

CLAIMS

1. An combustion engine comprising a cylinder (1) with a reciprocal piston inside;
5 the engine comprising a first lubricant supply (29A) with a pressurized first lubricant (50A) and a second lubricant supply (29B) with a second pressurized lubricant (50B); wherein the first lubricant (50A) is of a different type than the second lubricant (50B); the engine comprising a plurality of lubricant injectors (4) distributed along a perimeter of the cylinder (1) and fixed to a wall (3) of the cylinder (1) and
10 extending through the cylinder wall (3), wherein the injectors (4) are configured for lubricant injection into the cylinder (1) at various positions on the perimeter; wherein each of the plurality of injectors (4) is connected to the first lubricant supply (29A) through a first feed conduit (9A) for injecting the first lubricant (50A) into the cylinder (1) and to the second lubricant supply (29B) through a second lubricant feed conduit (9B) for injecting the second lubricant (50B) into the cylinder (1);
15 wherein each of the injectors is configured for selectively injecting the first or the second lubricant (50A, 50B); the engine further comprising a controller (11) for controlling the amount and timing of injection of the first and second lubricant (50A, 50B) by the plurality of injectors (4);
20 wherein each injector (4) comprises
- a first lubricant inlet (12A) for receiving the pressurized first lubricant (50A) from the first lubricant feed conduit (9A) and a second lubricant inlet (12B) for receiving the pressurized second lubricant (50b) from the second lubricant feed conduit (9A);
- at least one nozzle (5) with a nozzle aperture (5') extending into the cylinder (1)
25 for lubricant injecting in an injection-phase;
- a lubricant flow path from the first and second lubricant inlet (12A, 12B) to the at least one nozzle (5) for lubricant flow from the first and second lubricant inlet (12A, 12B) through the at least one nozzle (5) into the cylinder (1);
characterized in that each injector (4) comprises an actuator-driven selection-valve system (13) in the lubricant flow path, wherein the selection-valve system (13) is configured for selectively switching from an idle state to injection of the first or the second lubricant (50A, 50B) into the cylinder (1) through the at least one nozzle (5) in the injection-phase; wherein each injector (4) comprises an actua-
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tor (32, 33) for driving the selection-valve system (13), wherein the actuator (32, 33) is functionally connected to the controller (11) and configured for being activated by the controller (11) for selectively driving the selection-valve system (13) to cause injection of the first lubricant (50A) or the second lubricant (50B) under control by the controller (11) as a consequence of the activation of the actuator (32, 33) by the controller (11).

2. Engine according to claim 1, wherein the actuator is an electrically controlled actuator (32, 33) that is electrically connected to the controller (11) by an electrical connection (10, 10') for receiving injection-phase signals from the controller (11), the injection-phase signals indicating selection of the first or second lubricant (50A, 50B) by the selection-valve system (13) as well as timing for the injection.

3. Engine according to claim 1 or 2, wherein the selection-valve system (13) comprises a movable selection-valve member (25) that is connected to the actuator (32, 33, 36) for being driven by the actuator (32, 33, 36) from an idle-phase position or orientation, in which the selection-valve member (25) in the idle-phase blocks the flow path, selectively to a first or second injection-phase position or orientation; wherein the selection-valve member (25) in dependence of the injection-phase signal opens the flow path for the first lubricant (50A) when in the first injection-phase position or orientation or opens the flow path for the second lubricant (50B) when in the second injection-phase position or orientation for flow of the lubricant through the flow path and into the cylinder in the injection-phase.

4. Engine according to any preceding claim, wherein the flow path comprises a first canal (26A) from the first inlet (12A) to the selection-valve system (13) and a second canal (26b) from the second inlet (12B) to the selection-valve system (13), and a third canal (27) from the selection-valve system (13) towards the nozzle aperture (5'), wherein the selection-valve system (13) is configured for selectively opening for flow of the first lubricant (50A) from the first canal (26A) into the third canal (27) or flow of the second lubricant (50B) from the second canal (26B) into the third canal (27).

5. Engine according to claim 4 when dependent on claim 3, wherein the selection-valve member (25) is cylindrical, and wherein the selection-valve system (13) comprises a stationary valve member (23), the stationary valve member (23) comprising a cylindrical bushing (24) inside which the cylindrical selection-valve member (25) is arranged for at least one of displacing along or rotation about a longitudinal axis of the bushing (24); wherein the selection-valve member (25) comprises at least one throughput section (25A, 25C, 25D) arranged for connecting the first canal (26A) with the third canal (27) when the selection-valve member (25) is in the first position or orientation and for connecting the second canal (26A) with the third canal (27) when the selection-valve member (25) is in the second position or orientation.
6. Engine according to any preceding claim, wherein the nozzle (5) is provided inside the cylinder wall (3) and the actuator (32, 33, 36) is provided outside the cylinder wall (3), and wherein the actuator (32, 33, 36) is mechanically connected to the selection-valve member (25) by an actuator extension for driving the selection-valve member (25) by the actuator extension (31).
7. Engine according to any preceding claim, wherein the injector (4) comprises a base (30), wherein the base (30) comprises the first and second inlet (12A, 12B), and wherein a rigid flow chamber (16) connects the base (30) rigidly with the at least one nozzle (5), wherein the injector (4) is fixed to the cylinder wall (3) with the base (30) outside the cylinder (1) and with the at least one nozzle (5) fixed inside the cylinder wall (3); and wherein the flow chamber (16) contains the flow path for lubricant flow from the first and second lubricant inlet (12A, 12B) through the flow chamber (16) and to the at least one nozzle (5) for injection into the cylinder (1).
8. Engine according to any preceding claim, wherein the engine is a marine engine or an engine for a power plant.
9. Engine according to any preceding claim, wherein the engine is a large slow-running two-stroke engine.

10. A method for lubricating a combustion engine comprising a cylinder (1) with a reciprocal piston inside; the engine comprising a first lubricant supply (29A) with a pressurized first lubricant (50A) and a second lubricant supply (29B) with a second pressurized lubricant (50B); wherein the first lubricant (50A) is of a different type than the second lubricant (50B); the engine comprising a plurality of lubricant injectors (4) distributed along a perimeter of the cylinder (1) and fixed to a wall (3) of the cylinder (1) and extending through the cylinder wall (3), wherein the injectors (4) are configured for lubricant injection into the cylinder (1) at various positions on the perimeter; wherein each of the plurality of injectors (4) is connected to the first lubricant supply (29A) through a first feed conduit (9A) for injecting the first lubricant (50A) into the cylinder (1) and to the second lubricant supply (29B) through a second lubricant feed conduit (9B) for injecting the second lubricant (50B) into the cylinder (1); wherein each of the injectors is configured for selectively injecting the first or the second lubricant (50A, 50B); the engine further comprising a controller (11) for controlling the amount and timing of injection of the first and second lubricant (50A, 50B) by the plurality of injectors (4); wherein each injector (4) comprises

- a first lubricant inlet (12A) for receiving the pressurized first lubricant (50A) from the first lubricant feed conduit (9A) and a second lubricant inlet (12B) for receiving the pressurized second lubricant (50b) from the second lubricant feed conduit (9A);
- at least one nozzle (5) with a nozzle aperture (5') extending into the cylinder (1) for lubricant injecting in an injection-phase;
- a lubricant flow path from the first and second lubricant inlet (12A, 12B) to the at least one nozzle (5) for lubricant flow from the first and second lubricant inlet (12A, 12B) through the at least one nozzle (5) into the cylinder (1);

characterized in that each injector (4) comprises an actuator-driven selection-valve system (13) in the lubricant flow path, wherein the selection-valve system (13) is configured for selectively switching from an idle state to injection of the first or the second lubricant (50A, 50B) into the cylinder (1) through the at least one nozzle (5) in the injection-phase; wherein each injector (4) comprises an actuator (32, 33) for driving the selection-valve system (13), wherein the actuator (32, 33) is functionally connected to the controller (11) and configured for being activated by the controller (11) for selectively driving the selection-valve system (13) to cause injection of the first or the second lubricant under control by the controller

(11) as a consequence of the activation of the actuator (32, 33) by the controller (11);

5 wherein the method comprises activating the actuator (32, 33) by the controller (11) for starting an injection-phase with the first lubricant (50A) or the second lubricant (50B), and as a consequence thereof causing the selection-valve system (13) to open for flow of the first or the second lubricant (50A, 50B) through the flow path and injecting the first or second lubricant (50A, 50B) lubricant into the cylinder (1); at the end of the injection-phase, causing the actuator to close the selection-valve system (13) for lubricant supply.

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11. Method according to claim 10, wherein the actuator (32, 33, 36) is an electrically controlled actuator that is electrically connected to the controller (11) by an electrical connection (10, 10') for receiving the injection-phase signals from the controller (11); the injection-phase signals indicating selection of the first or second lubricant (50A, 50B) for injection as well as timing for the injection; wherein the method comprises receiving the injection-phase signal by the actuator (32, 33, 36) and in dependence of the injection-phase signal opening the flow path for injection of the first or second lubricant (50A, 50B) into the cylinder (1).

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12. Method according to claim 11, wherein the selection-valve system (13) comprises a movable selection-valve member (25) that is connected to the actuator (32, 33, 36) for being driven by the actuator (32, 33, 36) from an idle-phase position or orientation, in which the selection-valve member (25) in the idle-phase blocks the flow path, selectively to a first or second injection-phase position or orientation; wherein the selection-valve member (25) in dependence of the injection-phase signal opens the flow path for the first lubricant (50A) when the selection-valve member (25) is in the first injection-phase position or orientation or opens the flow path for the second lubricant (50B) when the selection-valve member (25) is in the second injection-phase position or orientation for flow of the lubricant through the flow path and into the cylinder in the injection-phase, wherein the method comprises receiving the injection-phase signal by the actuator (32, 33, 36) and moving the selection-valve member (25) by the actuator (32, 33, 36) in dependence of the injection-phase signal to a first or second injection-phase position or orientation and

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correspondingly opening the flow path for injection of the first or second lubricant (50A, 50B) into the cylinder (1).

13. Method according to any one of the claims 10-12, wherein the flow path
5 comprises a first canal (26A) from the first inlet (12A) to the selection-valve system (13) and a second canal from the second inlet (12B) to the selection-valve system (13), and a third canal (27) from the selection-valve system (13) towards the nozzle aperture (5'), wherein the method comprises selectively opening for flow of
10 the first lubricant (50A) from the first canal (26A) into the third canal (27) or opening for flow of the second lubricant (50B) from the second canal (26B) into the third canal (27) by the selection-valve system (13).

14. Method according to claim 13 when dependent on claim 11, wherein the selection-valve member (25) is cylindrical, and wherein the selection-valve system
15 (13) comprises a stationary valve member (23), the stationary valve member (23) comprising a cylindrical bushing (24) inside which the cylindrical selection-valve member (25) is arranged for at least one of displacing along or rotation about a longitudinal axis of the bushing (24); wherein the selection-valve member (25) comprises at least one throughput section (25A, 25C, 25D) arranged for connecting
20 the first canal (26A) with the third canal (27) in the first position or orientation and for connecting the second canal (26A) with the third canal (27) in the second position or orientation, wherein the method comprises selectively connecting the first canal (26A) with the third canal (27) in the first position or orientation or connecting the second canal (26A) with the third canal (27) in the second position or orientation in dependence of the injection-phase signal.
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15. Method according to anyone of the claims 10-14, wherein the nozzle (5) is provided inside the cylinder wall (3) and the actuator (32, 33, 36) is provided outside the cylinder wall (3), and wherein the actuator (32, 33, 36) is mechanically
30 connected to the selection-valve member (25) by an actuator extension (31), wherein the method comprises moving the selection-valve member (25) by the actuator (32, 33, 36) using the actuator extension (31).

16. Method according to anyone of the claims 10-15, wherein the method comprises activating the actuator (32, 33) by the controller (11) at least two times within an injection cycle with multiple injection phases and causing the injector (4) to inject the first lubricant (50A) in a first injection phase and subsequently the second lubricant (50B) in a second injection phase within a single revolution of the engine for providing the first as well as the second lubricant (50A, 50B) inside the cylinder (1) in the injection cycle.

17. A lubricant injector for mounting through one of a plurality of identical injection openings along a perimeter of cylinder wall (1) of a combustion engine; wherein the lubricant injector comprises

- a first lubricant inlet (12A) for receiving the pressurized first lubricant (50A) from the first lubricant feed conduit (9A) and for injecting the second lubricant (50B) into the cylinder (1) and a second lubricant inlet (12B) for receiving the pressurized second lubricant (50b) from the second lubricant feed conduit (9A) and for injecting the second lubricant (50B) into the cylinder (1);
- at least one nozzle (5) with a nozzle aperture (5') extending into the cylinder (1) for lubricant injecting in an injection-phase;
- a lubricant flow path from the first and second lubricant inlet (12A, 12B) to the at least one nozzle (5) for lubricant flow from the first and second lubricant inlet (12A, 12B) through the at least one nozzle (5) into the cylinder (1);

characterized in that each injector (4) comprises an actuator-driven selection-valve system (13) in the lubricant flow path, wherein the selection-valve system (13) is configured for selectively switching from an idle state to injection of the first or the second lubricant (50A, 50B) into the cylinder (1) through the at least one nozzle (5) in the injection-phase; wherein each injector (4) comprises an actuator (32, 33) for driving the selection-valve system (13), wherein the actuator (32, 33) is functionally connected to the controller (11) and configured for being activated by the controller (11) for selectively driving the selection-valve system (13) to cause injection of the first or the second lubricant under control by the controller (11) as a consequence of the activation of the actuator (32, 33) by the controller (11).

18. Injector according to claim 17, wherein the actuator (32, 33, 36) is an electrical actuator having an electrically controlled connector (10') for electrical connection to the controller (11) and for receiving injection-phase signals from the controller (11), the injection-phase signals indicating selection between the first or second lubricant (50A, 50B) for injection as well as timing for the injection.

19. Injector according to claim 17 or 18, wherein the selection-valve system (13) comprises a movable selection-valve member (25) that is connected to the actuator (32, 33, 36) for being driven by the actuator (32, 33, 36) from an idle-phase position or orientation, in which the selection-valve member (25) in the idle-phase blocks the flow path, selectively to a first or second injection-phase position or orientation; wherein the selection-valve member (25) in dependence of the injection-phase signal opens the flow path for the first lubricant (50A) when in the first injection-phase position or orientation or opens the flow path for the second lubricant (50B) when in the second injection-phase position or orientation for flow of the lubricant through the flow path and into the cylinder in the injection-phase.

20. Injector according to anyone of the claims 17-19, wherein the injector comprises only one nozzle (5), wherein the flow path comprises a first canal (26A) from the first inlet (12A) to the selection-valve system (13) and a second canal from the second inlet (12B) to the selection-valve system (13), and a third canal (27) from the selection-valve system (13) towards the nozzle aperture (5'), wherein the selection-valve system (13) is configured for selectively opening for flow of the first lubricant (50A) from the first canal (26A) into the third canal (27) or flow of the second lubricant (50B) from the second canal (26B) into the third canal (27).

21. Injector according to claim 20, wherein the selection-valve member (25) is cylindrical, and wherein the selection-valve system (13) comprises a stationary valve member (23), the stationary valve member (23) comprising a cylindrical bushing (24) inside which the cylindrical selection-valve member (25) is arranged for at least one of displacing along or rotation about a longitudinal axis of the bushing (24); wherein the selection-valve member (25) comprises at least one throughput section (25A, 25C, 25D) arranged for connecting the first canal (26A) with the third canal (27) when the selection-valve member (25) is in the first position or ori-

entation and for connecting the second canal (26A) with the third canal (27) when the selection-valve member (25) is in the second position or orientation.

22. Injector according to claim 21 wherein the throughput section (26A) is provided as a narrowing section (25A, 25C, 25D) of the selection-valve member (25) for flow of the first lubricant (50A) from the first canal (26A) or the second lubricant (50B) from the second canal (26B) through the narrowing section (25A, 25C, 25D) inside the bushing (54) into the third canal (27) in the injection-phase.

23. Injector according to anyone of the claims 17-22, wherein the injector comprises a base (30) for mounting to the cylinder wall (3) and a rigid flow chamber (16) connecting the base (30) with the nozzle (5) for fixing the nozzle (5) inside the cylinder wall (3) when the base is fixed to the cylinder wall (3), wherein the base comprises the first and second inlet (12A, 12B) and wherein the flow chamber (16) contains the flow path for lubricant flow from the first and second lubricant inlet (12A, 12B) through the flow chamber (16) and to the nozzle (5) for injection into the cylinder (1); wherein the actuator (32, 33, 36) is fixed to the base (31) for being provided outside the cylinder wall (3) when the injector is mounted at the cylinder wall (3).

24. Injector according to claim 23, wherein the selection-valve member (25) is located in the flow chamber (16), and the actuator (32, 33, 36) is mechanically connected to the selection-valve member (25) by an actuator extension (31) for driving the selection-valve member (25) by the actuator extension (31).

25. Injector according to claims 24 when directly or indirectly dependent on claim 2, wherein the actuator is an electromechanical actuator and comprises an electrical solenoid arrangement with a stationary solenoid part (32) and a movable solenoid part (33) and wherein the actuator-extension (31) is connected to the movable solenoid part (32) for being driven by electrical excitation of the solenoid (32), wherein the solenoid is configured for excitation by the injection-phase signals from the controller (11).

26. Injector according to claim 25, wherein the selection-valve member (25) is pre-stressed towards an idle-phase position by at least one spring (34A, 34B).

5 27. Injector according to any one of the claims 17-26, wherein the injector is configured for selecting and injecting only the first or only the second lubricant at a time.

10 28. Injector according to anyone of the claims 17-27, wherein injector (4) comprises an outlet-valve system (15) at the nozzle (5) and between the selection-valve system (13) and the nozzle aperture (5') for opening and closing for injection into the cylinder (1) during an injection cycle; the outlet-valve system (15) being configured for opening for lubricant flow to the nozzle aperture (5') during an injection-phase upon pressure rise above a predetermined limit at the outlet-valve system (15) and for closing the outlet-valve system (15) after the injection-phase upon
15 pressure decrease.

29. Use of an injector according to anyone of the claims 17-28 for SIP injection into the cylinder of a large marine engine or combustion engine for a power plant at a lubricant pressure in the range of 25 bar to 100 bar.

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