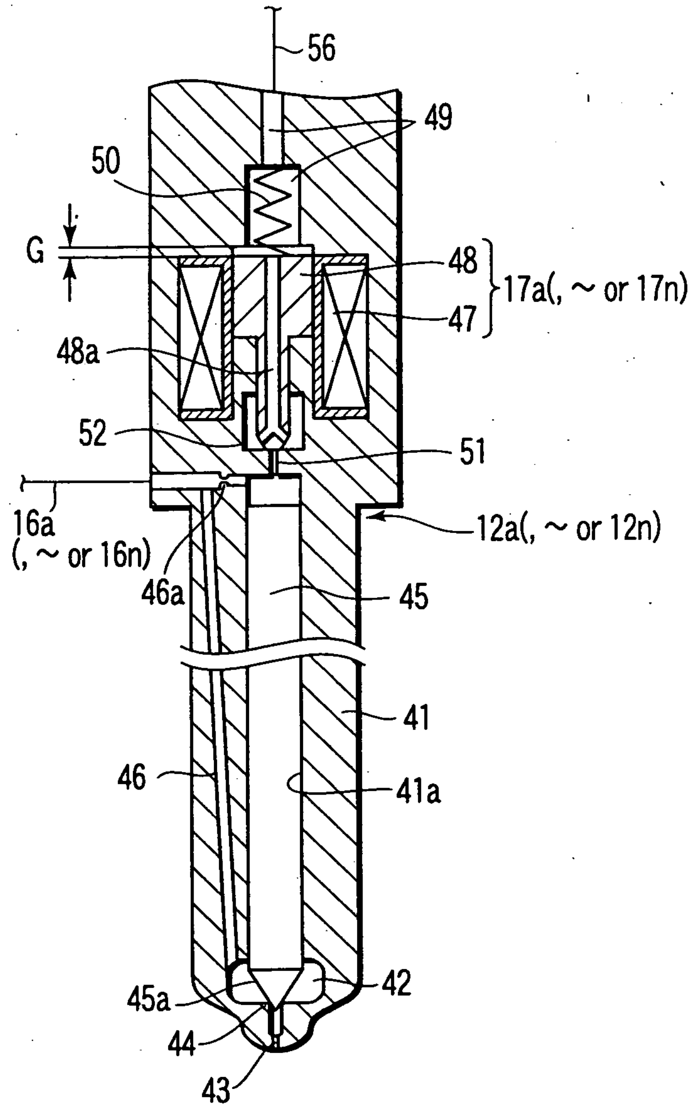
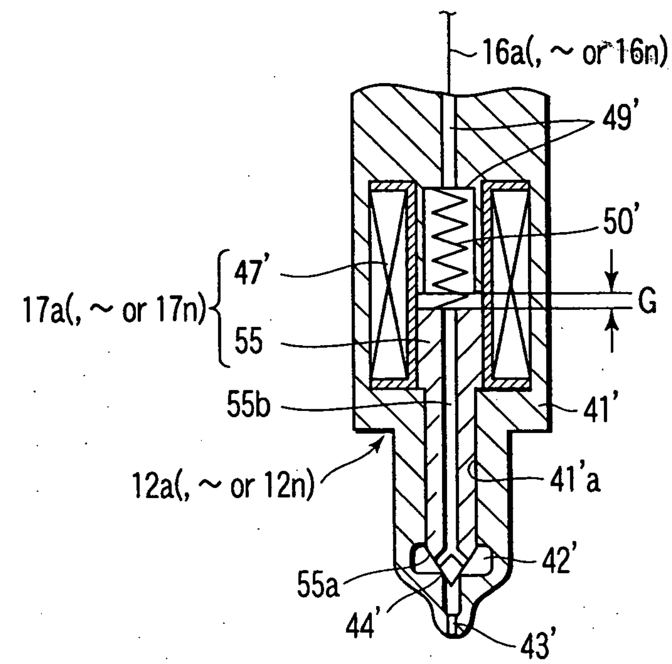

11a
12a
12b
12c
12d
12e
12n
17a
17b
17c
17d
17e
17n
16a
16b
16c
16d
16e
16n
18a
18b
18c
18d
18e
18n
14
15
20C
Control device
19
Crank angle signal
Engine load signal
Cylinder temperature signal
11n

FIG. 7


56
49
50
G
48
17a(, ~ or 17n)
47
48a
52
51
16a
(, ~ or 16n)
12a(, ~ or 12n)
46a
45
41
46
41a
45a
42
44
43

F I G. 8A


16a(, ~ or 16n)
49'
50'
47'
17a(, ~ or 17n)
55
G
55b
41'
12a(, ~ or 12n)
41'a
42'
55a
44'
43'

F I G. 8B

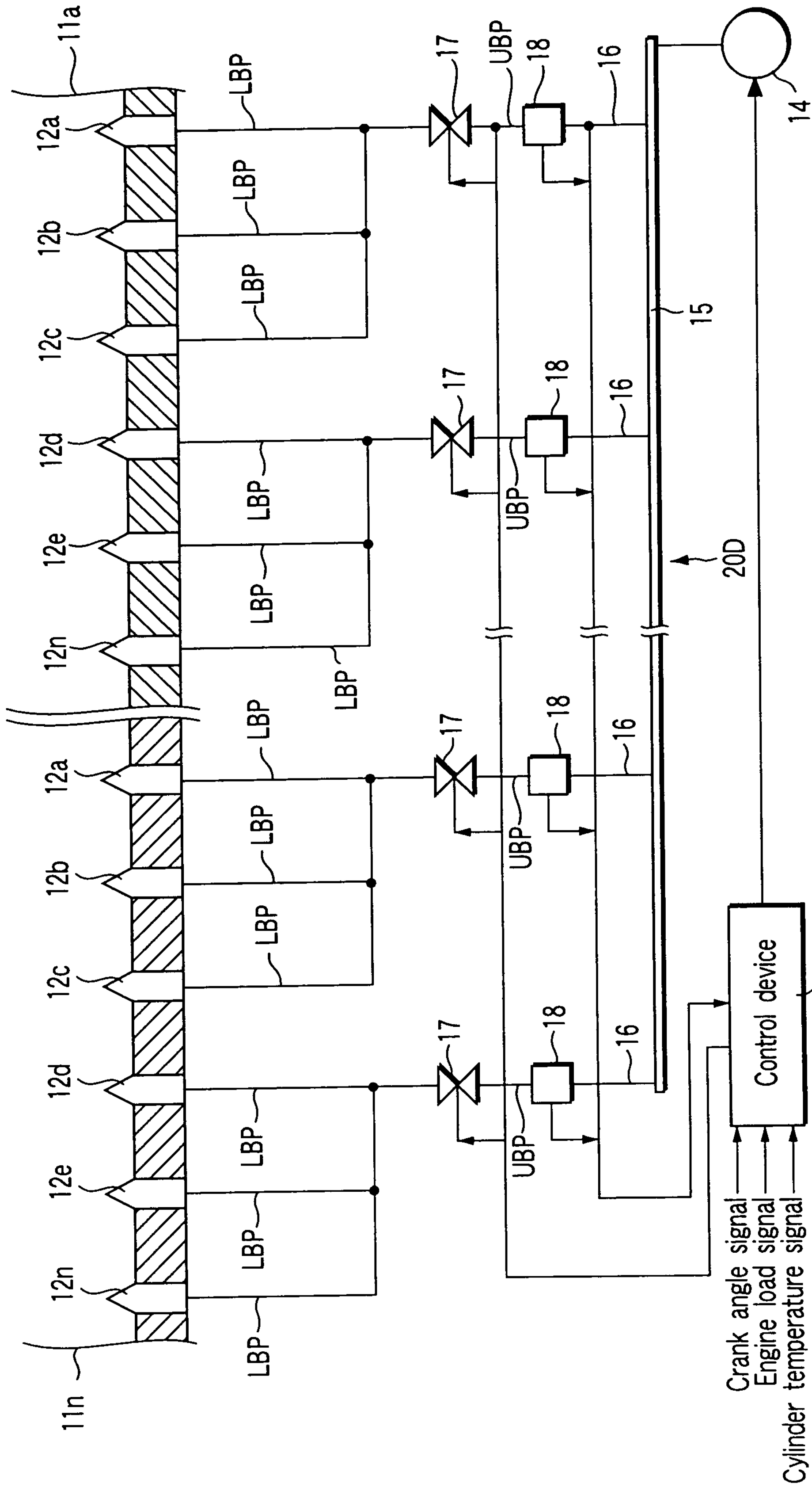

11a
11n
12a
12b
12c
12d
12e
12n
LBP
UBP
14
15
16
17
18
20D
Control device
19
Crank angle signal
Engine load signal
Cylinder temperature signal

FIG. 9

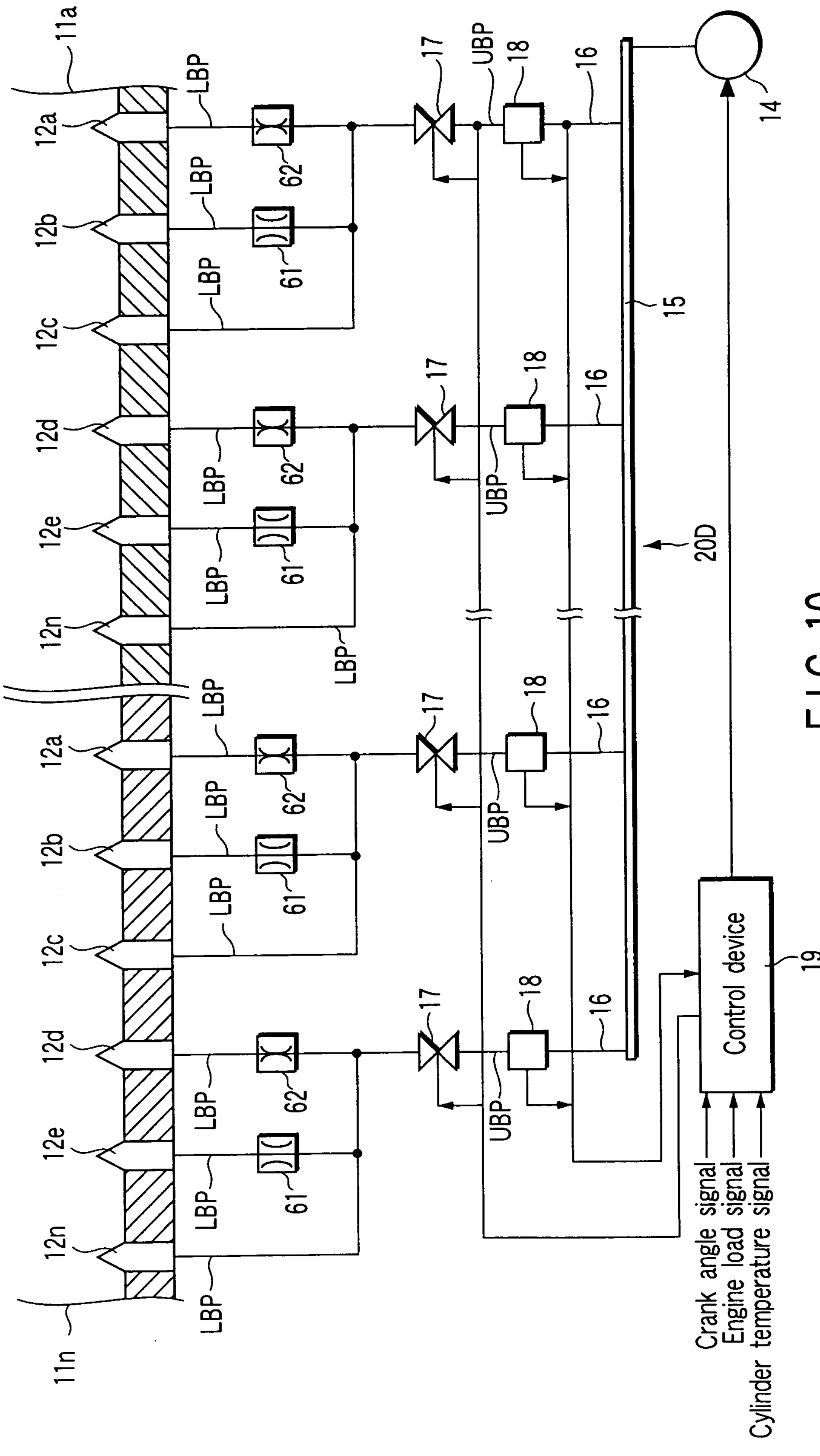

11a
11n
12a
12b
12c
12d
12e
12n
LBP
UBP
61
62
17
18
16
15
14
20D
Control device
19
Crank angle signal
Engine load signal
Cylinder temperature signal

FIG. 10

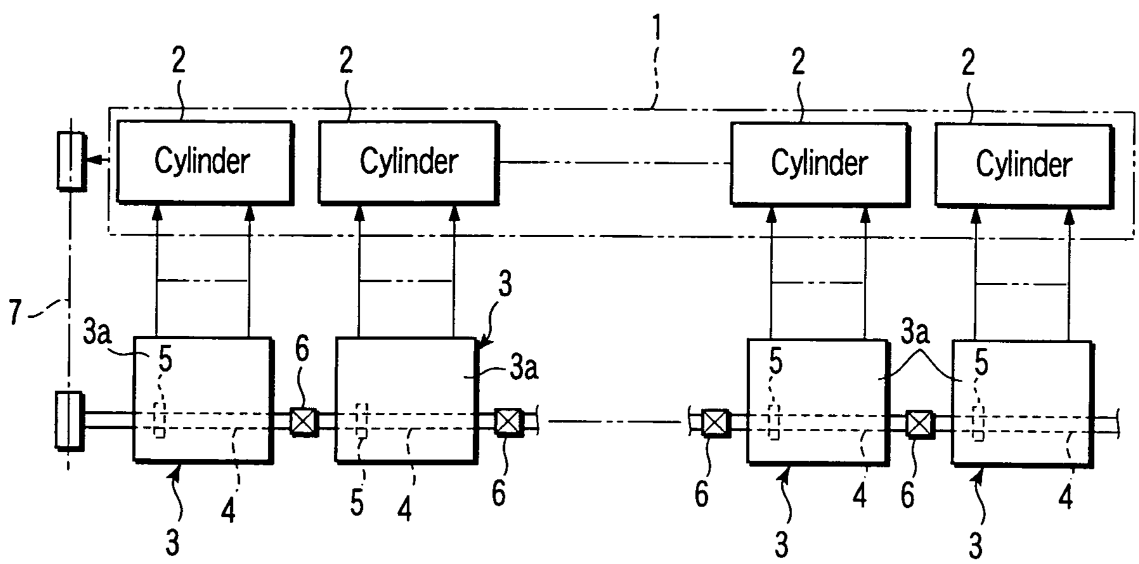

1
2
2
2
2
Cylinder
Cylinder
Cylinder
Cylinder
3
7
3a
5
6
3a
3a
5
5
6
6
6
4
5
4
6
4
4
3
3
3

FIG. 11