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(54) **System and method for dosing cylinder lubrication oil into large diesel engine cylinders**

System und Verfahren zur Dosierung von Schmieröl in große Dieselmotorzylinder

Système et procédé de dosage d'huile de graissage de cylindre dans de grands cylindres de moteur diesel

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Description

Field of the Invention

[0001] The present invention concerns a dosing system for cylinder lubrication oil in large diesel engine cylinders, e.g. in marine engines, including:

- a lubricating oil supply that may be constituted by a pump station or an accumulator;
- a supply line from the lubricating oil supply;
- a number of injectors having an inlet, an opening/closing valve unit and one or more nozzle apertures for injecting cylinder lubricating oil into an associated cylinder, and which are connected with the supply line, and corresponding to the number of cylinders in the engine or a multiple thereof; and
- a control unit controlling each opening/closing valve unit.

[0002] The invention further concerns a method for dosing cylinder lubrication oil into large diesel engine cylinders, e.g. in marine engines, including the steps of:

- pressurising the lubricating oil in a lubricating oil supply that may be constituted by a pump station or an accumulator;
- conducting the lubricating oil through a supply line from the lubricating oil supply;
- injecting the lubricating oil via a number of injectors having an inlet, an opening/closing valve and one or more nozzle apertures into an associated cylinder as the injector is connected with the supply line; and
- controlling each opening/closing valve unit by means of a control unit.

[0003] Furthermore there is described an injector for use in a dosing system for cylinder lubrication oil in large diesel engine cylinders, e.g. in marine engines, including:

- a lubricating oil supply that may be constituted by a pump station or an accumulator;
- a supply line from the lubricating oil supply; and
- a number of the injectors each having an inlet for connecting to the supply line, an opening/closing valve unit and one or more nozzle apertures for injecting cylinder lubricating oil into an associated cylinder; and
- a control unit controlling each opening/closing valve unit.

[0004] The invention is primarily intended for use in an electromagnetically controlled injector where the dosed amount is controlled via the opening time of a valve. This is different from other lubricating systems where the dosed amount is typically volumetrically controlled. The dosed amounts of oil can e.g. be in atomised form with direct control of spray as the valve has a built-in pump. In a system operation will primarily be performed with a valve which can be controlled by an electromagnet.

Background of the Invention

[0005] Today, both mechanical, hydraulic, and electromechanical cylinder lubricating systems exist.

[0006] Prior art solutions today based on time-controlled dosing have the disadvantage that the amount is very dependent on flow and viscosity conditions in oil supply lines.

[0007] From EP 0 049 603 A1 is known an electromechanical injector. A flow detector is used which has integrated switch function and which emits a signal when flow is present. The flow is monitored by the flow detector and the duration of the flow is compared with manually determined limit values. These are not flow measurements but only control of start and stop of a flow signal.

[0008] From EP 1 426 571 is known an injector and a cylinder lubrication system. This technique is based on a system where a solenoid valve is provided for each cylinder, the valve opening/closing for the flow to the individual valves. This design has the drawback that great demands are put on flow and viscosity conditions being uniform in the oil supply line in order to avoid different amounts of oil being delivered to each of the valves. For example, distances and temperature conditions in the oil supply lines are to be kept very uniform in order to ensure an even distribution among all lubrication points. In practice, this is big problem. The prior art has another disadvantage. By monitoring of the operation is used a pressure sensor which monitors the supply pressure to all the injectors. From practical experiments the control has learned to recognise patterns of one or more failing valves. This method puts great demands on the empirical data to be used for supervising the injectors, and for the same reason uncertainty in this matter occurs.

[0009] From EP 1 426 571 is also known local injectors that are based on using a needle valve with a valve body in the form of a needle and a corresponding valve seat. If the needle is inclined relative to the seat or not aligned with the seat, a leak occurs. The needle is therefore to be guided so that the needle is not displaced radially relative to the valve seat. This is typically achieved by having fine tolerances and fit of needle and valve boring (needle guide) in which the needle is positioned. There are drawbacks by this design as the injectors typically have a considerable length since they extend through a relatively thick cylinder wall and lining. The valve seat is to be as close as possible to the nozzle aperture in order to reduce the dead volume to be moved/accelerated before the valve begins to deliver the oil. This means that the relatively fine tolerances on the boring of the nozzle in which the needle is positioned and the needle are to be provided with great length in order to ensure that the needle is centred correctly in the seat. This fine tolerance and fit between the needle guide and the needle means that the valve is sensitive to dirt in piping and lubricating oil as it can get stuck in the very narrow gap appearing between the needle and the needle guide, meaning that relatively great demands are made to the purity of the oil supplied to the injector. This may cause the needle to be displaced off-centre relative to the seat or the needle movement to be blocked. In both cases there is a reduction of the valve function. This means that great demands are put on purity of the oil supplied to the injector.

[0010] From EP 1 582 706 a system is known which corresponds to the system and method mentioned by way of introduction. This document does not disclose that the dosing system includes a flow measuring unit. Accordingly, the document neither discloses how such flow measuring unit shall be arranged in relation to the injectors and/or to the cylinders. The document neither discloses how the flow measuring units are connected with the control unit. The document neither discloses how a regulation shall be effected based on the signals received by the control unit.

[0011] JP 2271019 discloses a lubrication device for injection of lubricant into an air/fuel mixture in the air intake in order to mix the lubricant with the air/fuel mixture before being sucked into the motor. The document relates to a quite different motor technology for a small combustion engine. There is no disclosure of lubricant which is injection through injectors into the cylinder. This document discloses that a controller controls the quantity of lubricant based on temperature of a sliding part and the revolution of the engine. This document does not disclose that load/index signals shall be delivered directly to the control unit for controlling timing and dosing of one or more of the nozzles which inject lubricant into the air/fuel mixture. I the system discloses there is no disclosure of a need to control the timing for the lubricant injection depending on reference signals form the engine.

[0012] US 4 913 108 discloses a system corresponding to the system disclosed in JP 2271019. This publication does not disclose any injector for injection of lubrication oil into the cylinder. The document relates to a quite different motor technology for a small combustion engine. It is disclosed that lubrication oil is delivered into an intake manifold in a vacuum system. A flow sensor is used for determining the amount of oil delivered from a pump and there is no disclosure of a sensor which is able to determine the amount of oil entering a specific cylinder.

[0013] In practice, in some cases it can be difficult to ensure sufficient purity of the supplied lubricating oil, e.g. during installation or replacement of the injectors or in connection with standstill for a long time. In these cases, a filtering in the supply to the injectors corresponding to the typical gap width of 5-10 μm or less would be desirable, but such a fine filtration has appeared difficult to establish in practice. Typically, there will be problems of establishing a stable supply of lubricating oil where the filter does not get clogged/blocked at frequent intervals. In general, central filters are used for the entire system as local filters at each cylinder or injector are difficult to mount and maintain. Typically, there are no problems with central filtration of the oil which is sufficient to avoid blocking of nozzle aperture(s) in individual injectors. In some cases is used a strainer/filter which is installed locally on the individual injectors. But these are difficult to access and difficult to clean and service. For a dosing system for cylinder lubricating oil is used a number of electromechanical injectors mounted in the cylinder wall and delivering lubricating oil into the cylinder. For injectors it is a fact that they operate with a needle valve and:

- that the injectors are located through a cylinder lining and possible cooling jacket which means that the distance from external contour to internal cylinder diameter is between 80 and 200 mm. Thereby there will be a need for a long needle, and the length of the needle to be guided is proportional with the length of the needle. It is necessary to guide close to the valve seat with regard to the sealing between the needle and the seat. A relatively long needle guide therefore appears, implying a great risk that dirt and foreign bodies can wedge and damage the function of the valve.
- that the valve seat on the injector is to be as close as possible to the nozzle aperture of the injector in order to minimise the dead volume between nozzle opening and valve seat.
- that special requirements are made to the design and making, and it is necessary to have relatively fine tolerances on the fit between needle guide and valve body/needle in order thereby to ensure that the valve body/needle are centred correctly in relation to the valve seat.

[0014] In practice, when working with needle valves it can be difficult to filter off particles in the lubricating oil with a size down to the typical gap opening used in needles, namely 5-10 μm or less. Typically, central filters are used for the entire system as cylinder local filters will be difficult to mount and maintain. Typically, there is no problem with filtering the oil locally or centrally with a filter that filters off particles larger than 0.01 mm; in practice experience typically shows that only a central filter with a mesh width of 0.025 mm or larger can be applied. Such a filtration is sufficient to avoid clogging of the nozzle aperture or apertures in the individual injectors. In order to prevent possible contaminated oil from blocking/jamming in the gap between the needle and the needle guide, there is a need for a large gap and a new type of valve body and valve seat since a larger gap will make a needle valve unsuited for use.

Object of the Invention

[0015] It is the purpose of the present invention to indicate a lubricating system and a method for dosing lubricating oil where the drawbacks of the prior art systems are avoided.

[0016] Moreover, the object of the invention is to indicate an injector that contributes to avoid drawbacks of the prior art systems and which will be more robust/reliable and simple in operation.

Description of the Invention

[0017] The objective is achieved with a system and method as described in the independent claims.

[0018] In order to overcome the drawback of dependence on flow and viscosity in the supply lines, the system according to the invention is peculiar in that the dosing system includes a flow measuring unit for each injector and/or for each cylinder, that the flow measuring units are connected with the control unit for use in a closed loop regulation, that signal lines are connected to the control unit for delivering load/index signals directly to the control unit for controlling, timing and dosing of one or more injectors per cylinder, depending on reference signals form the engine and that each injector is made as a unit, that the opening/closing valve is an electromechanical valve integrated in the injector for dosing the lubricating oil, where the electromechanical opening/closing valve includes a spring-biased valve stem.

[0019] The method according to the invention is peculiar by the step of a local flow measurement for each injector and/or a cylinder central flow measurement of the actually dosed amount of oil per cylinder, transmitting result of flow measurement to the control unit, comparing the flow measurement of the actually dosed amount of oil with an expected/planned amount of oil, and by the step of delivering load/index signals directly to the control unit for controlling timing and dosing of one or more injectors per cylinder, depending on reference signals from the engine and by the step of the control unit transmitting a control signal to the opening/closing unit for regulating timing and amount of oil to the required extent and that dosing of lubricating oil is performed by activating an opening/closing valve in the form of an electromechanical valve integrated in the injector for dosing the lubricating oil, for moving the valve stem of the opening/closing valve by injection of the lubricating oil.

[0020] In this connection, the period from activating injector to start of flow signal can be used for adjusting the injection timing of the system. Allowance can thus be made for possible changes in timing (delayed and accelerated delivery of lubricating oil) due to viscosity conditions. Deviations in viscosity conditions are interesting since they determine timewise execution and can cause faster or slower timing for the injection.

[0021] The injector is peculiar in that the opening/closing valve includes a ball valve body and an interacting valve seat, and that between a stem of the valve body and a wall in a valve guide of the opening/closing valve there is a gap with a width exceeding 10 μm.

[0022] The cross-sectional dimension of a nozzle aperture is typically the diameter of circular nozzle apertures.

[0023] According to a further embodiment of the invention, the dosing system is peculiar in that the control unit includes a local control box for each cylinder, controlling timing and dosing of all injectors per cylinder.

[0024] According to a further embodiment of the invention, the dosing system is peculiar in that four to ten injectors are used for each cylinder.

[0025] According to a further embodiment of the invention, the dosing system is peculiar in that a local pressure accumulator is provided for each injector or for all the injectors associated with each individual cylinder.

[0026] According to a further embodiment of the invention, the dosing system is peculiar in that each injector has an outlet for connection with a return line for conducting excess oil back to the lubricating oil supply or for performing pressure measurements.

[0027] According to a further embodiment of the invention, the dosing system is peculiar in that each injector is made as a unit, that the opening/closing valve includes a ball valve body and an interacting valve seat, and that between the stem of the valve body and the wall in the valve guide of the opening/closing valve there is a gap with a width exceeding 10 μm.

[0028] The dosing system is peculiar in that each injector is made as a unit, that the opening/closing valve is an electromechanical valve integrated in the injector for dosing the lubricating oil, where the electromechanical opening/closing valve includes a spring-biased valve stem.

[0029] According to a further embodiment of the invention, the dosing system is peculiar in that it includes flow measuring units with the same operation range for each injector and for each cylinder, and that the control unit is connected with all the flow measuring units and adapted for receiving signal from the flow measuring units at the injectors at relatively large flow rates and for receiving signal from the cylinder central flow measuring units at relatively small flow rates.

[0030] According to a further embodiment of the invention, the dosing system is peculiar in that it includes flow measuring units with different operation range for each injector and for each cylinder, that the control unit is connected with all the flow measuring units, that the flow measurement units with the lowest operating range are the local flow measuring units which are connected with the injectors, and that the flow measuring units with the highest operating ranges are the cylinder central flow measuring units.

[0031] According to a further embodiment of the invention, the dosing system is peculiar in that it only includes one cylinder central flow measuring unit which is combined with at least one local flow measuring unit connected with an injector.

[0032] According to a further embodiment of the invention, the dosing system is peculiar in that it includes a combination of a cylinder local flow measuring unit and an injector local flowswitch.

[0033] According to a further embodiment of the invention, the method is peculiar in that the injector local flow measurement is performed in combination with a central flow measurement per cylinder. In this way is achieved a more exact measurement wherein by relatively large flows the measurements from the local flowmeters on the individual injectors can be used and by the lesser flows (e.g. at low engine speeds and by small dosing amounts) the cylinder central flowmeters are used. The reason for this is that it is necessary that the dosing amount per injector is to "cover" a relatively large area.

[0034] An alternative embodiment will be that instead of using the same flowmeters (with same capacity), one may use different flow measuring units with different flow ranges, where the flow measurement unit with the least flow range is situated locally on the individual injector and the flowmeter with the greatest flow range is situated centrally of the cylinder. This method provides that the flow measuring system can more easily provide more precise flow measurements over the whole flow range.

[0035] An alternative embodiment will be to combine a central flowmeter with minimum one flowmeter mounted on one of the injectors. In that way is provided a measuring system which can handle large as well as small flows and a cheaper and more maintenance-free setup where the number of flowmeters is limited.

[0036] According to a further embodiment of the invention, the method is peculiar in that the supply pressure in the supply line is monitored.

[0037] According to a further embodiment of the invention, the method is peculiar in that the supply pressure in the supply line is used as parameter for controlling the dosing amount.

[0038] The method is peculiar in that dosing of lubricating oil is performed by activating an opening/closing valve in the form of an electromechanical valve integrated in the injector for dosing the lubricating oil, for moving the valve stem of the opening/closing valve by injection of the lubricating oil.

[0039] According to a further embodiment of the invention, the method is peculiar in that timing and dosing amount are controlled by the opening and closing time of the electromechanical valve.

[0040] According to a further embodiment of the invention, the method is peculiar in that flow measuring units with the same operating range are established for each injector and for each cylinder, that the control unit is connected with all the flow measuring units, that by large flow rates measurements from local flow measuring units at the injectors are selected, and by relatively small flow rates the measurements from the cylinder central flow measuring units are selected.

[0041] According to a further embodiment of the invention, the method is peculiar in that flow measuring units with different operation ranges are established for each injector and for each cylinder, that the flow measuring units with the lowest operating ranges are selected as the local flow measuring units which are connected with the injectors, and that the flow measuring units with the highest operating ranges are selected as the cylinder central flow measuring units.

[0042] According to a further embodiment of the invention, the method is peculiar in that only one cylinder central flow measurement is performed, and that this is combined with at least one local flow measurement at an injector.

[0043] According to a further embodiment of the invention, the method is peculiar in that flow measurement is performed as a combination of a cylinder local flow measurement with a cylinder local flow measuring unit and an injector local flow registration with an injector local flowswitch.

[0044] Further the injector is peculiar in that the valve seat is conical.

[0045] Further the injector is peculiar in that the area of the gap at least corresponds to the total area of the nozzle aperture(s) of the injector.

[0046] Further the injector is peculiar in that the injector includes a filter and that the gap of the opening/closing valve at least has the same width corresponding to half of the mesh width of the filter.

[0047] Further the injector is peculiar in that it includes an electromechanical actuator, preferably in the form of a solenoid valve or a piezo-electric element.

[0048] Further the injector is peculiar in that it has an outlet for connection with a return line for draining off excess oil or for performing pressure measurements. Further the injector is peculiar in that the injector includes a flow sight glass or a flowswitch for visually or electronically indicating an actual flow.

[0049] Further the injector is peculiar in that it is adapted to operate at a supply pressure between 30 and 100 bar.

[0050] Further the injector is peculiar in that it is adapted to operate with compact jet(s).

[0051] Further the injector is peculiar in that it is adapted to operate with atomised spray(s).

[0052] Further the injector is peculiar in that the gap width between the stem of the valve body and a boring in which the stem is received is at least half the size of the cross-sectional dimension of a nozzle aperture.

[0053] For each injector or for all injectors associated with a cylinder, a pulsating flow is to be measured concurrently.

[0054] In case of failing injectors, the other injectors can automatically supplement/replace one or more failing injectors based on the control in the control unit and the closed loop regulation.

[0055] It is preferred to have the opening/closing function of the dosing unit integrated in the injector while at the same time the control is designed so that based on actual measurement of consumption/flow, the delivered amounts can be controlled, hereby removing uncertainty due to viscosity (temperature, oil type), distances and diameters of supply lines.

[0056] The basic idea of using an injector with integrated opening/closing valve, preferably a solenoid valve, such that both piping and drawing of cables are appreciably simplified by only having one common supply line of pressurised lubricating oil (without need for a return line) provides that the dosing becomes proportional with the time where the opening/closing solenoid valve is open. Preferably, there is a separate local control box which is used for opening/closing the injector based on signals from the engine/control unit of the ship.

[0057] An electromechanically regulated injector designed for cylinder lubrication of large diesel engines entail advantages in relation to prior art lubricating systems. Systemwise it can regulate individually with regard to lubricating oil amount and timing.

[0058] The function is only dependent on a control box which can control each single injector separately or together with regard to timing and opening time. This can occur independently of other opening/closing valves and is only limited by the speed at which the opening/closing valve in an injector can execute the opening/closing cycle.

[0059] The measured flow is used for controlling the delivered amount in relation to the planned amount. By deviations of a given size for a given period of time, an associated local control box can correct the opening time for magnet valve(s) for the associated injector or injectors.

[0060] The injector is insensitive to particles which are smaller than the nozzle aperture and which are larger than the gap width. Operation can thereby be performed with a relatively coarse filtration of the oil. There is no risk of a valve body/ball will get stuck even if the oil contains small particles with sizes of 10 μm or larger. It will be no problem to operate with gap widths of 10 μm and up to 0.3 mm or larger in the opening/closing valve. The seat in the valve is designed as the seat in a check valve, typically with a conical shape, and the oil pressure in the valve will together with a closing element/spring keep the valve closed.

[0061] Even if a particle which is larger than the gap width (measured as a difference between radius of valve body/valve stem and radius of the boring of the valve housing in which the valve stem is disposed - radius difference) comes into the valve such that the valve stem is inclined or displaced to an off-centred position where the valve seat and the valve stem are not aligned, then the ball shape will ensure that the valve keeps tight. Inclined position can possibly also occur due to engine vibrations. This tightness is also ensured with a relatively large gap opening between the valve body and the wall in the boring.

[0062] The only critical wearing surface is the valve seat which is self-adjusting, providing great reliability of the valve function in the injector.

[0063] An alternative embodiment could be that instead of using a flow measuring unit with direct measurement of flow, an indirect method for determining flow is used. For example, one could use a flow measuring unit where a flowswitch (flow indicator) is used where it is presupposed that pressure and temperature are uniform such that the signal duration can be measured, thereby providing a signal which is proportional to the dosed amount to the control unit. For example, such an alternative embodiment can be provided in the form of a flow measurement unit where a ball is lifted off a ball seat and where a sensor is mounted for detecting this condition. In order to make the measurement independent of the viscosity, it can be necessary to integrate the flow measurement unit in a box with constant temperature, e.g. with a thermostatic temperature regulation.

[0064] An alternative embodiment will be to design the dosing system such that a central flow measurement unit per cylinder is used, combining this with a number of injector local flowswitches (flow indicators) such that a total measurement of consumption is obtained while simultaneously providing certainty that a flow exist in all injectors. In that way, the flow measurement of the dosing system is simplified as only monitoring of the total flow into the cylinder is performed, and where the local flow measurement units are replaced by simple flowswitches (typically one per injector) which only indicate the presence or absence of flow. The flow measuring unit is connected to the control unit or local control boxes controlling the injectors for each individual cylinder, and herein the planned and actual flows are compared. In case of deviations, the flowswitches can be used for considering if some injectors have stopped operating.

[0065] An alternative embodiment to the above mentioned dosing system could be that the control unit or the local cylinder control boxes, in addition to measuring the total actual consumption per cylinder, simultaneously compare flowswitch signals between the various injectors associated with the same cylinder such that a warning or an alarm is triggered to the user if deviation exceeding a given value occur, for example 20% of the time there is a flow signal.

[0066] An alternative use of the above mentioned flow signal could be that the period of time from activation of the injector to flow pulse start on the flowmeter is measured. This measured value is compared with a system-specific check measurement of the time which passes between activation of injector to the injector starting to dose. Presumably, both of the measurements will lie so close to each other that the signal from the flow measurement unit always can be used directly without any problems. In this way it is possible to control if the timing, i.e. the time for activating the solenoid, has to be adjusted in case that the deviation attains a given value.

[0067] A further possible embodiment of a dosing system could include a flow measuring unit in the form of a traditional oval-rotor based flow measuring unit. The drawback of this type of measuring unit is that typically it is not suited for a particularly large flow range as a given amount is required for turning the rotors one revolution, thereby causing emission of a signal. To this is added that the pulsating delivery of lubricating oil does not provide an even operation of the flow measurement unit. In order to obtain some usable measurements, it may be required to vary the period over which the pulses are counted. Starting with the expected flow, the local control box is to vary the period of time in which flow pulses are counted, and at the same time preferably making a continuous calculation with continuously overlapping periods. Based on empirical experiments, for a given flow measurement unit the correlation between a given flow interval and the number of pulses is to be established which is to be integrated in the local control box.

[0068] For a cylinder is used between four and ten injectors, depending on engine size and type.

[0069] The dosing system operates via a pressurised supply line with lubricating oil. The lubricating oil is kept at a constant pressure, and with regard to minimising disturbances/variations in the pressurised supply line to the individual cylinders/injectors, there may be a need for disposing accumulators per injector and/or centrally per cylinder.

[0070] Alternatively, for using accumulators in the system, one could use supply pipes with greater clearance such that the pipes become accumulators by themselves.

[0071] Timing of dosing the lubricating oil is either controlled locally or centrally. The activation time is continuously adapted, depending on the reference signals of the engine.

[0072] In order to monitor the function of injectors, various solutions can be used:

Primarily, concurrent flow measurements are used where the actually dosed amount is compared with the expected flow. This flow measurement can either be performed locally per injector or centrally per cylinder such that the actually dosed amounts can be used for a closed loop regulation.

[0073] In case of deviations, these are processed/handled by the local or the central control box, respectively. For example, the control is to be capable of identifying any problems with one or more injectors.

[0074] In combination with the above mentioned flow measurements, the supply pressure can be monitored in the pressurised supply line.

[0075] An alternative embodiment could be that a flow measurement unit can be used locally as well as having an additional control in the form of a central flow measurement unit.

[0076] It should be noted that the system to a certain degree may compensate for variations in pressure and thereby in delivery amount as the individual opening/closing times can be adjusted individually.

[0077] An alternative embodiment could be that the injectors for a cylinder (with separate control box per injector or cylinder) together ensure handling of errors, e.g. in the form of increasing the dosing amount at individual lubricating points or possibly via a cylinder central control box.

[0078] A control box controls timing and dosing of one or more injectors per cylinder, depending on reference signals from the engine (load, flywheel position and so on).

[0079] The local control box can be provided in immediate connection to an injector or alternatively be integrated in the individual injector.

[0080] The dosing amount is calculated from feed rate, choice of regulating algorithm, oil analyses, and other engine specific parameters, sulphur percentage, fuel type (residual TBN, Fe-contents etc.). These parameters are either read in automatically and directly or indirectly via a central control unit.

[0081] Alternatively, one may determine the minimum amount of lubricating oil to be supplied to a cylinder, either on the basis of the total area of the cylinder lining or exclusively on the basis of the area under the injection valves. The distribution and the starting point of the latter is then i.a. found as a function of the area conditions in the cylinder, possibly combined with some of the other parameters.

[0082] Alternatively, analysis of scavenge drain oil can be used as an active control parameter. Analysis of the drain oil can either be performed online or manually and on this background the amount of lubricating oil is regulated proportionally with the content of Fe particles. And if this does not improve the measured values within a given time, an alarm is raised.

[0083] Alternatively, one may use analysis of online measurements of residual TBN, either directly for adjusting distribution or as a combination of increased lubricating oil amount and a change of the distribution.

[0084] The injector according to this invention is equipped with ball valve body and an interacting valve seat which is typically conical but which also can be formed with a shape corresponding to the shape of the ball. Sealing is ensured even by large gap areas such that the gap area is not flow limiting, meaning that the area of the gap is at least to correspond to the total nozzle aperture area such that in case of several nozzle apertures per injector, the sum of the nozzle aperture areas is used.

[0085] In practice, this can mean that the gap can be as small as 0.005 mm as a particle of about 0.01 mm can press the valve body to one side and increase the gap width to 0.01 mm. Hereby, passage of particles with a size of 0.01 mm can be allowed without blocking the movement of the valve body and without the valve leaking as the ball body will fit tightly to the seat.

[0086] The gap width (radius difference) will, however, typically be about 0.15 mm or more since the nozzle apertures of the injector are typically 0.3 mm or more. Correspondingly, filters can be coarser and allow for larger particles, depending on the size of the nozzle apertures.

[0087] Use of the ball valve type can prevent dirt and particles from blocking the movement of the valve body as it can be operated in a secure way even with a large gap where there is spacing between the stem of the valve body and the boring such that the boring does not appear as a valve guide for the valve stem. Such a wide gap will make a needle valve unsuitable for the application.

[0088] The injector is simple to make, without close tolerances and complicated mounting.

[0089] The dosing system is simple to mount as there is only need for a common supply line per cylinder. All injectors are coupled on this supply line. There is no need for return lines, only an electric connection for each injector to a common control box which can be mounted locally on the individual cylinder. This provides serviceability and high reliability.

[0090] The solenoid in a solenoid valve can be a standard solenoid as used today. The injector has low power consumption as only the required lubricating oil amount is to be pumped up to the pressure level for injection.

[0091] It is possible to make the injector more intelligent by expanding the system which is particular embodiments may include sensors that are able to measure pressure, temperature or to take oil samples for analysis. Pressure provides information about piston position determination and knowledge about the load on the engine. Temperature says something about the condition in the cylinder. Oil samples can form basis for evaluation of the lubrication condition. On the background of data, injection time and duration can be calculated from a given control algorithm in the control unit.

[0092] Hereby is achieved the greatest possible redundancy as the probability of more than one injector failing at the same time is limited while at the same time the injector will continue its operation on already given data by network failure.

[0093] Installation and replacement of injectors are facilitated as they are self-adjusting.

[0094] Each injector has its own time-controlled dosing unit where timing and dosing amount are controlled by the opening and closing times of the injector.

[0095] The injector can either be provided with an atomiser valve or a valve with one or more jets/compact jets. The injector can be made in an embodiment where it only supplied with pressurised lubricating oil and without return lines. Typical supply pressures are between 30 and 100 bars.

[0096] The valve function of the injector is a ball valve.

[0097] The injector can be actuated electromechanically, for example in the form of a solenoid valve or piezomechanical element.

[0098] An alternative embodiment could be that the injector is equipped with a flow sight glass or a flowswitch for visually or electronically indicating an actual flow. In this way is provided a direct indication of the individual injector being active and functioning. On some engines, individual injectors are situated at difficult accessible locations, and here it will be advantageous with electronic monitoring which is detected locally but reported centrally. An example of such a solution could be a conical boring in a ball control glass in which a sensor detecting a ball is disposed.

[0099] Conclusively, the advantages of the invention can, among others, be said to include:

- Viscosity-independent injector/lubricating system.
- Simplified injector design.
- Simplified system - installationwise, maintenancewise.
- Robust and flexible system which is unaffected by single failing injectors.
- Possibility of optimising spray/lubricating oil amount at each individual injector, and thereby possibility of an integrated optimisation (not too little and not too much, respectively) at the individual injectors as opposed to previous systems where all injectors were evenly distributed.

Description of the Drawing

[0100] The invention will now be explained more closely with reference to the accompanying drawing, where:

Fig. 1	shows a schematic drawing of a dosing system according to the invention;
Fig. 2.1	shows further embodiment of a system according to the invention;
Fig. 2.2	shows a detail of the system shown in Fig. 2;
Fig. 3	shows further embodiment of a system according to the invention;
Fig. 4.1	and 4.2 show detailed views of an injector for use in the system according to the invention; and
Fig. 5	shows an alternative embodiment of an injector for use in the system according to the invention.

Detailed Description of the Invention

[0101] Figure 1 shows a complete lubricating system for N cylinders 1. Each cylinder is equipped with a number of X injectors 2 which are connected to a common lubricating oil supply line 31 having a constant supply pressure, e.g. in the magnitude 30 - 100 bars. The supply pressure is delivered by a hydraulic pump unit 10 which is supplied from the day tank 1000.

[0102] The pump station 10 includes two pumps 11, two filters 12 and two check valves 13 preventing the lubricating oil from running back through a still-standing pump 11. The pump station also includes two shut-off valves 14 that are inserted in the supply line 34 so that the filters 12 can be cleaned during operation. The two pumps 11 are standby for each other and start up automatically in case of a drop in oil pressure.

[0103] At the end of the supply lines 31 there is provided a pressure valve 20 or a stepless electronically controllable pressure valve 115 (the figure shows the latter in principle). Typically, the pressure in the supply line will be constant, and here is used a common pressure valve 20 where the pressure is constant. Alternatively, one can use the supply pressure in the supply line 31 as an additional parameter for the system such that it is possible to use various supply pressures depending on the amounts to be dosed, the time available for delivery (e.g.

3 - 6 crank degrees in order to impinge on the piston), viscosity conditions (oil type and temperature), and so on.

[0104] As shown on Figure 1, the pressure valve 20 can be an electronically controlled pressure valve with adjustable pressure which via the connection 505 to the general control 200 or possibly to a cylinder local control box 100. This adjustable pressure can be used as a parameter for the dosed lubricating oil amount.

[0105] Each cylinder is provided a branch pipe 22 coupled to the main supply 31. On the branch pipe 22 is mounted a flow measuring unit 4 that measures the actually supplied amount of lubricating oil. The signal from the flow measuring unit 4 is transmitted to a local control box 100 where the measured value is compared with the expected flow, and depending on the size of the deviation, the control box 100 can adjust the opening time for the individual injectors 2 for the cylinder in question.

[0106] On each injector 2 is mounted an electromechanical valve with a solenoid 1014. By activating the solenoid 1014, the injector is opened and the lubricating oil is delivered. The delivered amount of lubricating oil is proportional to the period in which the valve is kept open. However, this presupposes that the pressure in the supply line is constant, and for this purpose an accumulator 6 is provided.

[0107] A local control box 100 controlling opening/closing times for all associated injectors 2 are provided for each cylinder. By activating the injector 2, the lubricating oil is conducted from the supply line 31 branch pipes 22 through the flow measuring unit 4 and via a branch line 21 respective injectors 2. The flow measuring unit 4 that directly or indirectly measures the passing flow is connected to the local control box 100 where comparison between the expected and the actual flow is performed, from which possible corrections are calculated and the opening time for the solenoid 1014 of the injector is adjusted. In the shown embodiment, the accumulator 6 is provided between the flow measuring unit 4 and the branch piece 21 in order thereby to ensure an even flow across the flow measuring unit 4 where surges and return flow in the lubricating oil otherwise would disturb the flow measurement.

[0108] All the previously mentioned cylinder-specific control boxes 100 are connected to a main control box 200. From this main control box 200 operation information (e.g. planned lubricating oil amount) is transmitted to all connected units via signal cables 550 or via a network. In the same way, each local control box 100 also receives information about flywheel position via signal cables 601, and based on operational data from the main control box 200 the correct opening time and the associated opening period are controlled. In case of error, the local control box 100 triggers an alarm which is transmitted via signal cable 650 and via network.

[0109] The main control box 200 receives and transmits information from the marine engine about actual load, feed rate, oil pressure and temperature, and revolutions, and on this basis the correct activation time is calculated.

[0110] Alternatively to the embodiment shown in Figure 1, it will also be possible to let the engine central main control box 200 replace the local cylinder control boxes 100. This will require that the cylinder- or injector-specific flow measurement signals are all transmitted to the main control box 200 and hence that the main control box 200 controls all injectors. This procedure will simplify the control system but will require rather extensive drawing of cables. Particularly on smaller and compact engines, this variant could be usable.

[0111] Moreover, this embodiment would require that all flywheel reference signals (via signal line 601) and load/index signals (via signal line 501) are delivered directly to the main control box 200 from where possible alarm signals are emitted (via signal line 506). In this embodiment variant, the solenoid valves 1013 of the individual injectors will be activated directly from the main control box 200 via signal lines 120 and control the opening and closing of solenoid valves: common, individual, or both. Alarm signals are generated directly by the main control box and are transmitted via signal line 650 to the alarm system of the ship.

[0112] The Figures 2.1 and 2.2 show an embodiment variant where the cylinder local control boxes 100 are instead integrated in the individual injectors 2, meaning that the cylinder local control boxes 100 are substituted by injector local control boxes 101. This may necessitate using injector local individual flow measuring units 4.X, i.e. one flow measuring unit per injector 2, and possible individual accumulators that also are disposed between the flow measuring units 4.X and the injectors (this embodiment is not shown on the drawings 2.1 and 2.2 where only one local accumulator 6 per cylinder is shown).

[0113] The embodiments shown here are identical with the system described on Figure 1, i.e. the main control box 200 is also used here. The main control box 200 is now only processing the signals from the individual injectors and no longer the cylinderwise signals.

[0114] Figure 3 shows an alternative embodiment where all injectors are activated simultaneously such that the solenoids 1014 (associated with the cylinder concerned) are activated at once via a cable 120 that serially connects all the solenoids 1014 on the injectors associated with the same cylinder. In this embodiment there is a cylinder local control box 100 controlling all injectors and where cylinder local flow measuring units and possible accumulators are applied. This means that the system becomes more integrated and simple.

[0115] A possible alternative embodiment could be that instead of the cylinder local control box 100 mentioned in Figure 3, one injector local control box could control the remaining injectors based on one cylinder local flow measurements. As mentioned in connection with Figures 2.1 and 2.2, this variant will mean that one cylinder local control box is replaced by one injector local control box. Such an embodiment will be the absolutely most simple with a minimum of cables, flowmeters etc.

[0116] In principle, it is also possible with e.g. two or more injector local control boxes each controlling all injectors for one cylinder and independently of all others. If this is combined with a monitoring function in the active injector local control box 101, a redundant system can be built up where the succeeding injector is instructed to take over, e.g. via a relay access and a cable, due to error in a preceding injector. Finally, the injector local control box could be made to trigger an alarm when it fails when the preceding injector is failing at the same time.

[0117] Figures 4.1 and 4.2 show an injector as can be used in a system of the above mentioned type. On the Figure 3 is shown that each cylinder 1 has a number of injectors 2 (four are shown per cylinder on the drawing). Pressurised oil is supplied through the branch pipe 21 (see Fig. 2.1 and 3) to the injector 2 through supply channel 20100.

[0118] The injector shown in Figures 4 and 5 includes a nozzle 1001 which via an external screw thread is mounted in an internal valve housing 1006. The valve housing 1006 itself has a flange that partially rests upon the injector housing 1017 itself and partially upon an assembly flange 1007. The injector housing 1017 is fitted externally of the assembly of nozzle 1001 and valve housing 1006, and where the injector housing 1017 is mounted in a flange, e.g. by an interference fit. At the top, the internal valve housing 1006 consists of a flange with an O-ring groove and a subsequent turning that makes the valve housing 1006 continue a length up into the solenoid core/armature housing 1009. The O-ring 1008 ensures that the pressurised oil remains within valve housing 1006 and solenoid core/armature housing 1009. Around solenoid core/armature housing 1009 is provided a main flange 1010 which via screws 1011 clamps injector housing with nozzle, solenoid core/armature housing 1009 and assembly flange 1007. The nozzle/valve housing assembly 1001/1006 is located in the injector housing and by means of an O-ring 1002 it is ensured that no dirt or oil residues enter farther up in the injector housing 1017.

[0119] In the solenoid core/armature housing 1009 is located an armature/piston 1012 with an internal screw thread where the valve body 1003 is mounted, and where the threaded joint is secured by a pointed screw 1013. In the armature 1012 there are some channels 1023 for conducting the pressurised oil on in direction towards the nozzle. The possible travel of valve body/armature 1003/1012 is given by the cavity 20200.

[0120] In the injector 2, the oil is conducted through the injector via the cavity 20200 and through the channel 1023. The oil then continues out into the cavity 1022 and through the channel 1021 to the cavity 1020 from where the oil is conducted on via the gap 1030 to the cavity around the ball valve seat 1019. The gap is formed between the valve body stem 1003 and the wall 1031 in the boring in which the valve body stem is received.

[0121] When the solenoid 1014 is activated, the valve body 1003 is moved in direction against the solenoid 1014 until the cavity 20200 is filled by the armature/piston 1012. When the valve body 1003 with integrated ball 1016 is lifted off the ball seat 1019, pressurised oil is conducted through the valve seat 1019 via the channel 1018 out through the nozzle aperture 1040. When the electric signal through line 120 from the control box 100 to the injector solenoid 1013 is switched off, the spring 1005 ensures that the injector 2/ball seat 1019 is closed by pressing the valve body 1003 and armature/piston 1012 in direction against the ball seat 1019.

[0122] The spring 1005 shown in Figure 4 ensures that the valve is closed when the solenoid 1013 is switched off. In Figure 4 is shown that the spring force can be adjusted by adjusting the compression of the spring by a setting the position of the nut 1004. In practice, the necessary spring force for providing a satisfactorily rapid closing of the valve can be determined by empirical experiments as a compromise between solenoid fore and spring force is to be found; hence the compression will be constant and the "nut" be integrated in the valve body in the form of a rest/collar on which the spring bears.

[0123] When the ball seat 1019 is closed again, the pressurised oil in supply channel 20100/20200 will act on valve body 1003 such that spring 1005 and the oil pressure are both keeping the ball seat 1019 of the injector closed.

[0124] The injector valve function is performed by a ball valve body such as shown on Figure 4. It is possible to use injectors that spray and/or form oil jets, and to use injectors with one or more nozzle apertures 1040.

[0125] The injector controls by an electric signal 120 that enables free and independent control of when the injector/valve is to open and close, and thereby the opening period.

[0126] Figure 5 shows in principle a system that functionally corresponds to the system of Figure 4, however provided with an alternative embodiment for an injector where it is possible to provide pressure measurements or samples of possible lubricating oil residue from the cylinder through an outlet 20000 at the side of the flange. Externally of the nozzle/valve housing 1001/1006, the injector has a gap relative to the injector housing 1017, and through this gap there is communication to the outlet 20000.

Claims

1. A dosing system for cylinder lubrication oil in large diesel engine cylinders, e.g. in marine engines, including:

   - a lubricating oil supply that may be constituted by a pump station or an accumulator;
   - a supply line from the lubricating oil supply;
   - a number of multiple injectors in each cylinder, each injector having an inlet, an opening/closing valve unit and one or more nozzle apertures for

injecting cylinder lubricating oil into an associated cylinder, and which injectors are connected with the supply line; and

- a control unit controlling each opening/closing valve unit, wherein signal lines are connected to the control unit for delivering load/index signals directly to the control unit for controlling, timing and dosing of one or more injectors per cylinder, depending on reference signals from the engine;

characterised in

- **that** the dosing system includes a flow measuring unit for each injector and/or for each cylinder,
- **that** the flow measuring units are connected with the control unit,
- **that** the system is configured for closed loop regulation in which the actually dosed amount of lubricating oil is compared with the expected flow
- **that** each injector is made as an injector unit that is mounted in a wall of one of the cylinders,
- **that** the opening/closing valve is an electromechanical valve integrated in the injector unit for dosing the lubricating oil, where the electromechanical opening/closing valve in the injector unit includes a spring-biased valve stem.

2. Dosing system according to claim 1, **characterised in that** the control unit includes a local control box for each cylinder, controlling timing and dosing of all injectors per cylinder.

3. Dosing system according to claim 1 or 2, **characterised in that** four to ten injectors are used for each cylinder.

4. Dosing system according to any preceding claim, **characterised in that** a local pressure accumulator is provided for each injector or for all the injectors associated with each individual cylinder.

5. Dosing system according to any preceding claim, **characterised in that** each injector has an outlet for connection with a return line for conducting excess oil back to the lubricating oil supply or for performing pressure measurements.

6. Dosing system according to any preceding claim, **characterised in that** the opening/closing valve in the injector unit includes a ball valve body and an interacting valve seat, and that between the stem of the valve body and the wall in the valve guide of the opening/closing valve there is a gap with a width exceeding 10 μm.

7. Dosing system according to any preceding claim, **characterised in that** it includes flow measuring units with the same operation range for each injector and for each cylinder, and that the control unit is connected with all the flow measuring unit and adapted for receiving signal from the local flow measuring units at the injectors at relatively large flow rates and for receiving signal from the cylinder central flow measuring units at relatively small flow rates.

8. Dosing system according to any preceding claim 1 to 6, **characterised in that** it includes flow measuring units with different operation range for each injector and for each cylinder, that the flow measuring units with the lowest operating range are the local flow measuring units which are connected with the injectors, and that the flow measuring units with the highest operating ranges are the cylinder central flow measuring units.

9. A method for dosing for cylinder lubrication oil into large diesel engine cylinders, e.g. in marine engines, including the steps of:

- pressurising the lubricating oil in a lubricating oil supply that may be constituted by a pump station or an accumulator;
- conducting the lubricating oil through a supply line from the lubricating oil supply;
- injecting the lubricating oil into the cylinders via a number of injectors having an inlet, an opening/closing valve and one or more nozzle apertures into an associated cylinder as the injector is connected with the supply line; and
- controlling each opening/closing valve unit by means of a control unit, **characterised by** each injector being made as an injector unit mounted in a wall of one of the cylinders, the injector unit comprising the opening/closing valve in the form of an electromechanical valve integrated in the injector unit and configured for dosing the lubricating oil by moving a valve stem of the opening/closing valve for injection of the lubricating oil; the method comprising a local flow measurement for each injector and/or a cylinder central flow measurement of the actually dosed amount of oil per cylinder, transmitting result of flow measurement to the control unit, comparing the flow measurement of the actually dosed amount of oil with an expected/planned amount of oil, and by the step of delivering load/index signals directly to the control unit for controlling, timing and dosing of one or more injectors per cylinder, depending on reference signals from the engine and by the step of the control unit transmitting a control signal to the opening/closing valve unit for regulating timing and amount of oil to the required extent and that dosing of

lubricating oil is performed by activating the opening/closing valve.

10. Method according to claim 9, **characterised in that** the injector local flow measurement is performed in combination with a central flow measurement per cylinder.

11. Method according to claim 9 or 10, **characterised in that** the supply pressure in the supply line is monitored.

12. Method according to claim 11, **characterised in that** the supply pressure in the supply line is used as parameter for controlling the dosing amount.

13. Method according to any preceding claim 9 to 12, **characterised in that** timing and dosing amount are controlled by the opening and closing time of the electromechanical valve.

14. Method according to any preceding claim 9 to 13, **characterised in that** flow measuring units with the same operating range are established for each injector and for each cylinder, that the control unit is connected with all the flow measuring units, that by large flow rates measurements from local flow measuring units at the injectors are selected, and by relatively small flow rates the measurements from the cylinder central flow measuring units are selected.

15. Method according to any preceding claim 9 to 14, **characterised in that** flow measuring units with different operation ranges are established for each injector and for each cylinder, that the flow measuring units with the lowest operating ranges are selected as the local flow measuring units which are connected with the injectors, and that the flow measuring units with the highest operating ranges are selected as the cylinder central flow measuring units.

Patentansprüche

1. Dosiersystem für Zylinderschmieröl in großen Dieselmotorzylindern, z. B. in Schiffsmotoren, das Folgendes beinhaltet:

- eine Schmierölversorgung, die aus einer Pumpanlage oder einem Speicher bestehen kann;
- eine Versorgungsleitung von der Schmierölversorgung;
- eine Reihe von mehreren Einspritzvorrichtungen in jedem Zylinder, wobei jede Einspritzvorrichtung einen Einlass, eine Öffnungs-/Schließventileinheit und eine oder mehrere Düsenöffnungen zum Einspritzen von Zylinderschmieröl in einen zugehörigen Zylinder aufweist und wobei die Einspritzvorrichtungen mit der Versorgungsleitung verbunden sind; und
- eine Steuereinheit, die jede Öffnungs-/Schließventileinheit steuert, wobei Signalleitungen mit der Steuereinheit verbunden sind, um der Steuereinheit Last-/Indexsignale direkt zuzuführen, um eine oder mehrere Einspritzvorrichtungen pro Zylinder in Abhängigkeit von Referenzsignalen von dem Motor zu steuern, ihren Einspritzzeitpunkt zu steuern und sie zu dosieren; **dadurch gekennzeichnet,**
- **dass** das Dosiersystem eine Durchflussmesseinheit für jede Einspritzvorrichtung und/oder für jeden Zylinder beinhaltet,
- **dass** die Durchflussmesseinheiten mit der Steuereinheit verbunden sind,
- **dass** das System zu Regulierung mit geschlossenem Regelkreis konfiguriert ist, bei der die tatsächlich dosierte Menge von Schmieröl mit dem erwarteten Durchfluss verglichen wird,
- **dass** jede Einspritzvorrichtung als Einspritzvorrichtungseinheit gefertigt ist, die in einer Wand von einem der Zylinder montiert ist,
- **dass** das Öffnungs-/Schließventil ein elektromechanisches Ventil ist, das zum Dosieren des Schmieröls in die Einspritzvorrichtungseinheit integriert ist, wobei das elektromechanische Öffnungs-/Schließventil in der Einspritzvorrichtungseinheit einen federbelasteten Ventilschaft beinhaltet.

2. Dosiersystem nach Anspruch 1, **dadurch gekennzeichnet, dass** die Steuereinheit einen lokalen Steuerkasten für jeden Zylinder beinhaltet, der den Einspritzzeitpunkt und die Dosierung aller Einspritzvorrichtungen pro Zylinder steuert.

3. Dosiersystem nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** vier bis zehn Einspritzvorrichtungen für jeden Zylinder verwendet werden.

4. Dosiersystem nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** ein lokaler Druckspeicher für jede Einspritzvorrichtung oder für alle Einspritzvorrichtungen, die zu jedem einzelnen Zylinder gehören, bereitgestellt ist.

5. Dosiersystem nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** jede Einspritzvorrichtung einen Auslass zur Verbindung mit einer Rückführleitung aufweist, um überschüssiges Öl zu der Schmierölversorgung zurückzuleiten oder um Druckmessungen durchzuführen.

6. Dosiersystem nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das Öffnungs-/Schließventil in der Einspritzvorrichtungseinheit einen Kugelventilkörper und einen damit zusammenwirkenden Ventilsitz beinhaltet und dass zwischen dem Schaft des Ventilkörpers und der Wand in der Ventilführung des Öffnungs-/Schließventils ein Zwischenraum vorhanden ist, dessen Breite 10 μm übersteigt.

7. Dosiersystem nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** es Durchflussmesseinheiten mit dem gleichen Betriebsbereich für jede Einspritzvorrichtung und für jeden Zylinder beinhaltet und dass die Steuereinheit mit allen Durchflussmesseinheiten verbunden ist und dazu ausgelegt ist, bei verhältnismäßig großen Durchflussraten Signale von den lokalen Durchflussmesseinheiten an den Einspritzvorrichtungen zu empfangen und bei verhältnismäßig kleinen Durchflussraten Signale von den zentralen Durchflussmesseinheiten der Zylinder zu empfangen.

8. Dosiersystem nach einem der vorhergehenden Ansprüche 1 bis 6, **dadurch gekennzeichnet, dass** es Durchflussmesseinheiten mit unterschiedlichen Betriebsbereichen für jede Einspritzvorrichtung und für jeden Zylinder beinhaltet, dass die Durchflussmesseinheiten mit dem niedrigsten Betriebsbereich die lokalen Durchflussmesseinheiten sind, die mit den Einspritzvorrichtungen verbunden sind, und dass die Durchflussmesseinheiten mit den höchsten Betriebsbereichen die zentralen Durchflussmesseinheiten der Zylinder sind.

9. Verfahren zum Dosieren von Zylinderschmieröl in große Dieselmotorzylinder, z. B. in Schiffsmotoren, das die folgenden Schritte beinhaltet:

- Druckbeaufschlagen des Schmieröls in einer Schmierölversorgung, die aus einer Pumpanlage oder einem Speicher bestehen kann;
- Leiten des Schmieröls durch eine Versorgungsleitung von der Schmierölversorgung;
- Einspritzen des Schmieröls in die Zylinder über eine Reihe von Einspritzvorrichtungen, die einen Einlass, ein Öffnungs-/Schließventil und eine oder mehrere Düsenöffnungen in einen zugehörigen Zylinder aufweisen, wenn die Einspritzvorrichtung mit der Versorgungsleitung verbunden ist; und
- Steuern jeder Öffnungs-/Schließventileinheit mittels einer Steuereinheit, **dadurch gekennzeichnet, dass** jede Einspritzvorrichtung als Einspritzvorrichtungseinheit gefertigt ist, die in einer Wand von einem der Zylinder montiert ist, wobei die Einspritzvorrichtungseinheit das Öffnungs-/Schließventil in der Form eines elektromechanischen Ventils umfasst, das in die Einspritzvorrichtungseinheit integriert ist und dazu konfiguriert ist, das Schmieröl durch Bewegen eines Ventilschafts des Öffnungs-/Schließventils zur Einspritzung des Schmieröls zu dosieren; wobei das Verfahren Folgendes umfasst: eine lokale Durchflussmessung für jede Einspritzvorrichtung und/oder eine zentrale Durchflussmessung der Zylinder der tatsächlich dosierten Menge von Öl pro Zylinder, Übertragen des Ergebnisses der Durchflussmessung an die Steuereinheit, Vergleichen der Durchflussmessung der tatsächlich dosierten Menge von Öl mit einer erwarteten/geplanten Menge von Öl, und durch den Schritt des direkten Zuführens von Last-/Indexsignalen zu der Steuereinheit, um eine oder mehrere Einspritzvorrichtungen pro Zylinder in Abhängigkeit von Referenzsignalen von dem Motor zu steuern, ihren Einspritzzeitpunkt zu steuern und sie zu dosieren, und durch den Schritt, dass die Steuereinheit ein Steuersignal an die Öffnungs-/Schließventileinheit überträgt, um den Einspritzzeitpunkt und die Menge von Öl in dem erforderlichen Ausmaß zu regulieren, und dass das Dosieren von Schmieröl durch Aktivieren des Öffnungs-/Schließventils durchgeführt wird.

10. Verfahren nach Anspruch 9, **dadurch gekennzeichnet, dass** die lokale Durchflussmessung der Einspritzvorrichtung in Kombination mit einer zentralen Durchflussmessung pro Zylinder durchgeführt wird.

11. Verfahren nach Anspruch 9 oder 10, **dadurch gekennzeichnet, dass** der Versorgungsdruck in der Versorgungsleitung überwacht wird.

12. Verfahren nach Anspruch 11, **dadurch gekennzeichnet, dass** der Versorgungsdruck in der Versorgungsleitung als Parameter zum Steuern der Dosiermenge verwendet wird.

13. Verfahren nach Anspruch 9 bis 12, **dadurch gekennzeichnet, dass** der Einspritzzeitpunkt und die Dosiermenge durch die Öffnungs- und Schließzeit des elektromechanischen Ventils gesteuert werden.

14. Verfahren nach einem der vorhergehenden Ansprüche 9 bis 13, **dadurch gekennzeichnet, dass** Durchflussmesseinheiten mit dem gleichen Betriebsbereich für jede Einspritzvorrichtung und für jeden Zylinder eingerichtet sind, dass die Steuereinheit mit allen Durchflussmesseinheiten verbunden ist, dass durch große Durchflussraten Messungen von lokalen Durchflussmesseinheiten an den Einspritzvorrichtungen ausgewählt werden und durch verhältnismäßig kleine Durchflussraten die Messungen von den zentralen Durchflussmesseinheiten der Zylinder ausgewählt werden.

15. Verfahren nach einem der vorhergehenden Ansprüche 9 bis 14, **dadurch gekennzeichnet, dass** Durchflussmesseinheiten mit unterschiedlichen Betriebsbereichen für jede Einspritzvorrichtung und für jeden Zylinder eingerichtet sind, dass die Durchflussmesseinheiten mit den niedrigsten Betriebsbereichen als die lokalen Durchflussmesseinheiten ausgewählt werden, die mit den Einspritzvorrichtungen verbunden sind, und dass die Durchflussmesseinheiten mit den höchsten Betriebsbereichen als die zentralen Durchflussmesseinheiten der Zylinder ausgewählt werden.

Revendications

1. Système de dosage d'huile de graissage de cylindre dans de grands cylindres de moteur diesel, par exemple dans des moteurs marins, comprenant :

- une alimentation en huile de graissage qui peut être constituée par une station de pompage ou un accumulateur ;
- une conduite d'alimentation en provenance de l'alimentation en huile de graissage ;
- un certain nombre de multiples injecteurs dans chaque cylindre, chaque injecteur ayant une entrée, une unité de soupape d'ouverture/fermeture et une ou plusieurs ouvertures de buses permettant d'injecter l'huile de graissage de cylindre dans un cylindre associé, et lesdits injecteurs sont reliés à la conduite d'alimentation ; et
- une unité de commande commandant chaque unité de soupape d'ouverture/fermeture, dans lequel des lignes de transfert de signaux sont connectées à l'unité de commande pour fournir des signaux de charge/index directement à l'unité de commande pour la commande, le chronométrage et le dosage d'un ou de plusieurs injecteurs par cylindre, en fonction de signaux de référence en provenance du moteur ;

caractérisé en ce que

- le système de dosage comprend une unité de mesure de débit pour chaque injecteur et/ou pour chaque cylindre,
- les unités de mesure de débit sont connectées à l'unité de commande,
- le système est configuré pour une régulation en boucle fermée dans laquelle la quantité réellement dosée d'huile de graissage est comparée au débit attendu
- chaque injecteur est formé d'une unité d'injecteur qui est montée dans une paroi de l'un des cylindres,
- la soupape d'ouverture/fermeture est une soupape électromécanique intégrée dans l'unité d'injecteur pour le dosage de l'huile de graissage, dans lequel la soupape d'ouverture/fermeture électromécanique dans l'unité d'injecteur comprend une tige de soupape sollicitée par ressort.

2. Système de dosage selon la revendication 1, **caractérisé en ce que** l'unité de commande comprend une boîte de commande locale pour chaque cylindre, commandant le chronométrage et le dosage de tous les injecteurs par cylindre.

3. Système de dosage selon la revendication 1 ou 2, **caractérisé en ce que** quatre des dix injecteurs sont utilisés pour chaque cylindre.

4. Système de dosage selon une quelconque revendication précédente, **caractérisé en ce qu'**un accumulateur de pression local est prévu pour chaque injecteur ou pour tous les injecteurs associés à chaque cylindre individuel.

5. Système de dosage selon une quelconque revendication précédente, **caractérisé en ce que** chaque injecteur a une sortie pour le raccordement à une conduite de retour pour réacheminer l'huile en excès vers l'alimentation en huile de graissage ou pour réaliser des mesures de pression.

6. Système de dosage selon une quelconque revendication précédente, **caractérisé en ce que** la soupape d'ouverture/fermeture dans l'unité d'injecteur comprend un corps de soupape à bille et un siège de soupape interactif, et **en ce que**, entre la tige du corps de soupape et la paroi dans le guide de soupape de la soupape d'ouverture/fermeture, se trouve un espace d'une largeur dépassant 10 μm.

7. Système de dosage selon une quelconque revendication précédente, **caractérisé en ce qu'**il comprend des unités de mesure de débit ayant la même plage de fonctionnement pour chaque injecteur et pour chaque cylindre, et **en ce que** l'unité de commande est connectée à l'ensemble des unités de mesure de débit et conçue pour recevoir un signal en provenance des unités de mesure de débit local au niveau des injecteurs à des débits relativement importants et pour recevoir un signal en provenance des unités de mesure de débit central de cylindre à des débits relativement faibles.

8. Système de dosage selon une quelconque revendication précédente de 1 à 6, **caractérisé en ce qu'**il comprend des unités de mesure de débit ayant une plage de fonctionnement différente pour chaque injecteur et pour chaque cylindre, **en ce que** les unités de mesure de débit ayant la plage de fonctionnement la plus faible sont les unités de mesure de débit local qui sont connectées aux injecteurs, et **en ce que** les unités de mesure de débit ayant les plages de fonctionnement les plus élevées sont les unités de mesure de débit central de cylindre.

9. Procédé de dosage d'huile de graissage de cylindre dans de grands cylindres de moteur diesel, par exemple dans des moteurs marins, comprenant les étapes de :

- mise sous pression de l'huile de graissage dans une alimentation en huile de graissage qui peut être constituée par une station de pompage ou un accumulateur ;
- conduite de l'huile de graissage à travers une conduite d'alimentation en provenance de l'alimentation en huile de graissage ;
- injection de l'huile de graissage dans les cylindres par l'intermédiaire d'un certain nombre d'injecteurs ayant une entrée, une soupape d'ouverture/fermeture et une ou plusieurs ouvertures de buses dans un cylindre associé tandis que l'injecteur est raccordé à la conduite d'alimentation ; et
- commande de chaque unité de soupape d'ouverture/fermeture au moyen d'une unité de commande, **caractérisée en ce que** chaque injecteur est formé d'une unité d'injecteur montée dans une paroi de l'un des cylindres, l'unité d'injecteur comprenant la soupape d'ouverture/fermeture sous la forme d'une soupape électromécanique intégrée dans l'unité d'injecteur et conçue pour doser l'huile de graissage en déplaçant une tige de soupape de la soupape d'ouverture/fermeture pour l'injection de l'huile de graissage ; le procédé comprenant une mesure de débit local pour chaque injecteur et/ou une mesure de débit central de cylindre de la quantité réellement dosée d'huile par cylindre, la transmission du résultat de mesure de débit à l'unité de commande, la comparaison de la mesure de débit de la quantité réellement dosée d'huile avec une quantité attendue/planifiée d'huile, et grâce à l'étape de fourniture des signaux de charge/index directement à l'unité de commande pour la commande, le chronométrage et le dosage d'un ou de plusieurs injecteurs par cylindre, en fonction de signaux de référence en provenance du moteur et grâce à l'étape de transmission par l'unité de commande d'un signal de commande à l'unité de soupape d'ouverture/fermeture pour la régulation du chronométrage et de la quantité d'huile jusqu'à la quantité requise et **en ce que** le dosage de l'huile de graissage est effectué en activant la soupape d'ouverture/fermeture.

10. Procédé selon la revendication 9, **caractérisé en ce que** la mesure de débit local d'injecteur est effectuée en association avec une mesure de débit central par cylindre.

11. Procédé selon la revendication 9 ou 10, **caractérisé en ce que** la pression d'alimentation dans la conduite d'alimentation est surveillée.

12. Procédé selon la revendication 11, **caractérisé en ce que** la pression d'alimentation dans la conduite d'alimentation est utilisée comme paramètre pour la commande de la quantité de dosage.

13. Procédé selon une quelconque revendication précédente de 9 à 12, **caractérisé en ce que** le chronométrage et la quantité de dosage sont commandés par les temps d'ouverture et de fermeture de la soupape électromécanique.

14. Procédé selon une quelconque revendication précédente de 9 à 13, **caractérisé en ce que** les unités de mesure de débit ayant la même plage de fonctionnement sont établies pour chaque injecteur et pour chaque cylindre, **en ce que** l'unité de commande est connectée à l'ensemble des unités de mesure de débit, **en ce que** des mesures de débit élevé en provenance d'unités de mesure de débit local au niveau des injecteurs sont choisies, et **en ce que** des mesures de débit relativement faible en provenance des unités de mesure de débit central de cylindre sont choisies.

15. Procédé selon une quelconque revendication précédente de 9 à 14, **caractérisé en ce que** les unités de mesure de débit ayant des plages de fonctionnement différentes sont établies pour chaque injecteur et pour chaque cylindre, **en ce que** les unités de mesure de débit ayant les plages de fonctionnement les plus faibles sont choisies en tant qu'unités de mesure de débit local qui sont connectées aux injecteurs, et **en ce que** les unités de mesure de débit ayant les plages de fonctionnement les plus élevées sont choisies en tant qu'unités de mesure de débit central de cylindre.

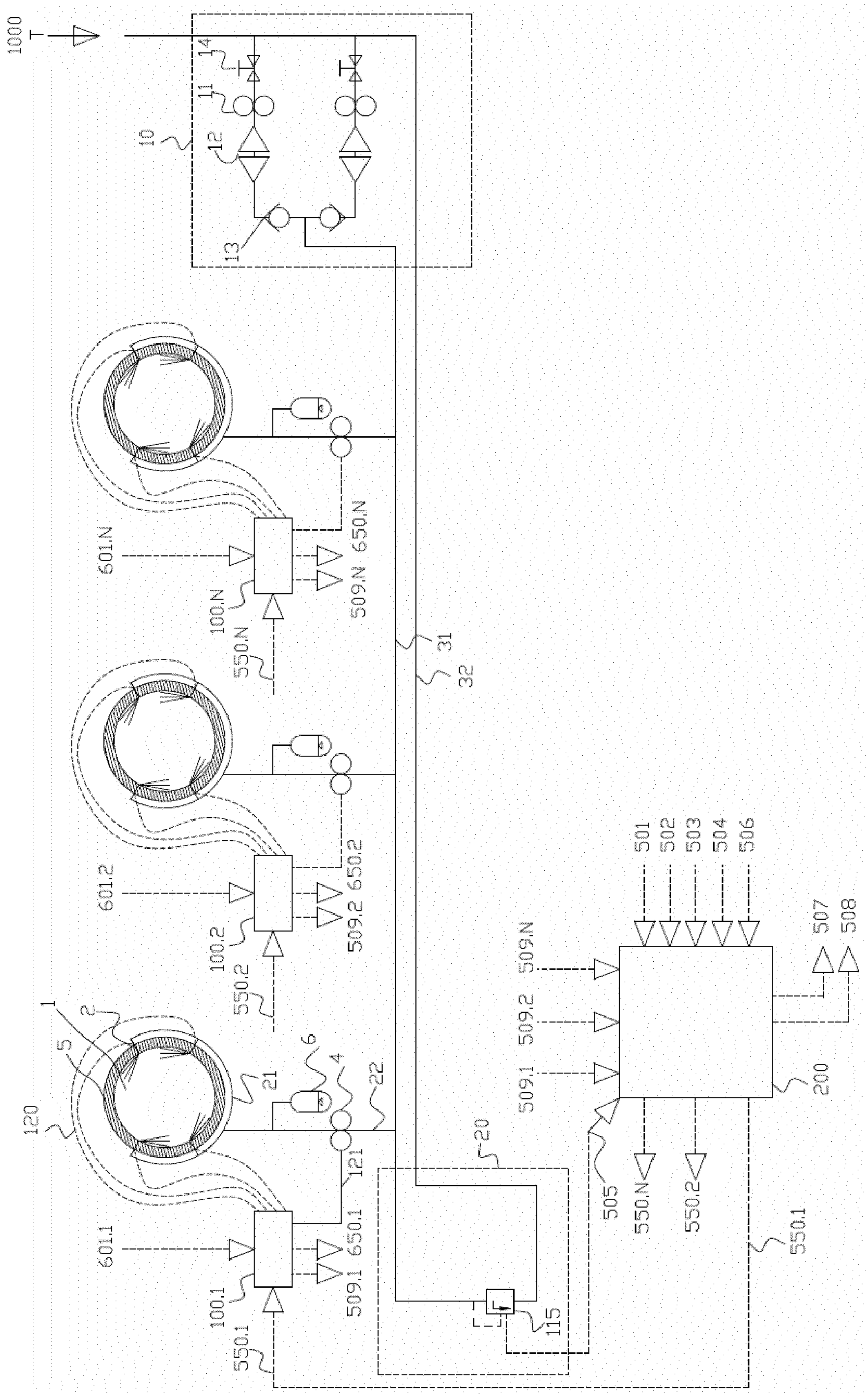
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Fig. 1

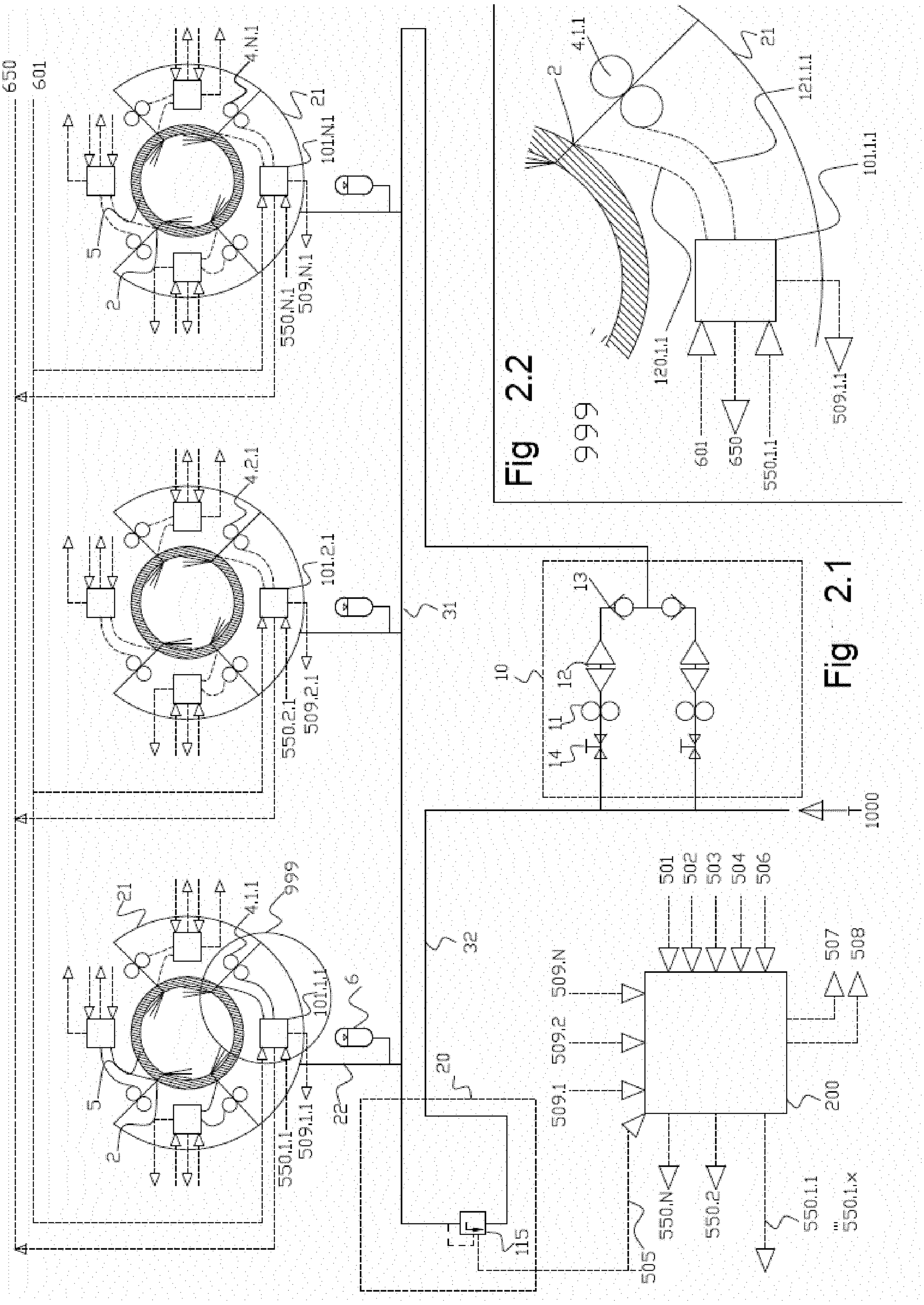
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Fig 2.1

Fig 2.2

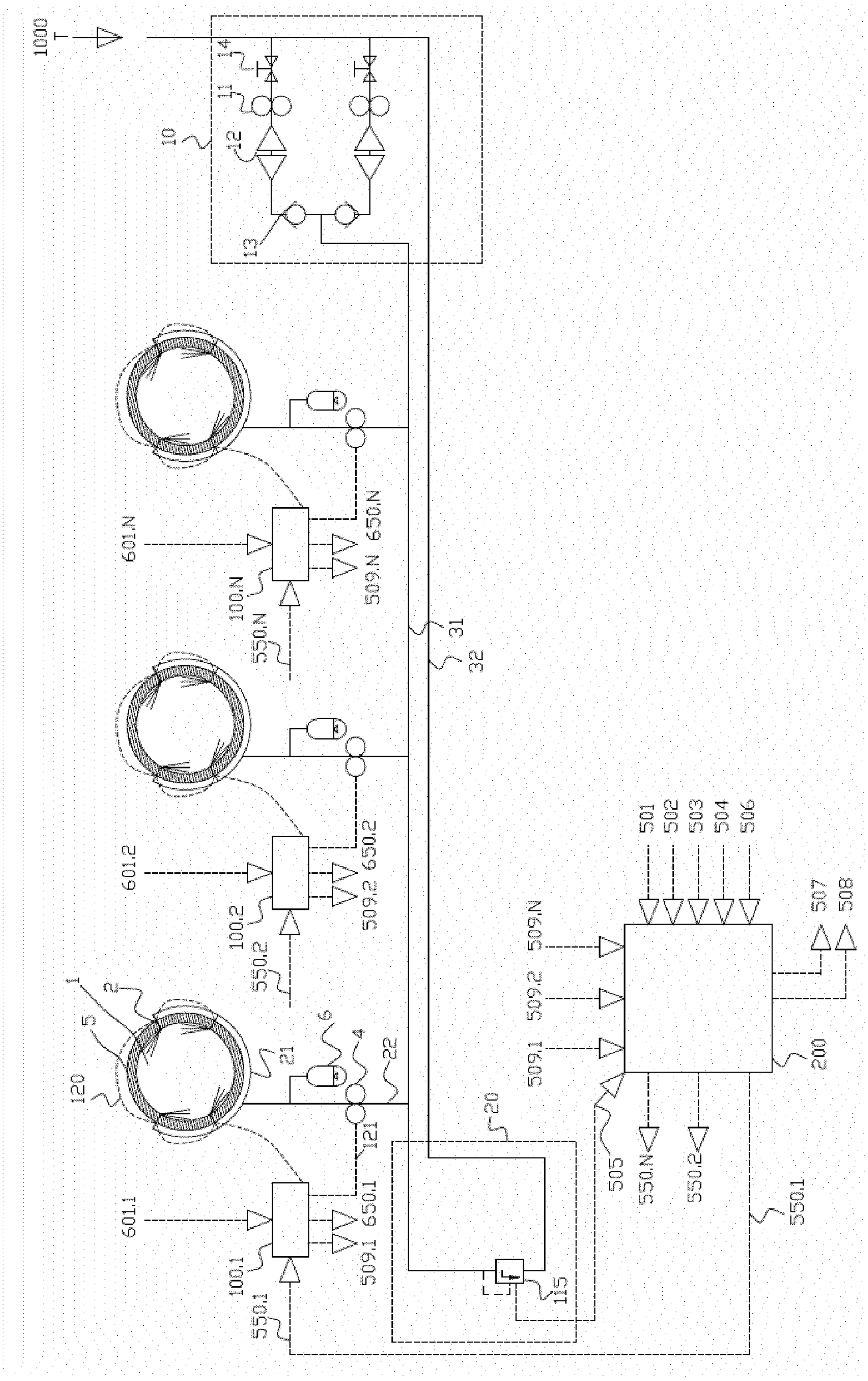
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Fig. 3

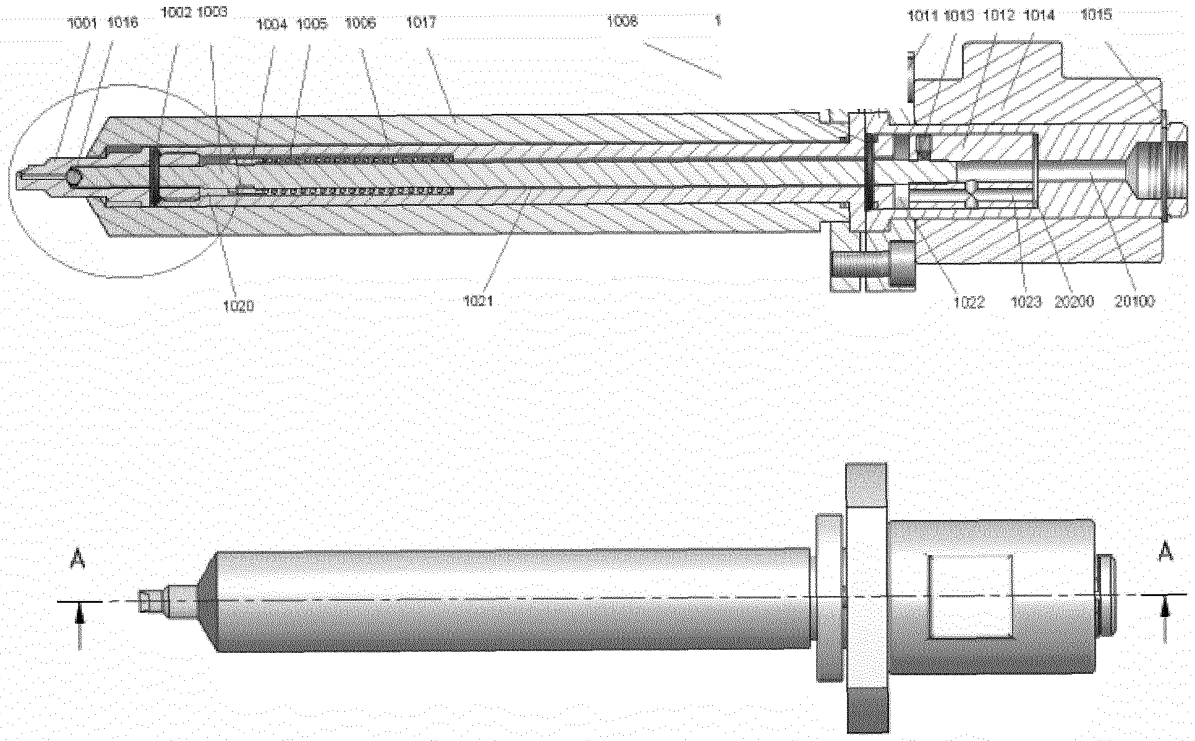
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Fig 4.1

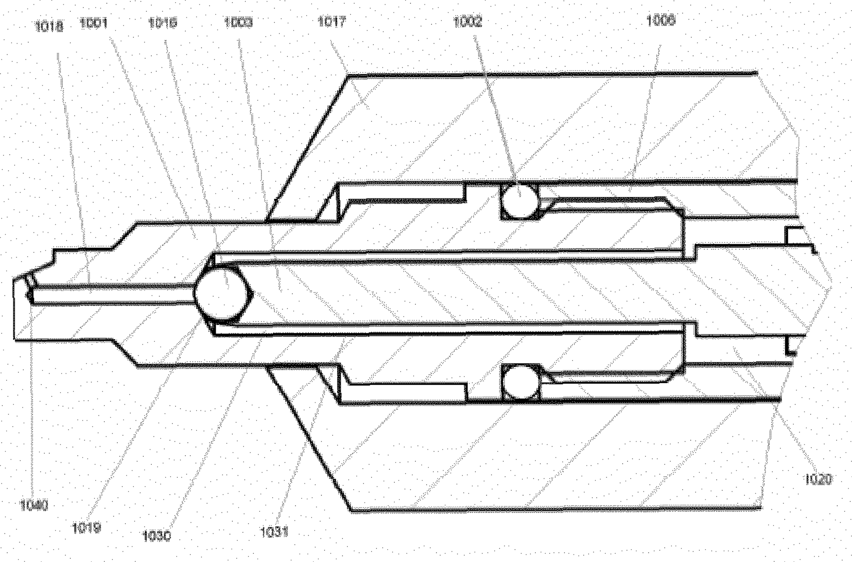
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Fig 4.2

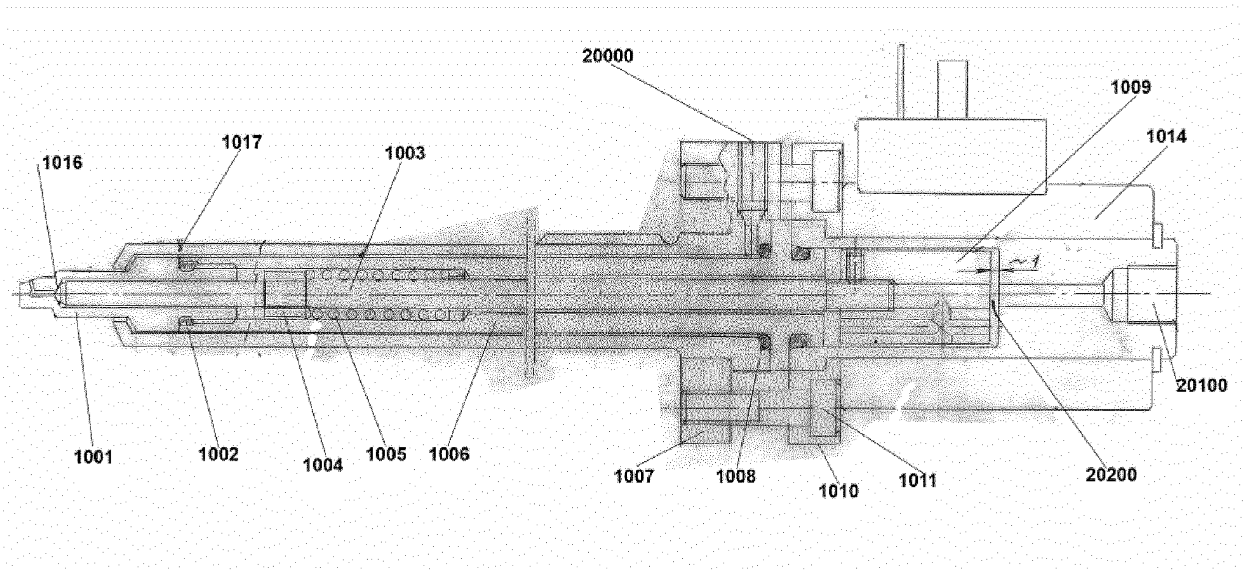
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Fig. 5

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