



(51) International Patent Classification:

F02M 53/06 (2006.01) *F02M 63/02* (2006.01)
F02M 53/04 (2006.01) *F02M 63/00* (2006.01)

(21) International Application Number:

PCT/FI2012/050266

(22) International Filing Date:

20 March 2012 (20.03.2012)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

20115343 12 April 2011 (12.04.2011) FI

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,

HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

Published:

- without international search report and to be republished upon receipt of that report (Rule 48.2(g))

(54) Title: AN ARRANGEMENT FOR AND METHOD OF REGULATING FUEL TEMPERATURE IN AT LEAST ONE FUEL INJECTOR

(57) Abstract: The invention relates to a fuel injection system (10) comprising a fuel injector(16) having a fuel admission section (18) arranged to controllably introduce fuel from the fuel injector, a pressure accumulator (24) in the fuel injector arranged in flow connection with the admission section and a fuel inlet (26) arranged in flow connection with the pressure accumulator, which fuel injection system is provided with at least one heat exchanger system (100). The at least one heat exchanger system (100) arranged to effect on the pressure accumulator (24) of the fuel injection system from outside thereof. The present invention relates also to a method of regulating temperature of at least one fuel injector, cylinder head and a combination of a cylinder head and a fuel injection system.



An arrangement for and method of regulating fuel temperature in at least one fuel injector

5 Technical field

[001] The present invention relates to a fuel injection system comprising a fuel injector having a fuel admission section arranged to controllably introduce fuel from the fuel injector, a pressure accumulator in the fuel injector arranged in flow connection with the admission section and a fuel inlet arranged in flow connection
10 with the pressure accumulator, which fuel injection system is provided with at least one heat exchanger system.

[002] The present invention relates also to an arrangement for regulating temperature of at least one fuel injector in a cylinder head of an internal combustion engine, the arrangement comprising a temperature regulation fluid flow circuit
15 provided with a heat exchanger system in which the temperature regulation fluid is in heat transfer connection with the at least one fuel injector.

[003] The present invention relates also to a method of regulating temperature of at least one fuel injector in a cylinder head of an internal combustion engine in which method a temperature regulation fluid is arranged to flow in heat exchange
20 connection with the at least one fuel injector.

[004] The present invention relates also to a cylinder head assembly for an internal combustion engine comprising a first cavity entity having at least one first inlet section for a first fluid and at least one first outlet section for the first fluid, the at least one first inlet section and at least one first outlet section being in flow connection with each
25 other via the first cavity entity in the cylinder head assembly.

[005] The present invention relates also to a combination of a cylinder head and a fuel injection system.

Background art

[006] Internal combustion engines are generally provided with fuel injection systems in which the pressurizing of the fuel and the control of injection are separated. In such systems an accumulator volume is used as storage of pressurized fuel the admission
5 of which into a combustion chamber is accomplished by means of a valve needle in the fuel injector nozzle. These systems are commonly known as common rail fuel injection systems. Such a system is described for example in WO 2009147291.

[007] It is known as such that the viscosity of the used fuel has an effect on its behavior in the fuel system and also on injection occurrence. It also known to control
10 the viscosity of the fuel by means of regulation of the fuel temperature. Thus this is fact that is to be taken into account both in the fuel delivery system and in the injector itself. Light fuel oil (LFO) or marine diesel oil (MDO) is commonly used in diesel engines. Heavy fuel oil (HFO) is typically used as a fuel in large engines i.e. such engines in which power more than 150kW per cylinder is created. Heavy fuel oil is
15 also susceptible to wide changes in viscosity when changing the temperature, from near solid state at room temperature (typically 20 °C) to liquid at 120 °C.

[008] Recently the interest of utilizing biofuels has been increasing. Biofuels are gaining increased attention, driven by factors such as oil price, the need for increased energy security, and concern over greenhouse gas emissions from fossil fuels. Also
20 (municipal) waste handling opens possibilities in energy production. Particularly using of vegetable oils is of interest, both as an additive in LFO or as crude straight liquid bio fuel (LBF). However, adequate controlling of the viscosity is even more important when vegetable oils are used.

[009] Operation of an injector is crucial to the controlled and successful combustion
25 in a piston engine. And, using vegetable or generally biomass originated liquid fuel requires special attention to the injection method and system so that the safe and reliable operation is guaranteed in all circumstances. A particular problems are in the first place to maintain the fuel viscosity at level low enough and in the second place not to exceed an operational temperature which causes e.g. polymerisation reactions.

30 [0010] There are systems and methods known in the prior art which aim to heat the fuel in a fuel injection system.

[0011] DE 10154455 A1 discloses a dual fuel system for diesel engine. In the system a first fuel tank contains diesel oil and the second fuel tank contains a biological fuel. Each tank feeds a fuel line with a filter and a high-pressure fuel pump supplying fuel to the injectors. The fuel system for the biological fuel is surrounded by a heating
5 jacket, which may be filled with engine cooling water. A control circuit is connected to the injector system to regulate switchover from the diesel oil to the biological fuel and void a volume of fuel from the injector system when the engine is being shut down.

[0012] WO 2005024225 A1 discloses a heating element in each injection valve and is placed directly in front of the injection valve in the injection line. The heating
10 element is provided in the form of an electric heating spiral that is oriented coaxial to the axial direction of the injection line.

[0013] DE 10341708 A1 discloses an internal combustion reciprocating piston engine suitable for heavy oil running. There is a common rail supplying fuel under pressure to injection valves. A heating element is installed in the fuel rail and centrally located.
15 The heating element may be hot steam operated or may be electrically operated.

[0014] US 2002129779 A1 discloses a cylinder head for a liquid-cooled internal combustion engine, with a cooling chamber configuration which is divided by an intermediate deck into a lower cooling chamber, and an upper cooling chamber adjoining the lower cooling chamber in the direction of the cylinder axis, where lower
20 and upper cooling chamber communicate with each other via at least one flow opening. There is also shown that a pipe for a fuel injector may be arranged in connection with the flow opening arranging an annular passage between the opening and the pipe.

[0015] Even if the known systems for heating fuel in a fuel system of an internal
25 combustion engine may be operable as such there has emerged a need to further develop an internal combustion engine to enhance its operation with fuel the viscosity of which is too high at ambient temperature and which without additional measures would not provide adequate operation of and engine.

[0016] Therefore it is an object of the invention is to provide a fuel injection system
30 for a piston engine which operates better in various operation conditions of the engine.

[0017] It is also an object of the invention to provide a arrangement for regulating temperature of at least one fuel injector in a cylinder head of an internal combustion engine.

5 [0018] It is further an object of the invention to provide a method of regulating temperature of at least one fuel injector in a cylinder head of an internal combustion engine.

[0019] It is still further an object of the invention to provide a cylinder head assembly for an internal combustion engine.

10 [0020] It is still further an object of the invention to provide a combination of a cylinder head and a fuel injection system.

[0021] In this context the term "lower end" relating to a fuel injector means the end of an elongated injector at which at least one injection opening is located and "upper end" relating to a fuel injector means an end opposite to the lower end. Generally the term "lower" means the side of the injector being closer to the end of an elongated
15 injector at which at least one injection opening is located and the term "upper" the side opposite to the lower side. This applies regardless of the actual position, alignment or orientation of the fuel injector.

20

Disclosure of Invention

[0022] Objects of the invention are met by a fuel injection system comprising a fuel injector having a fuel admission section arranged to controllably introduce fuel from the fuel injector, a pressure accumulator in the fuel injector arranged in flow
25 connection with the admission section and a fuel inlet arranged in flow connection with the pressure accumulator, which fuel injection system is provided with at least one heat exchanger system. It is characteristic to the invention that the at least one heat exchanger system arranged to effect on the pressure accumulator of the fuel injection system from outside thereof.

30

[0023] According to an embodiment of the invention the pressure accumulator is arranged at the upper end of the fuel injector and the heat exchanger system is arranged to effect on the upper end.

5 [0024] According to an embodiment of the invention the heat exchanger system comprises a jacket arranged on the upper end of the fuel injector, and that the jacket is provided with a temperature regulation fluid space and at least one inlet and at least one outlet opening into the temperature regulation fluid space.

10 [0025] According to an embodiment of the invention the heat exchange system comprises at least two separate jackets, lower and upper, in the longitudinal axis of the injector arranged to surround the pressure accumulator.

[0026] According to another embodiment of the invention the upper jacket is at a
15 location of the injector where it will be outside the cylinder head when being installed into the cylinder head and the lower jacket is in the cylinder head.

[0027] According to an embodiment of the invention the pressure accumulator is arranged in flow connection with the fuel admission section at a upper end thereof
20 and at least one heat exchanger system arranged to effect at least on the pressure accumulator at a lower end thereof.

[0028] According to a still another embodiment of the invention the at least one heat exchanger system is integrated in connection with the pressure accumulator
25 structure.

[0029] According to a still another embodiment of the invention the fuel injection system is provided with two separate, independently controllable heat exchanger systems.

30 [0030] Objects of the invention are also met with an arrangement for regulating fuel temperature in at least one fuel injector in a cylinder head of an internal combustion engine the arrangement comprising a temperature regulation fluid flow circuit provided with a heat exchanger system in which the temperature regulation fluid is in
35 heat transfer connection with the at least one fuel injector. It is characteristic to the

invention that the temperature regulation fluid flow circuit is provided heater system operable independent from the running of the engine.

5 [0031] This way it is possible to provide advantageous stand-by conditions for fuel when engine is on standby to ensure effective start times.

[0032] According to an embodiment of the invention the temperature regulation fluid circuit is a separable and/or independently operable section of the fluid circuit of the engine.

10 [0033] According to another embodiment of the invention the temperature regulation fluid flow circuit is provided with two separate, independently controllable heat exchanger systems.

15 [0034] According to a further embodiment of the invention the temperature regulation fluid circuit is in connection with lubrication oil circuit of the engine.

[0035] According to an embodiment of the invention the temperature regulation fluid circuit is in connection with cooling fluid system of the engine.

20 [0036] According to an embodiment of the invention the arrangement comprises a control system which is set to maintain the arrangement for regulating temperature operating while the engine is in stand-by-mode.

25 [0037] According to a still further embodiment of the invention the temperature regulation fluid flow circuit is provided with two separate heat exchanger system, in which one of the heat exchanger systems has cooling fluid of the engine as the temperature regulation fluid and the other heat exchanger system has lubrication oil of the engine as the temperature regulation fluid.

30 [0038] According to a still further embodiment of the invention the temperature regulation fluid flow circuit is provided with two separate heat exchanger system, in which both heat exchanger systems have lubrication oil of the engine as the temperature regulation fluid.

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[0039] According to a still further embodiment of the invention the temperature regulation fluid flow circuit is provided with two separate heat exchanger system, in which both heat exchanger systems have cooling fluid of the engine as the temperature regulation fluid.

5

[0040] Objects of the invention are also met by a method of regulating temperature of at least one fuel injector in a cylinder head of an internal combustion engine in which method a temperature regulation fluid is arranged to flow in heat exchange connection with the at least one fuel injector, characterized in that the temperature regulation fluid flow is operated independent from the running of the engine.

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[0041] According to an embodiment of the invention the temperature regulation fluid flow is operated while the engine is in stand-by mode.

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[0042] According to an embodiment of the invention the temperature regulation fluid flow is operated by circulating fuel in heat exchange connection with the at least one fuel injector.

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[0043] According to an embodiment of the invention the temperature regulation fluid flow circuit is operated by circulating lubrication oil in heat exchange connection with the at least one fuel injector.

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[0044] According to an embodiment of the invention the temperature regulation fluid flow is operated by circulating cooling water in heat exchange connection with the at least one fuel injector.

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[0045] Object of the invention are also met by a cylinder head assembly for an internal combustion engine comprising a first cavity entity having at least one first inlet section for a first fluid and at least one first outlet section for the first fluid, the at least one first inlet section and at least one first outlet section being in flow connection with each other via the first cavity entity in the cylinder head assembly, characterized in that the cylinder head assembly comprises a second cavity entity having at least one second inlet section for a second fluid and at least one second outlet section for the second fluid, and that the at least one second inlet section and

at least one second outlet section being in flow connection with each other via the second cavity entity in the cylinder head assembly.

5 [0046] According to an embodiment of the invention the cylinder head is provided with a third cavity extending through the cylinder head having inside surface arranged to accommodate an installation of a fuel injector therein, and that the second cavity entity is arranged to at least partially open into the third cavity.

10 [0047] Object of the invention are also met by a combination of a cylinder head according to claim 20 and a fuel injection system according to claim 1.

Brief Description of Drawings

15 [0048] In the following, the invention will be described with reference to the accompanying exemplary, schematic drawings, in which
Figure 1 illustrates an embodiment of the invention in which a fuel injection system is installed in a cylinder head in a piston engine,
Figure 2 illustrates an embodiment of the invention in which a fuel injector has been
20 adapted for use in an internal combustion engine,
Figure 3 illustrates another embodiment of the invention depicting a cylinder head assembly for an internal combustion engine,
Figure 4 illustrates a still another embodiment of the invention depicting a cylinder head assembly for an internal combustion engine, and
25 Figure 5 illustrates an embodiment of the invention in which a fuel injector has been adapted for use in an internal combustion engine.

Detailed Description of Drawings

30 [0049] Figure 1 shows schematically a fuel injection system 10 installed in a cylinder head 12 in a piston engine partially bordering a combustion chamber 14 of the engine. The fuel injection system comprises a fuel injector 16 in which a fuel admission section 18 is arranged to controllably introduce fuel from the fuel injection to the combustion chamber 14. The fuel admission section 18 includes at least a

metering device 20, such as a needle unit and a control system 22 controlling the operational state of the metering device 20. The fuel injector further comprises a pressure accumulator 24 which is at the upper end of the injector in flow communication with the fuel admission section 18. The fuel injection system also
5 comprises a fuel inlet 26 which is connected to a source of pressurized fuel 28, such as a so called common rail system.

[0050] Further, the fuel injection system 10 is provided with at least one heat exchanger system 100, which is arranged to effect on the pressure accumulator 24 of
10 the fuel injection system from outside thereof. In other words, the at least one heat exchanger system 100 is arranged to transfer heat through the outer wall 31 of the accumulator 24 in to the fuel therein. This provides an operation which does not directly affect on the flow channel of the fuel. Particularly when the temperature dependency of the viscosity of the fuel to be injected is such that the fuel becomes
15 inoperable or operable with difficulty below the normal operational temperature of the fuel, the heat exchanger system 100 may be used to maintain the fuel in the injector at a temperature at which the viscosity is at acceptable level, i.e. low enough. The fuel injection system is particularly advantageous for biomass based fuel such as vegetable oil, olive oil, rapeseed oil, palm oil, animal fats etc. containing fuels.

20

[0051] The injector 16 comprises an elongated body, which may be constructed of several parts, even if not shown here. The pressure accumulator 24 is arranged at the upper end of the fuel injector 16 and the fuel admission section 18 at the lower
25 end, opposite to the upper end. There is a fuel inlet 26 arranged to the fuel injector to provide a connection with the pressure accumulator at the lower end of the accumulator, to which also the fuel admission section 18 is connected. The heat exchanger system is arranged effect the upper end of the injector 16, however the applied heat also effects on the fuel admission section 18.

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[0052] As can be seen from the figure 1 the heat exchanger system 100 comprises a jacket 102 or alike at the upper end of the fuel injector 16. The jacket is provided with a temperature regulation fluid space 104 bordered by the fuel injector and the jacket. The jacket 102 at the upper end of the accumulator 24 is provided with an inlet 106
35 and an outlet 108 in order to provide a circulation of temperature regulation fluid through the temperature regulation fluid space 104. This way the temperature

regulation of the fuel injector, and particularly the fuel contained in the accumulator, may be maintained.

5 [0053] In the embodiment of figure 1 the cylinder head 12 is arranged to operate as a second jacket 110 surrounding the fuel injector 16.

[0054] Cylinder head is provided with an annular groove extending circumferentially around the fuel injector 16 and being provided with sealings 30. The jacket is provided with a lower temperature regulation fluid space 104' bordered by the fuel
10 injector 16 and the jacket formed by the cylinder head 12. The second jacket 110 at the lower end of the accumulator 24 is provided with an inlet 106' and an outlet 108' in order to provide a circulation of temperature regulation fluid through the temperature regulation fluid space 104'. This way the temperature regulation of the fuel injector, and particularly the fuel contained in the accumulator, may be
15 maintained. Preferably the lower temperature regulation fluid space is bigger than the fluid space 104 in the jacket. The arrangement may additionally be provided with an intermediate sleeve 17 through which heat may be conducted but which provides an additional wall for preventing the escape of the temperature regulation fluid when disassembling the injector 16.

20 [0055] Thus, there are two separate temperature regulation fluid spaces, upper space 104 and lower 104' space arranged in the longitudinal axis 16' of the injector to circumvent the accumulator. This way both ends of the elongated accumulator may be heated while there is adequate longitudinal dimension or area for other purposes
25 which is not described here.

[0056] The upper and the lower spaces may be connected to a common temperature regulation fluid circuit. In this case temperature regulation fluid is preferably the lubrication oil of the engine.

30 [0057] The upper and the lower spaces may be connected to separate, independently controllable temperature regulation fluid circuit. In this case temperature regulation fluids are preferably the lubrication oil of the engine and the cooling fluid of the engine.

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[0058] In figure 2 there is shown an embodiment of the invention in which the fuel injector 16 as outlined in figure 1 has been adapted for use in an internal combustion engine. Figure 2 shown a piston engine 50 comprising a valve cover 50.1, cylinder head 12, engine block 50.2 and oil sump 50.3. As is evident only such elements of the engine which are relevant or useful to describing the operation of the invention are shown here. The fuel injector 16 has been arranged into the cylinder head 12 of the engine 50. The engine is provided with an arrangement 52 for regulating temperature of at least one fuel injector 16 in a cylinder head 12 of an internal combustion engine 50. The arrangement comprises a temperature regulation fluid flow circuit 54. The temperature regulation fluid flow circuit 54 is provided with a heat exchanger system 100 in which the temperature regulation fluid is in heat transfer connection with the fuel injector 16.

[0059] In the embodiment shown in figure 2 the temperature regulation fluid is lubrication oil of the engine 50. Thus, the temperature regulation fluid flow circuit 54 connected to the lubrication system 50.4 of the engine 50. The lubrication system of the engine may be of a type known as such.

[0060] While the engine is operated the lubrication oil is controlled to flow through the temperature regulation fluid flow circuit 54 and particularly through the heat exchanger system 100. The circuit 54 is provided with a heater system 56 by means of which heat may be brought to the temperature regulation fluid. This way the temperature of fuel oil in the accumulator 24 remains at adequate range even if the upper end of the injector 16 i.e. the pressure accumulator 24 protrudes out from the cylinder head 12.

[0061] Now, when the engine is to be stopped for longer periods of time the risk relating to increase of fuel oil viscosity is increasing. Thus at this stage the engine is set to a stand-by mode at which the engine is not running but it is maintained at a state from which a quick starting is possible. Preferably at least the electronics of the engine is operating during the stand-by mode. By setting the engine to stand-by mode also the heater system 56 of the temperature regulation fluid flow circuit 54 is maintained operating independent from the running of the engine 50. In this case the heater system 56 is shown as external system, but it may also be integrated into the engine 50.

[0062] Advantageously the temperature regulation fluid is lube oil, thus the external heater system 56 is connected to the lubrication system 50.4 of the engine 50.

5 [0063] The temperature regulation fluid circuit is a separable and/or independently operable section of the lubrication oil circuit 50.4 of the engine, thus the external heater system 56 is provided with a pumping means 58 which may be operated even if the engine is at stand-by mode. Stand-by mode may be used in engines for example in connection with ships and power plants, particularly in emergency power
10 plants. There may be valves 55 arranged into the oil circuit make sure that during the stand-by mode the circulation through other part of the engine are prevented or minimize.

[0064] When the engine often or usually comprises several cylinders and several fuel
15 injectors, the circuit 54 is in connection with each of the injector. The heat exchanger system 100 of each injector system is independently controllable.

[0065] The arrangement 52 is provided with a control system 60 which is set to maintain the arrangement 52 for regulating temperature operating while the engine is
20 at stand-by mode..The control system is provided with a probe 61 which is arranged in vicinity of the fuel injector 16

[0066] According to an embodiment of the invention the temperature of the at least one fuel injector, and thus the temperature of the fuel therein, arranged in a cylinder
25 head of an internal combustion engine is controlled by arranging a temperature regulation fluid to flow in heat exchange connection with the at least one fuel injector, and the temperature regulation fluid flow is operated independent from the running of the engine so, that the flow in heat exchange connection with the at least one fuel injector may be maintained even when the engine is not running i.e. during the stand-
30 by mode. Thus, preferably the temperature regulation fluid flow is operated at least during a predetermined period while the engine is stopped.

[0067] Particularly when the engine is operated so that it is stopped after a running period and planned or decided to be started within a predetermined time, i.e. the

engine is at stand-by mode, the temperature regulation fluid flow is operated until the engine is started again. In this case the predetermined time may be even 2-7 days

5 [0068] Preferably temperature regulation fluid flow circuit is operated by circulating lubrication oil in heat exchange connection with the at least one fuel injector.

[0069] Now turning to the figure 3, one can see that the cylinder head 12 assembly for an internal combustion engine which is substantially similar to that shown in figure 1 except that figure 3 discloses the structure of the cylinder head 12 in more detailed
10 manner. The cylinder head 12 comprises according to an embodiment of the invention a first cavity entity 120 having at least one first inlet section 122 for a first fluid and at least one first outlet section 124 for the first fluid, the at least one first inlet section 122 and at least one first outlet section 124 being in flow connection with each other via the first cavity entity 120 in the cylinder head assembly. The cylinder
15 head assembly further comprises a second cavity entity 110' having at least one second inlet section 106' for a second fluid and at least one second outlet section 108' for the second fluid. The at least one second inlet section 106' and at least one second outlet section 108' being in flow connection with each other via the second cavity entity 110' in the cylinder head assembly.

20 [0070] This way the cylinder head assemble may provide two separate and independently controllable cooling or heat exchanger systems and thus making it possible to control the temperature and temperature distribution in the cylinder head in more precise manner.

25 [0071] The cylinder head 12 is provided with a third cavity 130 extending through the cylinder head 12 having inside surface arranged to accommodate an installation of a fuel injector 16 therein. Additionally the second cavity entity 110' is arranged to at least partially open into the third cavity 130. This way the second cavity entity may
30 be arranged to be bordered by the fuel injector 16 after it installation into the third cavity entity.

[0072] Thus the third cavity entity is arranged for installation of the fuel injector, the second cavity entity is arranged to operate as heat exchange system to effect on the
35 pressure accumulator 24 of the fuel injection system from outside thereof, according

to a preferred embodiment by connection to the lubrication system of the engine. The first cavity entity is arranged to operate as conduit for engine cooling medium circuit. Preferably the heat exchanger system is arranged to effect on the pressure accumulator of the fuel injection system from outside thereof and is co connected to the temperature regulation fluid flow circuit 54, cf. figure 2.

[0073] Thus a combination of a cylinder head 12 and a fuel injection system 10 provides advantageous effects particularly for use of biomass-based liquid fuel. The co-operation of the fuel injector construction and the cylinder head construction the fuel may be maintained at adequate low viscosity i.e. high temperature state at all situations.

[0074] It is also according to an embodiment of the invention conceivable to arrange the second cavity entity arranged to operate as heat exchange system to effect on the pressure accumulator 24 to by in connection with the cooling system of the engine.

[0075] Additionally it is according to an embodiment of the invention conceivable to arrange the second cavity entity arranged to operated as heat exchange system to effect on the pressure accumulator 24 by means of making use of the fuel system of the engine as the temperature regulation fluid circuit.

[0076] In figure 4 one can see a still further embodiment of the invention in which the cylinder head 12 assembly for an internal combustion engine is substantially similar to that shown in figure 1 except that the heat exchanger system 100 of the fuel injector 16 is different. In this case, the fuel injection system 10 is provided with a heat exchanger system 100' integrated in to the fuel injector 16, which is arranged to effect on the pressure accumulator 24 of the fuel injection system from outside thereof.

[0077] The heat exchanger system 100' comprises borings 101 which are arranged into the outer wall 31 of the accumulator and parallel with the longitudinal axis 16' of the injector 16. There may be several borings arranged around the accumulator 24, even if only some of borings 101 are shown here for clarity reasons. The heat exchanger system 100' is provided with an inlet 106 and an outlet 108 in order to provide a circulation of temperature regulation fluid through the temperature

regulation fluid space 104. This way the temperature regulation of the fuel injector, and particularly the fuel contained in the accumulator, may be maintained.

[0078] A first set of the borings are connected to the inlet 106 and the second set
5 of the borings are connected to the outlet 108. All of the borings belonging to the same set of borings are connected with each other both at their upper and lower ends. The first set and the second of the borings are connected with each other only at the lower part thereof. There is an annular groove 103 arranged in the injector 16 which serves as the connection of the first set and the second of the borings. The
10 upper ends of the borings in a set may also be connected with each other by a partially circumscribing groove 105 or alike.

[0079] In figure 5 there is shown a still further embodiment of the invention in which the fuel injector 16 as outlined in figure 1 has been adapted for use in an internal
15 combustion engine. Figure 5 shown a piston engine 50 comprising a valve cover 50.1, cylinder head 12, engine block 50.2 and oil sump 50.3. As is evident only such elements of the engine which are relevant or useful to describing the operation of the invention are shown here. The fuel injector 16 has been arranged into the cylinder head 12 of the engine 50. The engine is provided with an arrangement 52 for
20 regulating temperature of at least one fuel injector 16 in a cylinder head 12 of an internal combustion engine 50. The arrangement comprises a temperature regulation fluid flow circuit 54. The temperature regulation fluid flow circuit 54 is provided with a heat exchanger system 100 in which the temperature regulation fluid is in heat transfer connection with the fuel injector 16. Here the temperature regulation fluid is
25 lubrication oil of the engine 50. Thus, the temperature regulation fluid flow circuit 54 connected to the lubrication system 50.4 of the engine 50. The lubrication system of the engine may be of a type known as such. The operation of the arrangement 52 for regulating temperature corresponds that described in connection with figure 2.

30 [0080] In figure 5 there is shown a second arrangement 52' for regulating temperature of the fuel injector 16 in a cylinder head 12 of an internal combustion engine 50. The arrangement comprises a second temperature regulation fluid flow circuit 54'. The second temperature regulation fluid flow circuit 54 is also provided with a heat exchanger system 100 in which the temperature regulation fluid is in heat

transfer connection with the fuel injector 16. Here the temperature regulation fluid is cooling fluid of the engine 50. The cooling fluid system 50.6 of the engine may be of a type known as such.

5 [0081] While the engine is operated the cooling fluid is controlled to flow through the temperature regulation fluid flow circuit 54' and particularly through the heat exchanger system 100. The circuit 54' is provided with a heater system 56' by means of which heat may be brought to the temperature regulation fluid when necessary. This way the temperature of fuel oil in the accumulator 24 remains at adequate range
10 making use both the cooling fluid and lubrication oil.

[0082] Now, when the engine is to stopped for longer periods of time the risk of fuel oil viscosity is increasing. Thus at this stage the engine is set to a stand-by mode at which the engine is not running but it is maintained at a state from which a quick
15 starting is possible. Preferably at least the electronics of the engine is operating during the stand-by mode. By setting the engine to stand-by mode also the heater system 56' of the temperature regulation fluid flow circuit 54' may be maintained operating independent from the running of the engine 50. In this case the heater system 56' is shown as external system, but it may also be integrated into the engine
20 50.

[0083] Advantageously the temperature regulation fluid is engine cooling fluid, thus the external heater system 56' is connected to the cooling system 50.6 of the engine 50.

25 [0084] The temperature regulation fluid circuit is a separable and/or independently operable section of the cooling fluid system 50.6 of the engine, thus the external heater system 56' is provided with a pumping means 58' which may be operated even if the engine is at stand-by mode. Stand-by mode may be used in engines for
30 example in connection ships and power plants, particularly in emergency power plants.

[0085] The arrangement 52' is connected to the control system 60 which is set to maintain the arrangement 52' for regulating temperature operating while the engine is

at stand-by mode..The control system is provided with a probe 61 which is arranged in vicinity of the fuel injector 16

5 [0086] Method of regulating temperature of at least one fuel injector in a cylinder head of an internal combustion engine is according to an embodiment of the invention practiced so that the temperature regulation fluid flow is operated by circulating lubrication oil in heat exchange connection with the at least one fuel injector and / or by circulating cooling water in heat exchange connection with the at least one fuel injector

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[0087] While the invention has been described herein by way of examples in connection with what are, at present, considered to be the most preferred embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but is intended to cover various combinations or modifications of its features, and several other applications included within the scope of the invention, as defined in the appended claims. The details mentioned in connection with any embodiment above may be used in connection with another embodiment when such combination is technically feasible.

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Claims:

1. A fuel injection system (10) comprising a fuel injector (16) having a fuel admission section (18) arranged to controllably introduce fuel from the fuel injector, a pressure accumulator (24) in the fuel injector arranged in flow connection with the admission section and a fuel inlet (26) arranged in flow connection with the pressure accumulator, which fuel injection system is provided with at least one heat exchanger system (100), **characterized** in that the at least one heat exchanger system (100) arranged to effect on the pressure accumulator (24) of the fuel injection system from outside thereof.
2. A fuel injection system according to claim 1, **characterized** in that the pressure accumulator (24) is arranged at the upper end of the fuel injector and the heat exchanger system (100) is arranged to effect on the upper end.
3. A fuel injection system according to claim 2, **characterized** in that the heat exchanger system (100) comprises a jacket (102) arranged on the upper end of the fuel injector, and that the jacket is provided with a temperature regulation fluid space (104) and at least one inlet (106) and at least one outlet (108) opening into the temperature regulation fluid space.
4. A fuel injection system according to claim 3, **characterized** in that the heat exchange system comprises at least two separate jackets (102, 110) in the longitudinal axis of the injector arranged to surround the pressure accumulator.
5. A fuel injection system according to claim 1 or 2, **characterized** in that at least one heat exchanger system (100') is integrated in connection with the pressure accumulator structure.
6. A fuel injection system according to claim 1 or 2, **characterized** in that fuel injection system is provided with two separate, independently controllable heat exchanger systems (56,56').
7. A fuel injection system according to anyone of the preceding claims 1 - 6, **characterized** in that the pressure accumulator is arranged in flow connection with the fuel admission section at a upper end thereof and at least one heat

exchanger (100,100') system arranged to effect on the pressure accumulator at a lower end thereof.

8. An arrangement for regulating fuel temperature in at least one fuel
5 injector (16) in a cylinder head of an internal combustion engine (50), the arrangement comprising a temperature regulation fluid flow circuit (54) provided with at least one heat exchanger system (100, 100') in which the temperature regulation fluid is in heat transfer connection with the at least one fuel injector (16), **characterized** in that the temperature regulation fluid flow circuit (54) is
10 provided heater system (56) operable independent from the running of the engine.

9. An arrangement for regulating fuel temperature according to claim 8, **characterized** in that the temperature regulation fluid flow circuit (54) is provided
15 with two separate, independently controllable heat exchanger systems (100, 100').

10. An arrangement for regulating fuel temperature according to claim 8, **characterized** in that the temperature regulation fluid circuit (54) is in connection
20 with lubrication oil circuit (50.4) of the engine.

11. An arrangement for regulating fuel temperature according to claim 8 or 10, **characterized** in that the temperature regulation fluid circuit is a separable and/or independently operable section of the fluid circuit of the engine.

25 12. An arrangement for regulating fuel temperature according to claim 8, **characterized** in that the temperature regulation fluid circuit (54) is in connection with cooling fluid system (50.6) of the engine.

30 13. An arrangement for regulating fuel temperature according to anyone of the preceding claims 8 - 12, **characterized** in that arrangement comprises a control system (60) which is set to maintain the arrangement for regulating temperature operating while the engine is in stand-by mode.

35 14. Method of regulating temperature of at least one fuel injector (16) in a cylinder head of an internal combustion engine in which method a temperature

regulation fluid is arranged to flow in heat exchange connection with the at least one fuel injector, **characterized** in that the temperature regulation fluid flow is operated independent from the running of the engine.

- 5 15. Method according to claim 14, **characterized** in that the temperature regulation fluid flow is operated while the engine is in stand-by mode.

16. Method according to claim 14, **characterized** in that the temperature
10 regulation fluid flow circuit is operated by circulating lubrication oil in heat exchange connection with the at least one fuel injector.

17. Method according to claim 14, **characterized** in that the temperature
regulation fluid flow is operated by circulating cooling water in heat exchange
15 connection with the at least one fuel injector.

18. Cylinder head assembly for an internal combustion engine comprising a
first cavity entity (120) having at least one first inlet section (122) for a first fluid
and at least one first outlet section (124) for the first fluid, the at least one first
20 inlet section (122) and at least one first outlet section (124) being in flow
connection with each other via the first cavity entity (120) in the cylinder head
assembly, **characterized** in that the cylinder head assembly comprises a second
cavity entity (110') having at least one second inlet section (106') for a second
fluid and at least one second outlet section (108') for the second fluid, and that
25 the at least one second inlet section and at least one second outlet section being
in flow connection with each other via the second cavity entity (110') in the
cylinder head assembly.

19. Cylinder head assembly according to claim 18, **characterized** in that the
30 cylinder head is provided with a third cavity (130) extending through the cylinder
head having inside surface arranged to accommodate an installation of a fuel
injector (16) therein, and that the second cavity entity (10') is arranged to at least
partially open into the third cavity (130).

- 35 20. A combination of a cylinder head assembly according to claim 18 and a
fuel injection system according to claim 1.

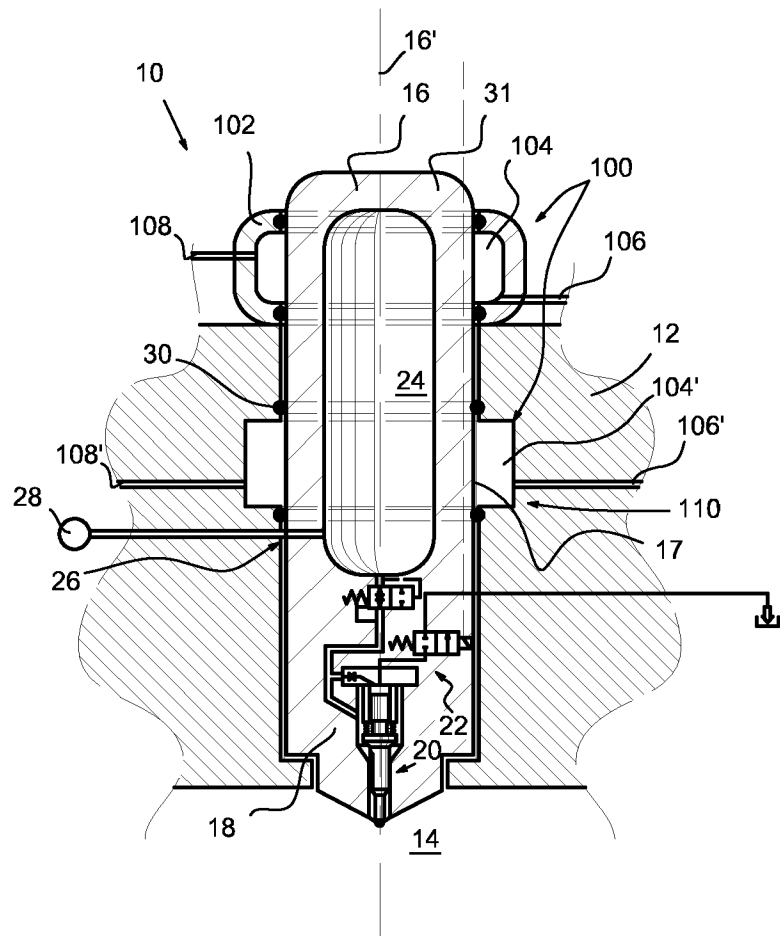


FIG. 1

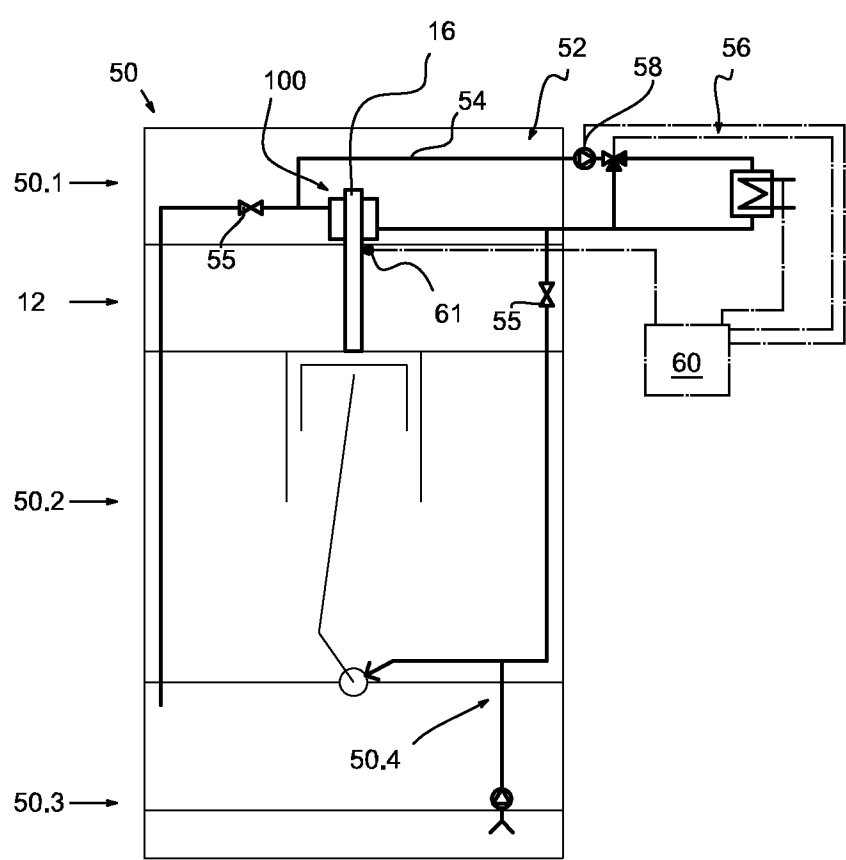


FIG. 2

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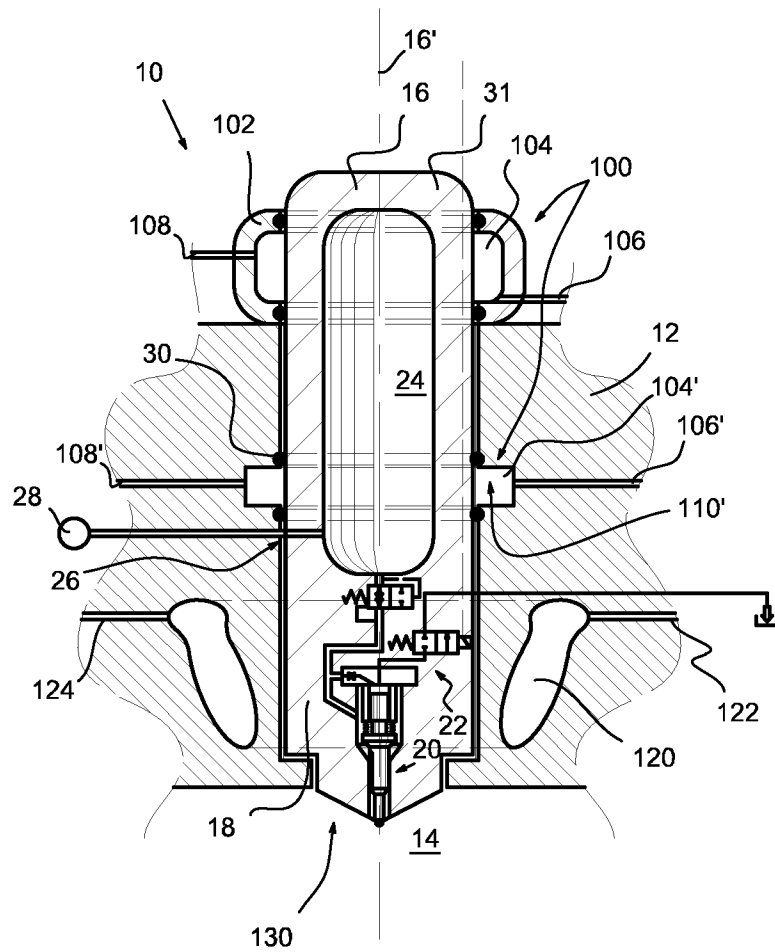


FIG. 3

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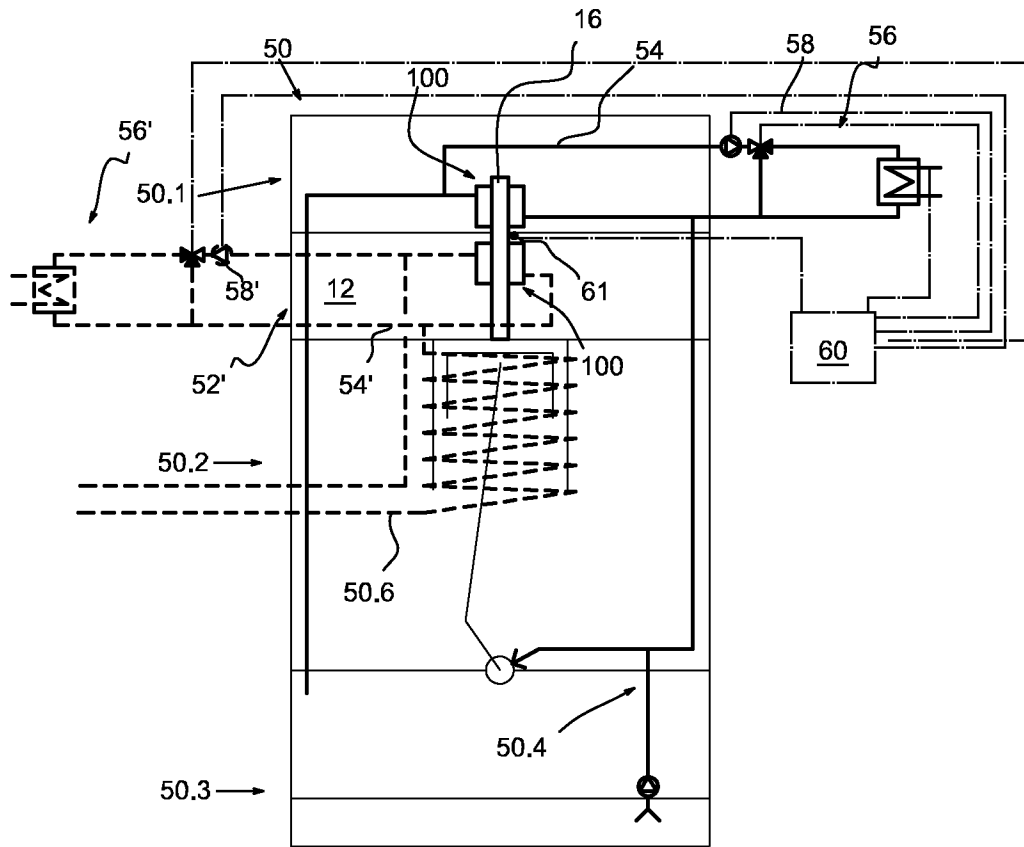


FIG. 5