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(54) Title: SUBASSEMBLY FOR A COMPRESSION IGNITION ENGINE WITH A RECIRCULATION VALVE ON A SECONDARY EXHAUST MANIFOLD

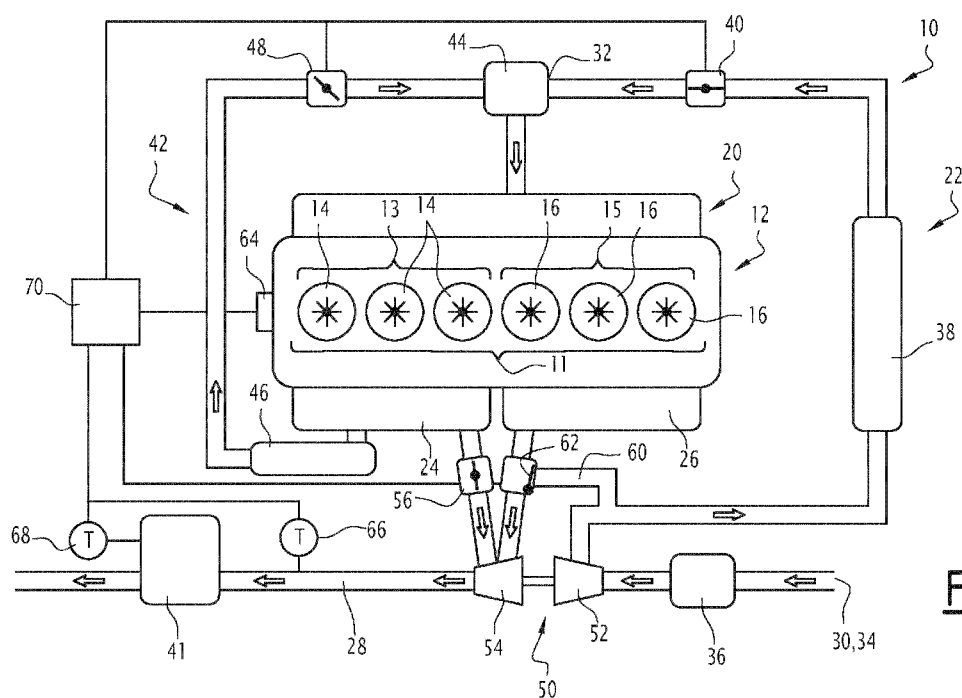


FIG.1

(57) Abstract: This subassembly comprises a primary exhaust manifold (24) for collecting exhaust gas of at least one primary cylinder (14) of a compression ignition engine (12), a secondary exhaust manifold (26) for collecting exhaust gas of at least one secondary cylinder (16) of the compression ignition engine (12), an exhaust gas passage (28) for collecting exhaust gas from both primary and secondary exhaust manifolds (24, 26) and draining these exhaust gas away, a feeding line (22) for feeding fresh air to the cylinders (14, 16) of the compression ignition engine (12), a bypass (60) connecting the secondary exhaust manifold (26) to the feeding line (22), and a recirculation valve (62) having a first configuration allowing circulation of exhaust gas from the secondary exhaust manifold (26) to the exhaust gas passage (28) while closing the bypass (60), and a second configuration blocking circulation of exhaust gas from the secondary exhaust manifold (26) to the exhaust gas passage (28) while opening the bypass (60).

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Subassembly for a compression ignition engine with a recirculation valve on a secondary exhaust manifold

FIELD

5 The present invention concerns a subassembly for a compression ignition engine, of the type comprising:

- a primary exhaust manifold for collecting exhaust gas of at least one primary cylinder of the compression ignition engine,
- 10 - a secondary exhaust manifold for collecting exhaust gas of at least one secondary cylinder of the compression ignition engine,
- an exhaust gas passage for collecting exhaust gas from both primary and secondary exhaust manifolds and draining these exhaust gas away, and
- a feeding line for feeding fresh air to the cylinders of the compression ignition engine.
- 15

The invention further concerns a compression ignition engine assembly, of the type comprising a compression ignition engine including at least one primary cylinder and at least one secondary cylinder, a deactivation system for deactivating the or each secondary cylinder while the or each primary cylinder is active, and a subassembly of the type mentioned above, wherein the primary exhaust manifold of said subassembly is connected to the compression ignition engine so as to collect exhaust gas of the or each primary cylinder, and the secondary exhaust manifold of the subassembly is connected to the compression ignition engine so as to collect exhaust gas of the or each secondary cylinder.

- 20

The invention also concerns an operation method for operating a compression ignition engine assembly of the type mentioned above.

- 25

BACKGROUND

Such compression ignition engine assemblies are known, for instance from US 2015/0040560. In such assemblies, deactivation of the secondary cylinders is usually performed by shutting off fuel injection in the secondary cylinders. Furthermore, motion of the intake valves of the secondary cylinders is stopped using a variable valve actuation system, so as to reduce friction in the engine and prevent the engine from exhausting into the exhaust line fresh air pumped by the secondary cylinders.

- 30
- 35

This deactivation allows reducing the flow of exhaust gas produced by the engine and increasing the temperature of that exhaust gas during critical engine operating conditions, thus preventing cooling down of the exhaust gas aftertreatment systems used for depollution of the exhaust gas.

5 However, these known compression ignition engine assemblies do not provide entire satisfaction in that they require a more complex mechanism for the valve train system that increases the cost of the engine and increases the risks on the durability of the assembly.

Cylinder deactivation is also commonly used in the field of spark ignited engines, wherein it allows significant fuel economy. In this technical field, assemblies are known,
10 for instance from US 4 344 393, in which a dedicated valve regulates the feeding of fresh air to the secondary cylinders, and a recirculation pipe allows recirculation of exhaust gas of the secondary cylinders to the inlet of these secondary cylinders.

However, such assemblies do not provide entire satisfaction in that their size is usually too big with regards to the volume constraints fixed by the vehicle manufacturers.

SUMMARY OF THE INVENTION

An aim of the invention thus consists of simplifying the architectures of compression ignition engine assemblies that allow cylinders deactivation. Other aims of the invention
20 consist of reducing the cost of such assemblies, increasing their durability, and limiting their size.

To that end, the invention relates to a subassembly of the aforementioned type, wherein the subassembly further comprises a bypass connecting the secondary exhaust manifold to the feeding line, and a recirculation valve having a first configuration allowing
25 circulation of exhaust gas from the secondary exhaust manifold to the exhaust gas passage while closing the bypass, and a second configuration blocking circulation of exhaust gas from the secondary exhaust manifold to the exhaust gas passage while opening the bypass.

This subassembly prevents cold exhaust gas coming from the secondary exhaust manifold to cool down a downstream exhaust gas aftertreatment system in a very efficient
30 manner. To prevent such a cooling from happening, it is indeed sufficient to switch the secondary recirculation valve 62 into its second configuration, which can be done in very simple manner.

Also, the secondary recirculation valve and the bypass are especially simple to
35 install since they merely need minor modifications of the "hot part" of the engine that do not increase the size of the whole assembly.

According to specific embodiments of the invention, this subassembly further includes one or several of the following features, considered alone or along any technically feasible combination:

- the subassembly further comprises at least one turbocharger including a compressor positioned in the feeding line for compressing fresh air provided to the compression ignition engine and a turbine located in the exhaust gas passage for driving the compressor;

- the bypass connects the secondary exhaust manifold to the feeding line downstream of the compressor;

- the feeding line comprises a charge air cooler downstream of the compressor;

- the bypass connects the secondary exhaust manifold to the feeding line upstream of the charge air cooler;

- the subassembly comprises a recirculation line for feeding the cylinders of the compression ignition engine with exhaust gas coming from the primary exhaust manifold; and

- the recirculation valve has a third configuration providing an increased flow resistance to the flow of exhaust gas between the secondary exhaust manifold and the exhaust gas passage, while allowing circulation of gas between the secondary exhaust manifold and the exhaust gas passage and closing the bypass.

The invention also relates to a compression ignition engine assembly of the type mentioned above, wherein the subassembly consists of a subassembly as defined above.

According to specific embodiments of the invention, this compression ignition engine assembly further includes one or several of the following features, considered alone or along any technically feasible combination:

- the compression ignition engine assembly further comprises a control unit controlling the recirculation valve so that the recirculation valve is in its second configuration at least when the or each secondary cylinder is deactivated, and preferably only when the or each secondary cylinder is deactivated; and

- the feeding line is connected to the compression ignition engine so as to provide fresh air to both the primary and secondary cylinders.

The invention further relates to an operation method for operating the compression ignition engine assembly defined above, comprising the following successive steps:

- operating the compression ignition engine with the primary and secondary cylinders active, the recirculation valve being in its first configuration,

- deactivating the or each secondary cylinder while switching the recirculation valve from its first configuration to its second configuration, and

- operating the compression ignition engine with the or each primary cylinder active, the or each secondary cylinder being inactive and the recirculation valve being in its second configuration.

According a specific embodiment of the invention, this operation method further comprises the following feature:

- the operation method further comprises a step of reactivating the or each secondary cylinder while switching the recirculation valve from its second configuration to its first configuration.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features and advantages of the invention will appear more clearly while reading the following description, provided only as an example and made with reference to the attached drawings, wherein:

- Figure 1 is a scheme of a compression ignition engine assembly according to the invention, said assembly being in a first operation mode,
- Figure 2 is a scheme of the compression ignition engine assembly of Figure 1, said assembly being in a second operation mode,
- Figure 3 is a block diagram of a deactivation function implemented by a control unit of the compression ignition engine assembly of Figure 1,
- Figure 4 is block diagram of a first sub-function of the deactivation function of Figure 3,
- Figure 5 is block diagram of a sub-function of the first sub-function of Figure 4,
- Figure 6 is block diagram of a second sub-function of the deactivation function of Figure 3,
- Figure 7 is a block diagram of an operation method for operating the compression ignition engine of Figure 1,
- Figure 8 is a block diagram of a first checking step of the method of Figure 7, and
- Figure 9 is a block diagram of a second checking step of the method of Figure 7.

DETAILED DESCRIPTION

The compression ignition engine assembly 10 of Figure 1 comprises an internal combustion engine 12 consisting of a compression ignition engine. This compression

ignition engine 12 includes, in a known manner, cylinders 11, including a primary group 13 of primary cylinders 14 and a secondary group 15 of secondary cylinders 16, fuel injectors (not shown) to inject fuel in the cylinders 14, 16, inlet valves (not shown) to let gas enter into the cylinders 11, exhaust valves (not shown) to let gas exit the cylinders 11, pistons (not shown) movable in the cylinders to compress gas within the cylinders 11, and a crank shaft (not shown) to convert translation of the pistons within the cylinders 11 into the rotary motion of a shaft. Being a compression ignition engine, the engine 12 is configured so that fuel injected in the cylinders 11 is ignited under the sole effect of the high heat and compression of the gas within the cylinders 11.

The compression ignition engine assembly 10 further comprises an inlet manifold 20 for feeding each cylinder 11 with combustion gas, a feeding line 22 for feeding fresh air to the cylinders 11, a primary exhaust manifold 24 for collecting exhaust gas from each primary cylinder 14, a secondary exhaust manifold 26 for collecting exhaust gas from each secondary cylinder 16, and an exhaust gas passage 28 for collecting exhaust gas from both primary and secondary exhaust manifolds 24, 26 and draining these exhaust gas away.

The feeding line 22 is connected to the compression ignition engine 10 so as to provide fresh air to both the primary and secondary cylinders 14, 16, and in particular so as to provide fresh air to every cylinder 11. To that end, the feeding line 22 is connected to the compression ignition engine 10 via the inlet manifold 20.

The feeding line 22 includes, from an upstream end 30 thereof down to a downstream end 32 thereof:

- an air inlet 34 that forms the upstream end 30,
- an air filter 36, and
- a charge air cooler 38.

In the shown example, the feeding line 22 further comprises an intake throttle valve 40. This valve 40 is here downstream of the charge air cooler 38.

The exhaust gas passage 28 comprises an exhaust gas aftertreatment system 41. This exhaust gas aftertreatment system 41 is configured so as to depollute exhaust gas crossing this aftertreatment system 41. To that end, the exhaust gas aftertreatment system 41 typically comprises at least one of: a diesel oxidation catalyzer, a particulate filter, a selective catalytic reactor and an urea injector that is commonly arranged between the diesel oxidation catalyzer and the selective catalytic reactor.

The exhaust gas passage 28 is configured so that substantially all exhaust gas that is drained by said passage 28 crosses this exhaust gas aftertreatment system 41.

The compression ignition engine assembly 10 also comprises a recirculation line 42 for recirculating at least part of the exhaust gas from the primary cylinders 14, and a mix chamber 44 for mixing the recirculated gas with fresh air provided by the feeding line 22.

This recirculation line 42 is configured for feeding the cylinders 11 with exhaust gas coming from the primary exhaust manifold 24. To that end, the recirculation line 42 connects the primary exhaust manifold 24 to the mix chamber 44. It comprises a cooler 46 for cooling the gas recirculating through the line 42, and a primary recirculation valve 48 for regulating the flow of recirculated gas circulating through the line 42.

In an alternative not shown, the recirculation line 42 is arranged to recirculate gas from the primary cylinders 14 and from the secondary cylinders 16. According to this alternative, the recirculation line 42 connects the primary exhaust manifold 24 and the secondary exhaust manifold 26 to the mix chamber 44.

The mix chamber 44 is connected to the feeding line 22, to the recirculating line 42, and to the inlet manifold 20. It is positioned downstream from both the feeding line 22 and the recirculating line 42 and upstream of the inlet manifold 20, so that fresh air provided by the feeding line 22 mixes in the chamber 44 with the recirculated gas provided by the recirculating line 42 before this mix feeds the inlet manifold 20.

The compression ignition engine assembly 10 further comprises a turbocharger 50. This turbocharger 50 includes a compressor 52 positioned in the feeding line 22 for compressing fresh air provided to the compression ignition engine 10 and a turbine 54 located in the exhaust gas passage 28 for driving the compressor 52.

The compressor 52 is positioned downstream of the air filter 36 and upstream of the charge air cooler 38.

The turbine 54 is located upstream of the exhaust gas aftertreatment system 41.

The compression ignition engine assembly 10 also comprises a primary backpressure valve 56 for regulating the pressure of exhaust gas in the primary exhaust manifold 24.

This primary backpressure valve 56 is interposed between the primary exhaust manifold 24 and the exhaust gas passage 28. It has a first configuration providing minimal flow resistance to exhaust gas flowing from the primary exhaust manifold 24 to the exhaust gas passage 28 and a second configuration providing maximal flow resistance to exhaust gas flowing from the primary exhaust manifold 24 to the exhaust gas passage 28. Preferably, the primary backpressure valve 56 also has different intermediate configurations between the first and the second configurations that provide different intermediate flow resistance to exhaust gas flowing from the primary exhaust manifold 24 to the exhaust gas passage 28.

The primary backpressure valve 56 allows increasing the flow resistance to exhaust gas of the primary cylinders 14, thus slowing down the engine 10, in phases where the engine 10 needs to be slowed down, such as when the engine 10 is dragging.

According to the invention, the compression ignition engine assembly 10 further comprises a bypass 60 connecting the secondary exhaust manifold 26 to the feeding line 22, and a secondary recirculation valve 62.

The bypass 60 connects the secondary exhaust manifold 26 to the feeding line 22 downstream of the compressor 52 and upstream of the charge air cooler 38. In an alternative (not shown), the bypass 60 connects the exhaust manifold 26 to the feeding line 22 upstream of the compressor 52.

The secondary recirculation valve 62 is interposed between the secondary exhaust manifold 26 on the one hand and the exhaust gas passage 28 and the bypass 60 on the other hand. It has a first configuration, shown in Figure 1, allowing circulation of exhaust gas from the secondary exhaust manifold 26 to the exhaust gas passage 28 while closing the bypass 60, and a second configuration, shown in Figure 2, blocking circulation of exhaust gas from the secondary exhaust manifold 26 to the exhaust gas passage 28 while opening the bypass 60.

Here, the secondary recirculation valve 62 further comprises a third configuration, not shown, where the secondary recirculation valve 62 acts as a secondary backpressure valve. In this configuration, the secondary recirculation valve 62 provides, when compared to the first configuration, an increased flow resistance to the flow of exhaust gas between the secondary exhaust manifold 26 and the exhaust gas passage 28, while allowing circulation of gas between the secondary exhaust manifold 26 and the exhaust gas passage 28 and closing the bypass 60.

In an alternative embodiment (not shown), a dedicated secondary backpressure valve is provided between the secondary exhaust manifold 26 and the exhaust gas passage 28, upstream or downstream of the secondary recirculation valve 62. In another alternative embodiment (not shown), there is no primary backpressure valve 56 and, in place, a common backpressure valve is installed in the exhaust gas passage 28, upstream or downstream of the turbine 54.

The compression ignition engine assembly 10 also comprises a deactivation system 64 for deactivating the secondary cylinders 16 while the primary cylinders 14 are active, temperature units 66, 68 to determine temperature of the exhaust gas aftertreatment system 41 and of exhaust gas in the exhaust gas passage 28, and a control unit 70 for controlling the valves 40, 48, 56, 62 and the deactivation system 64.

The deactivation system 64 is configured for controlling the fuel injectors so that the injection settings of the secondary cylinders 16 are:

- identical to the injection settings of the primary cylinders 14 when the secondary cylinders 16 shall be active, and
- different from the injection settings of the primary cylinders 14 when the secondary cylinders 16 shall be inactive.

By "injection settings", it is hereby meant the settings that determine the injection pattern of fuel into the cylinders, including the timing, the pulses and the quantity and the pressure of each injection.

For instance, the deactivation system 64 is configured for controlling the fuel injectors so that fuel is injected into the secondary cylinders 16 in the same manner as into the primary cylinders 14 when the secondary cylinders 16 are active, and in a reduced quantity (in comparison with the primary cylinders 14) when the secondary cylinders 16 are inactive, said reduced quantity being allowed to be zero (in which case injection of fuel into the secondary cylinders 16 is merely stopped).

The temperatures units 66, 68 comprise a first temperature unit 66 for determining temperature of exhaust gas in the exhaust gas passage 28, upstream of the exhaust gas aftertreatment system 41 and preferably downstream of the turbine 54, and a second temperature unit 68 for determining temperature of the exhaust gas aftertreatment system 41.

In the shown example, the first temperature unit 66 consists of a first temperature sensor for measuring the temperature of exhaust gas in the exhaust gas passage 28, and the second temperature unit 68 consists of a second temperature sensor for measuring the temperature in or downstream of the exhaust gas aftertreatment system 41.

Alternatively, both temperature units 66, 68 comprise processing units that calculate the temperature of exhaust gas in the exhaust gas passage 28 and the temperature of the exhaust gas in the aftertreatment system 41 based on models stored in the memory of these processing units. These processing units may then be part of the control unit 70.

The control unit 70 preferably consists of a data processing unit comprising a processor (not shown) and a memory (not shown) storing programs able to be executed by the processor. Alternatively, the control unit 70 is at least partly formed by programmable logic devices and/or dedicated integrated circuits.

The control unit 70 is configured for controlling the secondary recirculation valve 62 and the deactivation system 64 so as to manage switching of the compression ignition engine assembly 10 between a first operation mode and a second operation mode.

In the first operation mode, both the primary and secondary cylinders 14, 16 are active, while the secondary recirculation valve 62 is in its first configuration. In the second operation mode, only the primary cylinders 14 are active, the secondary cylinders 16 being inactive, and the secondary recirculation valve 62 is in its second configuration.

5 The control unit 70 is configured to control the secondary recirculation valve 62 so that said valve 62 is in its second configuration in the second operation mode. In other words, the control unit 70 is configured to control the secondary recirculation valve 62 so that said valve 62 is in its second configuration at least when the secondary cylinders 16 are deactivated. Preferably, the control unit 70 is configured to control the secondary
10 recirculation valve 62 so that said valve 62 is in its second configuration only when the secondary cylinders 16 are deactivated.

The control unit 70 is configured so as to switch the secondary recirculation valve 62 from its first configuration to its second configuration and to control the deactivation system 64 so that it deactivates the secondary cylinders 16 when it identifies that several
15 operating conditions for deactivation are simultaneously met, and to switch the secondary recirculation valve 62 from its second configuration to its first configuration and to control the deactivation system 64 so that it reactivates the secondary cylinders 16 when it identifies that, among several operating conditions for reactivation, at least one of these operating conditions for reactivation is met.

20 The operating conditions for deactivation include:

- the compression ignition engine assembly 10 being in a temperature critical situation, that is to say a situation in which the temperature of the exhaust gas is lower than the temperature of the exhaust gas after-treatment system 41, so that the exhaust gas will cool down the exhaust gas after-treatment system 41,
- 25 - the compression ignition engine 12 being in an operating point that is sustainable with the secondary cylinders 16 being deactivated,
- a torque demand demanded to the compression ignition engine 12 being under a preset threshold,
- the compression ignition engine 12 not being in need of a transient torque
30 increase, and
- the compression ignition engine assembly 10 not being in a thermal power enforcement state, which is a state wherein the exhaust gas aftertreatment system 41 is in a heating state requiring all cylinders 11 to be active.

To determine whether the compression ignition engine assembly 10 is in a
35 temperature critical situation, the control unit 70 is configured for:

- comparing the first temperature to a critical threshold value equal to the second temperature, preferably minus a criticality margin, and
- in case the first temperature is under the critical threshold value, concluding that the compression ignition engine assembly 10 is in a temperature critical situation.

The criticality margin is non-zero and is preferably above 10°C. For instance, the criticality margin is comprised between 10 and 50°C.

To determine whether the compression ignition engine 12 is in an operating point that is sustainable with the secondary cylinders 16 being deactivated, the control unit 70 is configured for:

- checking if the compression ignition engine 12 is in a low-load operating point, such as an idling operating point or a low-load motoring operating point, and
- in case the compression ignition engine 12 is in a low-load operating point, concluding that the compression ignition engine 12 is in an operating point that is sustainable with the secondary cylinders 16 being deactivated.

An idling operating point is defined as an operating point where the engine 12 is running at idle speed, which is the rotational speed the engine 12 runs on when the engine 12 is decoupled from the drivetrain and the accelerator of the engine 12 is released, and at which the engine 12 generates enough power to run reasonably smoothly and operate its ancillary equipment (water pump, alternator, and, if equipped, other accessories such as power steering), but not enough to perform heavy work, such as moving the vehicle. In that operating point, even though the accelerator is released, a certain amount of fuel keeps being injected into the engine 12 in order to keep the engine 12 running.

A low load motoring operating point is defined as an operating point where the engine 12 is running above a certain rotational speed, but low or no fuel is injected into the engine 12, such as when the engine 12 is operating under very low load or when the engine is dragging, i.e. when the vehicle normally driven by the engine 12 is coasting down a hill. In that operating point the accelerator is partially or completely released, but the engine 12 remains coupled to the drivetrain and is kept running by the drive force of the gearbox main shaft.

To determine whether the torque demand demanded to the compression ignition engine 12 is under a preset threshold, the control unit 70 is configured for determining a driver torque demand, and comparing the driver torque demand to the preset threshold.

To determine whether the compression ignition engine 12 is not in need of a transient torque increase, the control unit 70 is configured for:

- determining the driver torque demand,
- determining the time derivative of the driver torque demand, and comparing this time derivative to a derivative threshold value,
- determining the gas pressure in the inlet manifold, and comparing this gas pressure to a pressure threshold depending on the driver torque demand, and
- concluding that the compression ignition engine 12 is not in need of a transient torque increase when and only when all the following conditions are simultaneously met:
 - o the time derivative of the driver torque demand is under the derivative threshold value, and
 - o the gas pressure in the inlet manifold is above the pressure threshold.

To determine whether the compression ignition engine assembly 10 is not in a thermal power enforcement state, the control unit 70 is configured for:

- comparing the second temperature and a temperature threshold, said temperature threshold typically being the minimum temperature for the exhaust gas after treatment system 41 to operate effectively and being preferably comprised between 200 and 220°C,
- in case the second temperature is under the temperature threshold:
 - o calculating a predicted first thermal power provided to the exhaust gas aftertreatment system 41 when the secondary cylinders 16 are deactivated,
 - o calculating a predicted second thermal power provided to the exhaust gas aftertreatment system 41 when all cylinders 11 are active, and
 - o comparing the predicted first and second thermal powers, and
- in case the second temperature is above the temperature threshold, or the second temperature is under the temperature threshold while the first thermal power is higher than the second thermal power, concluding that the compression ignition engine assembly 10 is not in a thermal power enforcement state.

To calculate the predicted first thermal power, the control unit 70 is configured for determining a predicted reduced exhaust flow and a predicted increased exhaust temperature if the secondary cylinders 16 are deactivated, and for applying the following formula:

$$(E1) P_1 = Q_1 \times (T_1 - T_0) \times C$$

wherein P_1 is the predicted first thermal power, Q_1 is the predicted exhaust flow when the secondary cylinders 16 are deactivated, T_1 is the predicted exhaust temperature

when the secondary cylinders 16 are deactivated, T_0 is the last known temperature of the exhaust gas aftertreatment system 41 determined by the second temperature unit 68, and C is the heat capacity of the exhaust gas.

The predicted reduced exhaust flow and predicted increased exhaust temperature are typically determined using tables stored in a memory of the control unit 70 and that provide, for a given torque and a given rotation speed of the engine 12, the exhaust flow and the exhaust temperature of the engine 12 when the secondary cylinders are inactive. The data contained in these tables preferably consist of measurements made on a reference engine similar to the compression ignition engine 12.

To calculate the predicted second thermal power, the control unit 70 is configured for determining a predicted increased exhaust flow and a predicted reduced exhaust temperature if all cylinders 14, 16 are active, and for applying the following formula:

$$(E2) P_2 = Q_2 \times (T_2 - T_0) \times C$$

wherein P_2 is the predicted second thermal power, Q_2 is the predicted exhaust flow if the secondary cylinders 16 are active, T_2 is the predicted exhaust temperature if the secondary cylinders 16 are active, T_0 is the last known temperature of the exhaust gas aftertreatment system 41 determined by the second temperature unit 68, and C is the heat capacity of the exhaust gas.

The predicted increased exhaust flow and predicted reduced exhaust temperature are typically determined using tables stored in a memory of the control unit 70 and that provide, for a given torque and a given rotation speed of the engine 12, the exhaust flow and the exhaust temperature of the engine 12 when the secondary cylinders 16 are active. The data contained in these tables preferably consist of measurements made on a reference engine similar to the compression ignition engine 12.

The operating conditions for reactivation include:

- the compression ignition engine assembly 10 being in an excess temperature situation, that is to say a situation wherein the temperature of the exhaust gas upstream of the exhaust gas after treatment system 41 with all cylinders 11 active is sufficient to ensure heating of the exhaust gas after treatment system 41,
- the torque demand demanded to the compression ignition engine 12 being above a preset threshold,
- the compression ignition engine 12 being in need of a transient torque increase, and
- the compression ignition engine assembly 10 being in the thermal power enforcement state.

To determine whether the compression ignition engine assembly 10 is in an excess temperature situation, the control unit 70 is configured for:

- determining a predicted exhaust temperature with all cylinders 11 being active,
- comparing the predicted exhaust temperature to an excess threshold value equal to the second temperature, preferably plus an excess margin, and
- in case the predicted exhaust temperature is above the excess threshold value, concluding that the compression ignition engine assembly 10 is in an excess temperature situation.

The excess margin is non-zero and is preferably above 10°C. For instance, the excess margin is comprised between 10 and 50°C.

To determine whether the torque demand demanded to the compression ignition engine 12 is above the preset threshold, the control unit 70 is configured for determining a driver torque demand, and comparing the driver torque demand to the preset threshold.

To determine whether the compression ignition engine 12 is in need of a transient torque increase, the control unit 70 is configured for:

- determining the driver torque demand,
- determining the time derivative of the driver torque demand, and comparing this time derivative to a derivative threshold value,
- determining the gas pressure in the inlet manifold, and comparing this gas pressure to a pressure threshold depending on the driver torque demand, and
- concluding that the compression ignition engine 12 is in need of a transient torque increase when at least one of the following conditions is met:
 - o the time derivative of the driver torque demand is above the derivative threshold value, and
 - o the gas pressure in the inlet manifold is under the pressure threshold.

To determine whether the compression ignition engine assembly 10 is in a thermal power enforcement state, the control unit 70 is configured for:

- comparing the second temperature and the temperature threshold,
- in case the second temperature is under the temperature threshold:
 - o calculating the predicted first thermal power provided to the exhaust gas aftertreatment system 41 when the secondary cylinders 16 are deactivated, as described above,
 - o calculating the predicted second thermal power provided to the exhaust gas aftertreatment system 41 when all cylinders 11 are active, as described above, and
 - o comparing the predicted first and second thermal powers, and

- in case the second temperature is under the temperature threshold while the first thermal power is lower than the second thermal power, concluding that the compression ignition engine assembly 10 is in a thermal power enforcement state.

5 To perform this control of the valve 62 and of the deactivation system 64 on the basis of these operating conditions, the control unit 70 implements a deactivation function 100, shown in Figure 3.

10 This deactivation function 100 includes a thermal sub-function 102 to analyze the thermal state of the exhaust passage 28 and deduce therefrom if deactivation of the secondary cylinders 16 would be advantageous or not. The deactivation function 100 also includes an operating point sub-function 104 to analyze the operating point of the engine 12 and deduce therefrom if deactivation of the secondary cylinders 16 is possible and sustainable or not. The deactivation function 100 further includes an operator 106 to trigger a switching command for switching the compression ignition assembly 10 into its
15 second operation mode when and only when the outputs of the sub-functions 102, 104 show that deactivation of the secondary cylinders 16 is advantageous, possible and sustainable, and to trigger a switching command for switching the compression ignition assembly 10 into its first operation mode in the other cases.

20 In the shown example, the control unit 70 is configured to process the sub-functions 102, 104 in parallel.

With reference to Figure 4, the thermal sub-function 102 comprises a first sub-function 110 for determining whether the compression ignition engine assembly 10 is in a temperature critical situation, a second sub-function 112 for determining whether the compression ignition engine assembly 10 is in an excess temperature situation, and a
25 third sub-function 114 for determining whether the compression ignition engine assembly 10 is in a thermal power enforcement state. The thermal sub-function 102 also comprises a signal generator 116 for generating a signal representative of the fact that deactivation of the secondary cylinders 16 is interesting, said signal generator 116 being configured to be triggered by the first sub-function 110 when said sub-function 110 determines that the
30 compression ignition engine assembly 10 is in a temperature critical situation. The thermal sub-function 102 further comprises a resetting operator 118 configured for stopping the signal generator 116 as soon as the second sub-function 112 determines that the compression ignition engine assembly 10 is in an excess temperature situation or that the third sub-function 114 determines that the compression ignition engine assembly 10 is in a
35 thermal power enforcement state.

The first sub-function 110 comprises a first calculation operator 120 for calculating the critical threshold value. This first calculation operator 120 is configured for subtracting the criticality margin to the second determined temperature so as to form the critical threshold value.

5 The first sub-function 110 further comprises a first comparison operator 122 for comparing the first temperature to the critical threshold value. This first comparison operator 122 is configured for producing a triggering signal intended for triggering the signal generator 116 when the first temperature is under the critical threshold value.

10 The second sub-function 112 comprises a second calculation operator 124 for calculating the excess threshold value. This second calculation operator 124 is configured for adding the second margin to the second determined temperature so as to form the excess threshold value.

15 The second sub-function 112 further comprises a second comparison operator 126 for comparing the predicted exhaust temperature to the excess threshold value. This second comparison operator 126 is configured for producing a resetting signal intended for stopping the signal generator 116 when the predicted exhaust temperature is above the excess threshold value.

20 With reference to Figure 5, the third sub-function 114 comprises a primary comparison operator 130 for comparing the second temperature to the temperature threshold, a primary calculation operator 132 for calculating the predicted first thermal power, a secondary calculation operator 134 for calculating the predicted second thermal power, and a secondary comparison operator 136 for comparing the predicted first and second thermal power.

25 The primary calculation operator 132 is configured for calculating the predicted first thermal power using formula (E1) mentioned above.

 The secondary calculation operator 134 is configured for calculating the predicted second thermal power using formula (E2) mentioned above.

30 The third sub-function 114 further comprises a signal generator 138 for generating a signal representative of the fact that the compression ignition engine assembly 10 is in a thermal power enforcement state. This signal generator 138 is configured to be triggered when the primary and secondary comparison operators 130, 132 simultaneously indicate that the second temperature is under the temperature threshold and the predicted first thermal power is lower than the predicted second thermal power, and to be deactivated in the other cases.

35 With reference to Figure 6, the operating point sub-function 104 comprises a first sub-function 140 for determining whether the compression ignition engine 12 is in an

operating point that is sustainable with the secondary cylinders 16 being inactive, and a second sub-function 142 for determining whether the torque demand demanded to the compression ignition engine 12 is sustainable with the secondary cylinders 16 being inactive.

5 The first sub-function 140 is configured for checking in the engine map if the compression ignition engine 12 is in a low-load operating point, such as an idling operating point or a motoring operating point. The first sub-function 140 is further configured for producing a signal reflecting the fact that the compression ignition engine 12 is in an operating point that is sustainable with the secondary cylinders 16 being inactive when the compression ignition engine 12 is in a low-load operating point.

10 The second sub-function 142 comprises a first comparison operator 144 and a second comparison operator 146. The first comparison operator 144 is configured for comparing a driver torque demand to a preset threshold and for producing a signal reflecting that this torque demand is sustainable with the secondary cylinders 16 being inactive when the driver torque demand is under said preset threshold. The second comparison operator 146 is configured for:

- determining the time derivative of the driver torque demand, and comparing this time derivative to a derivative threshold value,
- determining the gas pressure in the inlet manifold, and comparing this gas pressure to a pressure threshold depending on the drive torque demand, and
- producing a signal reflecting that the torque demand is sustainable with the secondary cylinders 16 being inactive when and only when all the following conditions are simultaneously met:
 - the time derivative of the driver torque demand is under the derivative threshold value, and
 - the gas pressure in the inlet manifold is above the pressure threshold.

20 The operating point sub-function 104 further comprises a signal generator 148 configured to produce an output signal reflecting that deactivation of the secondary cylinders 16 is possible and sustainable when and only when the output signals of the first sub-function 140, the first operator 144 and the second operator 146 simultaneously show that the compression ignition engine 12 is in an operating point that is sustainable with the secondary cylinders 16 being inactive, and that the torque demand is sustainable with the secondary cylinders 16 being inactive.

30 An example of an operation method 200 for operating the compression ignition engine assembly 10 will now be described, with reference to Figure 7.

In a first step 210, the compression ignition engine assembly 10 is provided with the compression ignition engine 12 being operated with the primary and secondary cylinders 14, 16 active, the secondary recirculation valve 62 being in its first configuration. In other words, the compression ignition engine assembly 10 is, in this first step 210, in its first operation mode.

This first step 210 is followed by a second step 220 of the control unit 70 checking if the operating conditions for deactivation are met and, in case each operating condition for deactivation is met, by a step 230 of the control unit 70 switching the compression ignition engine assembly 10 into its second operation mode.

With reference to Figure 8, the checking step 220 comprises a first sub-step 222 of determining whether the compression ignition engine assembly 10 is in a temperature critical situation, a second sub-step 224 of determining whether the compression ignition engine 12 is in an operating point that is sustainable with the secondary cylinders 16 being inactive, a third sub-step 226 of determining whether the torque demand demanded to the compression ignition engine 12 is sustainable with the secondary cylinders 16 being inactive, and a fourth sub-step 228 of determining whether the exhaust gas aftertreatment system 41 is not in a thermal power enforcement state.

During first sub-step 222, the control unit 70 determines whether the compression ignition engine assembly 10 is in a temperature critical situation. To that end, the control unit 70 successively:

- compares the temperature in the exhaust gas passage 28 to the critical threshold value, and
- in case the temperature in the exhaust gas passage 28 is under the critical threshold value, concludes that the compression ignition engine assembly 10 is in a temperature critical situation.

If the control unit 70 determines that the compression ignition engine assembly 10 is in a temperature critical situation, it is proceeded with second sub-step 224. If the control unit 70 determines that the compression ignition engine assembly 10 is not in a temperature critical situation, the method 200 reverts back to step 210.

During second sub-step 224, the control unit 70 determines whether the compression ignition engine 12 is in an operating point that is sustainable with the secondary cylinders 16 being inactive. To that end, the control unit 70 successively:

- checks in the engine map if the compression ignition engine 12 is in a low-load operating point, and

- in case the compression ignition engine 12 is in a low-load operating point, concludes that the compression ignition engine 12 is in an operating point that is sustainable with the secondary cylinders 16 being inactive.

If the control unit 70 determines that the compression ignition engine 12 is in an operating point that is sustainable with the secondary cylinders 16 being inactive, it is proceeded with third sub-step 226. If the control unit 70 determines that the compression ignition engine 12 is not in an operating point that is sustainable with the secondary cylinders 16 being inactive, the method 200 reverts back to step 210.

During third sub-step 226, the control unit 70 determines whether the driver torque demand demanded to the compression ignition engine 12 is under a preset threshold and the compression ignition engine 12 is not in need of a transient torque increase.. To that end, the control unit 70 successively:

- determines the driver torque demand, and compares the driver torque demand to the preset threshold,
- determines the time derivative of the driver torque demand, and compares this time derivative to a derivative threshold value, and
- determines the gas pressure in the inlet manifold, and compares this gas pressure to a pressure threshold depending on the driver torque demand.

If the control unit 70 determines that the driver torque demand is under the preset threshold, the time derivative of the driver torque demand is under the derivative threshold value, and the gas pressure in the inlet manifold is above the pressure threshold, it is proceeded with fourth sub-step 228. If the control unit 70 determines that either the driver torque demand is above the preset threshold, the time derivative of the driver torque demand is above the derivative threshold value, or the gas pressure in the inlet manifold is under the pressure threshold, the method 200 reverts back to step 210.

During fourth sub-step 228, the control unit 70 determines whether the exhaust gas aftertreatment system 41 is not in a thermal power enforcement state. To that end, the control unit 70 successively:

- compares the second temperature and the temperature threshold,
- in case the second temperature is under the temperature threshold:
 - o calculates the predicted first thermal power provided to the exhaust gas aftertreatment system 41 if the secondary cylinders 16 are deactivated,
 - o calculates the predicted second thermal power provided to the exhaust gas aftertreatment system 41 all cylinders 11 are active, and
 - o compares the predicted first and second thermal powers, and

- in case the second temperature is above the temperature threshold, or the second temperature is under the temperature threshold while the first thermal power is higher than the second thermal power, concludes that the compression ignition engine assembly 10 is not in a thermal power enforcement state.

If the control unit 70 determines that the exhaust gas aftertreatment system 41 is not in a thermal power enforcement state, it is proceeded with step 230. If the control unit 70 determines that the exhaust gas aftertreatment system 41 is in a thermal power enforcement state, the method 200 reverts back to step 210.

During step 230, the control unit 70 switches the compression ignition engine assembly 10 into its second operation mode. To that end, the control unit 70 switches the secondary recirculation valve 62 from its first configuration to its second configuration and controls the deactivation system 64 so that it deactivates the secondary cylinders 16.

Back to Figure 7, step 230 is followed by a step 240 of the compression ignition engine assembly 10 being in its second operation mode. During that step, the secondary recirculation valve 62 remains in its second configuration and the secondary cylinders 16 remain deactivated while the primary cylinders 14 are active.

Further to step 240, the method 200 comprises a step 250 of checking if at least one operating condition for reactivation is met and, in case at least one operating condition for reactivation is met, a step 260 of the control unit 70 switching the compression ignition engine assembly 10 back into its first operation mode.

With reference to Figure 9, the checking step 250 comprises a first sub-step 252 of determining whether the compression ignition engine assembly 10 is in an excess temperature situation, a second sub-step 254 of determining whether the torque demand demanded to the compression ignition engine 12 is above a preset threshold, and a third sub-step 256 of determining whether the exhaust gas aftertreatment system 41 is in a thermal power enforcement state.

During first sub-step 252, the control unit 70 determines whether the compression ignition engine assembly 10 is in an excess temperature situation. To that end, the control unit 70 successively:

- determines the predicted exhaust temperature with all cylinders 11 being active,
- compares the predicted exhaust temperature to the excess threshold value, and

- in case the predicted exhaust temperature is above the excess threshold value, concludes that the compression ignition engine assembly 10 is in an excess temperature situation.

If the control unit 70 determines that the compression ignition engine assembly 10 is in an excess temperature situation, it is proceeded with step 260. If the control unit 70 determines that the compression ignition engine assembly 10 is not in an excess temperature situation, it is proceeded with second sub-step 254.

During second sub-step 254, the control unit 70 determines whether the torque demand demanded to the compression ignition engine 12 is unsustainable. To that end, the control unit 70 successively:

- determines the driver torque demand, and compares the driver torque demand to the preset threshold,
- determines the time derivative of the driver torque demand, and compares this time derivative to a derivative threshold value, and
- determines the gas pressure in the inlet manifold, and compares this gas pressure to a pressure threshold depending on the driver torque demand.

If the control unit 70 determines that either the driver torque demand is above the preset threshold, the time derivative of the driver torque demand is above the derivative threshold value, or the gas pressure in the inlet manifold is under the pressure threshold, it is proceeded with step 260. If the control unit 70 determines that the driver torque demand is under the preset threshold while the time derivative of the driver torque demand is under the derivative threshold value and the gas pressure in the inlet manifold is above the pressure threshold, it is proceeded with third sub-step 256.

During third sub-step 256, the control unit 70 determines whether the exhaust gas aftertreatment system 41 is in a thermal power enforcement state. To that end, the control unit 70 successively:

- compares the second temperature and the temperature threshold,
- in case the second temperature is under the temperature threshold:
 - o calculates the predicted first thermal power provided to the exhaust gas aftertreatment system 41 if the secondary cylinders 16 are deactivated,
 - o calculates the predicted second thermal power provided to the exhaust gas aftertreatment system 41 all cylinders 11 are active, and
 - o compares the predicted first and second thermal powers, and
- in case the second temperature is under the temperature threshold while the first thermal power is lower than the second thermal power, concludes that the

compression ignition engine assembly 10 is in a thermal power enforcement state.

If the control unit 70 determines that the exhaust gas aftertreatment system 41 is in a thermal power enforcement state, it is proceeded with step 260. If the control unit 70 determines that the exhaust gas aftertreatment system 41 is not in a thermal power enforcement state, the method 200 reverts back to step 240.

During step 260, the control unit 70 switches the compression ignition engine assembly 10 back into its first operation mode. To that end, the control unit 70 switches the secondary recirculation valve 62 from its second configuration to its first configuration and controls the deactivation system 64 so that it reactivates the secondary cylinders 16.

Further to step 260, the method 200 reverts back to step 210.

The invention described above thus provides a compression ignition engine assembly that allows cylinders deactivation while having an architecture which is significantly simplified. Indeed, the compression ignition engine assembly 10 does not need complicated variable valve actuation systems to prevent cold exhaust gas coming from deactivated cylinders to cool down the exhaust gas aftertreatment system: in place, the secondary recirculation valve 62 provides this function. Yet, this secondary recirculation valve 62 can be particularly simple and compact, and it does not need heavy machinery to be controlled.

Furthermore, the secondary recirculation valve 62 and the bypass 60 are especially simple to install since they merely need minor modifications of the "hot part" of the engine 12 that do not increase the size of the assembly 10. Thus, the secondary recirculation valve 62 and the bypass 60 may be installed on existing engine assembly designs that do not allow cylinders deactivation with very light review of these designs.

As a consequence thereof, the compression ignition engine assembly 10 has a limited size and a limited cost. In addition, the compression ignition engine assembly 10 has a good durability, since it does not suffer the durability problems of variable valve actuation systems.

CLAIMS

1.- A subassembly for a compression ignition engine (12), comprising:

- a primary exhaust manifold (24) for collecting exhaust gas of at least one primary cylinder (14) of the compression ignition engine (12),
- a secondary exhaust manifold (26) for collecting exhaust gas of at least one secondary cylinder (16) of the compression ignition engine (12),
- an exhaust gas passage (28) for collecting exhaust gas from both primary and secondary exhaust manifolds (24, 26) and draining these exhaust gas away, and
- a feeding line (22) for feeding fresh air to the cylinders (14, 16) of the compression ignition engine (12),

wherein said subassembly further comprises a bypass (60) connecting the secondary exhaust manifold (26) to the feeding line (22), and a recirculation valve (62) having a first configuration allowing circulation of exhaust gas from the secondary exhaust manifold (26) to the exhaust gas passage (28) while closing the bypass (60), and a second configuration blocking circulation of exhaust gas from the secondary exhaust manifold (26) to the exhaust gas passage (28) while opening the bypass (60).

2.- The subassembly of claim 1, further comprising at least one turbocharger (50) including a compressor (52) positioned in the feeding line (22) for compressing fresh air provided to the compression ignition engine (12) and a turbine (54) located in the exhaust gas passage (28) for driving the compressor (52).

3.- The subassembly of claim 2, wherein the bypass (60) connects the secondary exhaust manifold (26) to the feeding line (22) downstream of the compressor (52).

4.- The subassembly of claim 2 or 3, wherein the feeding line (22) comprises a charge air cooler (38) downstream of the compressor (52).

5.- The subassembly of claim 4, wherein the bypass (60) connects the secondary exhaust manifold (26) to the feeding line (22) upstream of the charge air cooler (38).

6.- The subassembly of anyone of the previous claims, comprising a recirculation line (42) for feeding the cylinders (14, 16) of the compression ignition engine (12) with exhaust gas coming from the primary exhaust manifold (24).

7.- The subassembly of anyone of the previous claims, wherein the recirculation valve (62) has a third configuration providing an increased flow resistance to the flow of exhaust gas between the secondary exhaust manifold (26) and the exhaust gas passage (28), while allowing circulation of gas between the secondary exhaust manifold (26) and the exhaust gas passage (28) and closing the bypass (60).

8.- A compression ignition engine assembly (10), comprising a compression ignition engine (12) including at least one primary cylinder (14) and at least one secondary cylinder (16), a deactivation system (64) for deactivating the or each secondary cylinder (16) while the or each primary cylinder (14) is active, and the subassembly of anyone of the previous claims, wherein the primary exhaust manifold (24) of said subassembly is connected to the compression ignition engine (12) so as to collect exhaust gas of the or each primary cylinder (14), and the secondary exhaust manifold (26) of the subassembly is connected to the compression ignition engine (12) so as to collect exhaust gas of the or each secondary cylinder (16).

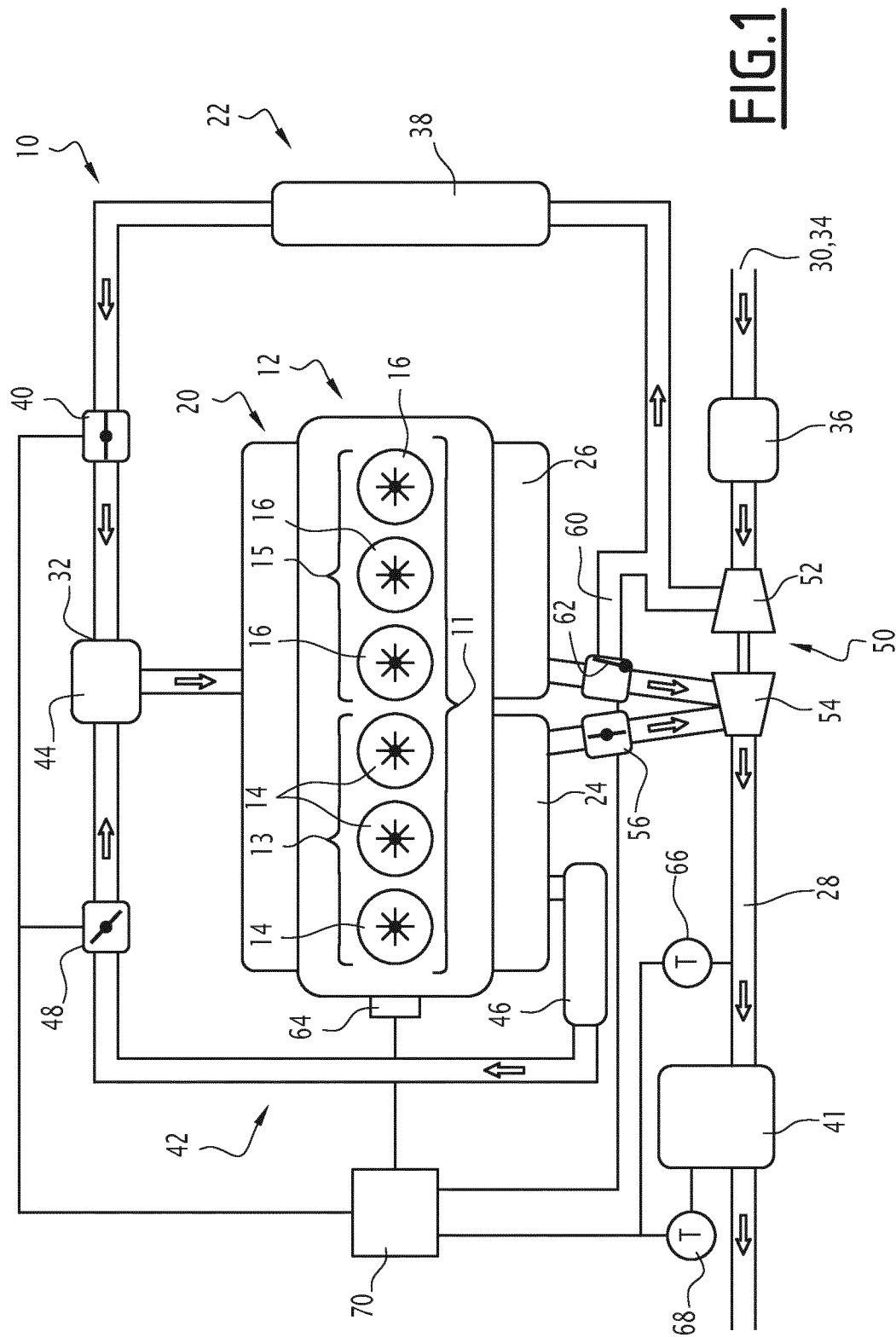
9.- The compression ignition engine assembly (10) of claim 8, further comprising a control unit (70) controlling the recirculation valve (62) so that the recirculation valve (62) is in its second configuration at least when the or each secondary cylinder (16) is deactivated, and preferably only when the or each secondary cylinder (16) is deactivated.

10.- The compression ignition engine assembly (10) of claim 8 or 9, wherein the feeding line (22) is connected to the compression ignition engine (12) so as to provide fresh air to both the primary and secondary cylinders (14, 16).

11.- An operation method (200) for operating the compression ignition engine assembly (10) of anyone of claims 8 to 10, comprising the following successive steps:

- operating (210) the compression ignition engine (12) with the primary and secondary cylinders (14, 16) active, the recirculation valve (62) being in its first configuration,
- deactivating (230) the or each secondary cylinder (16) while switching the recirculation valve (62) from its first configuration to its second configuration, and
- operating (240) the compression ignition engine (12) with the or each primary cylinder (14) active, the or each secondary cylinder (16) being inactive and the recirculation valve (62) being in its second configuration.

12.- The operation method (200) of claim 11, further comprising a step (260) of reactivating the or each secondary cylinder (16) while switching the recirculation valve (62) from its second configuration to its first configuration.



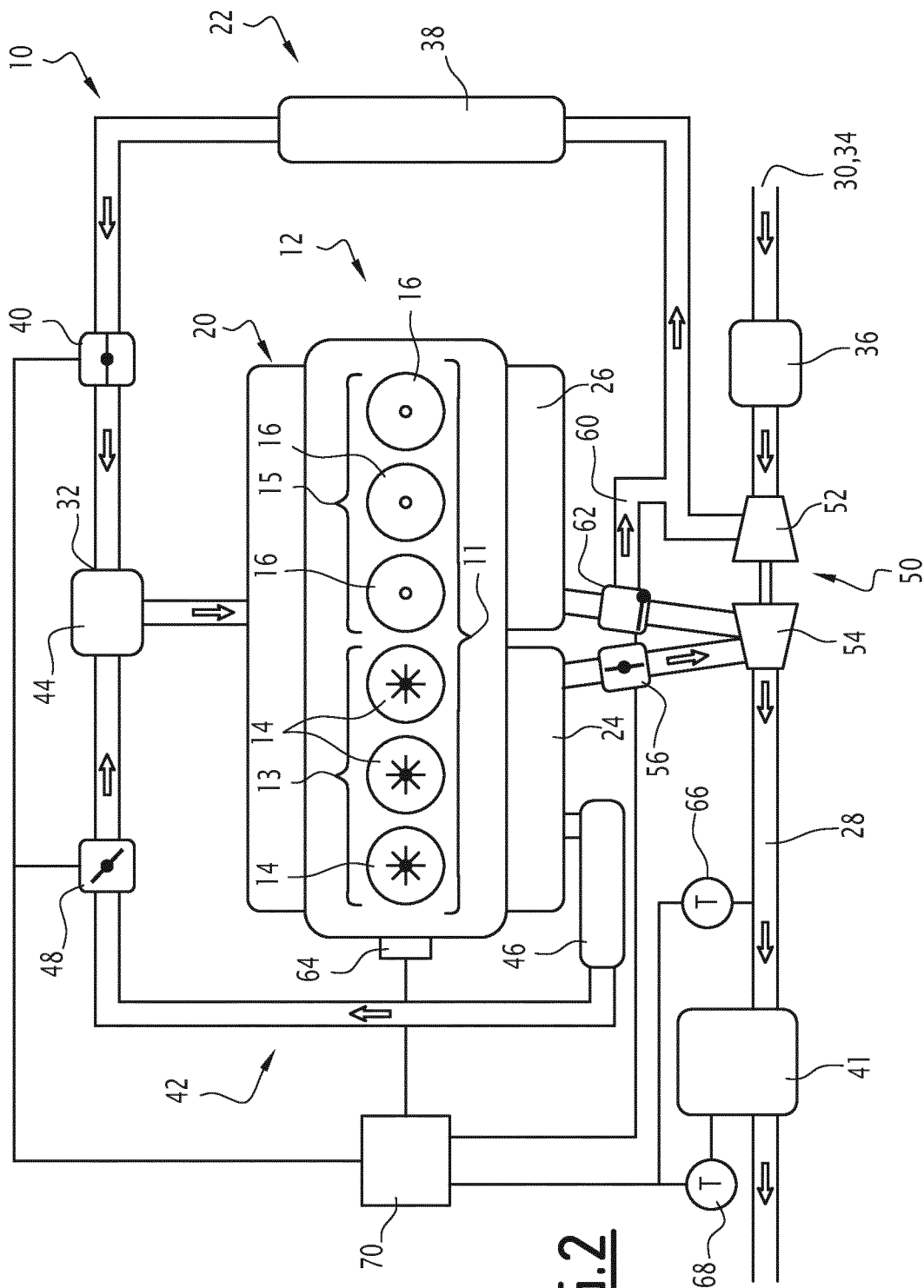
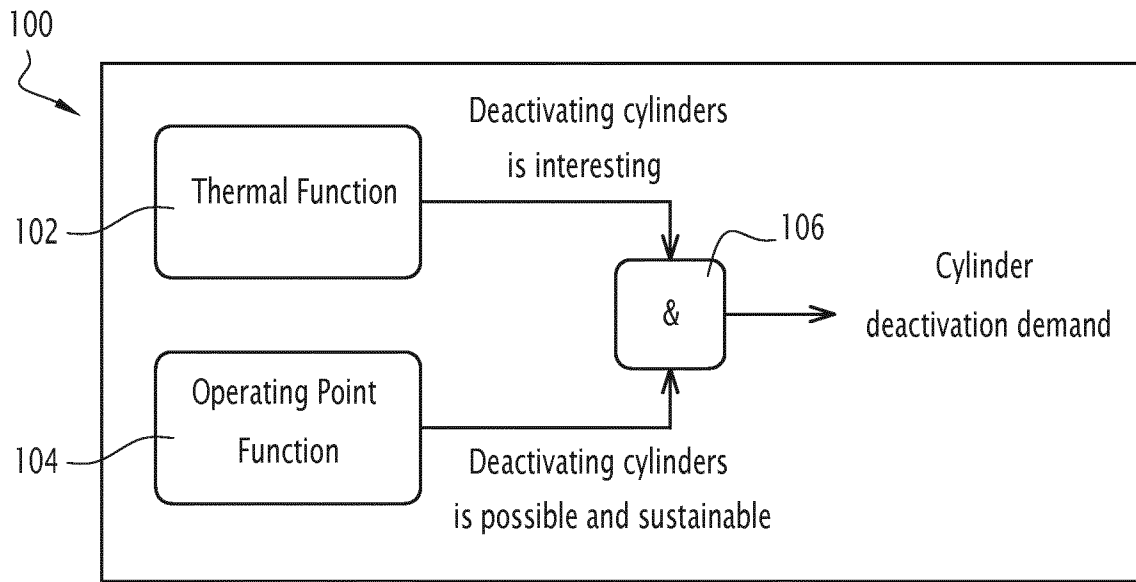
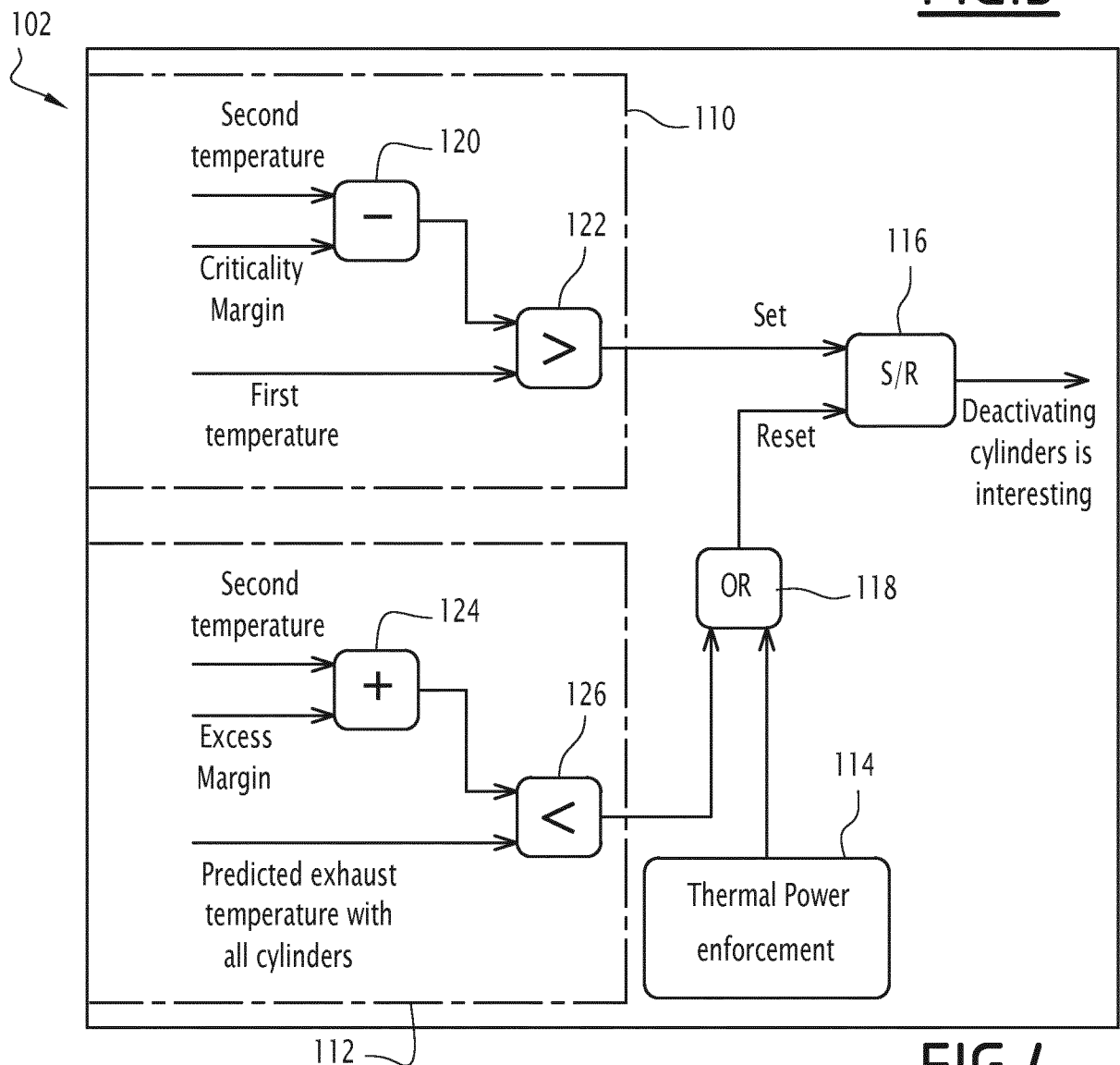
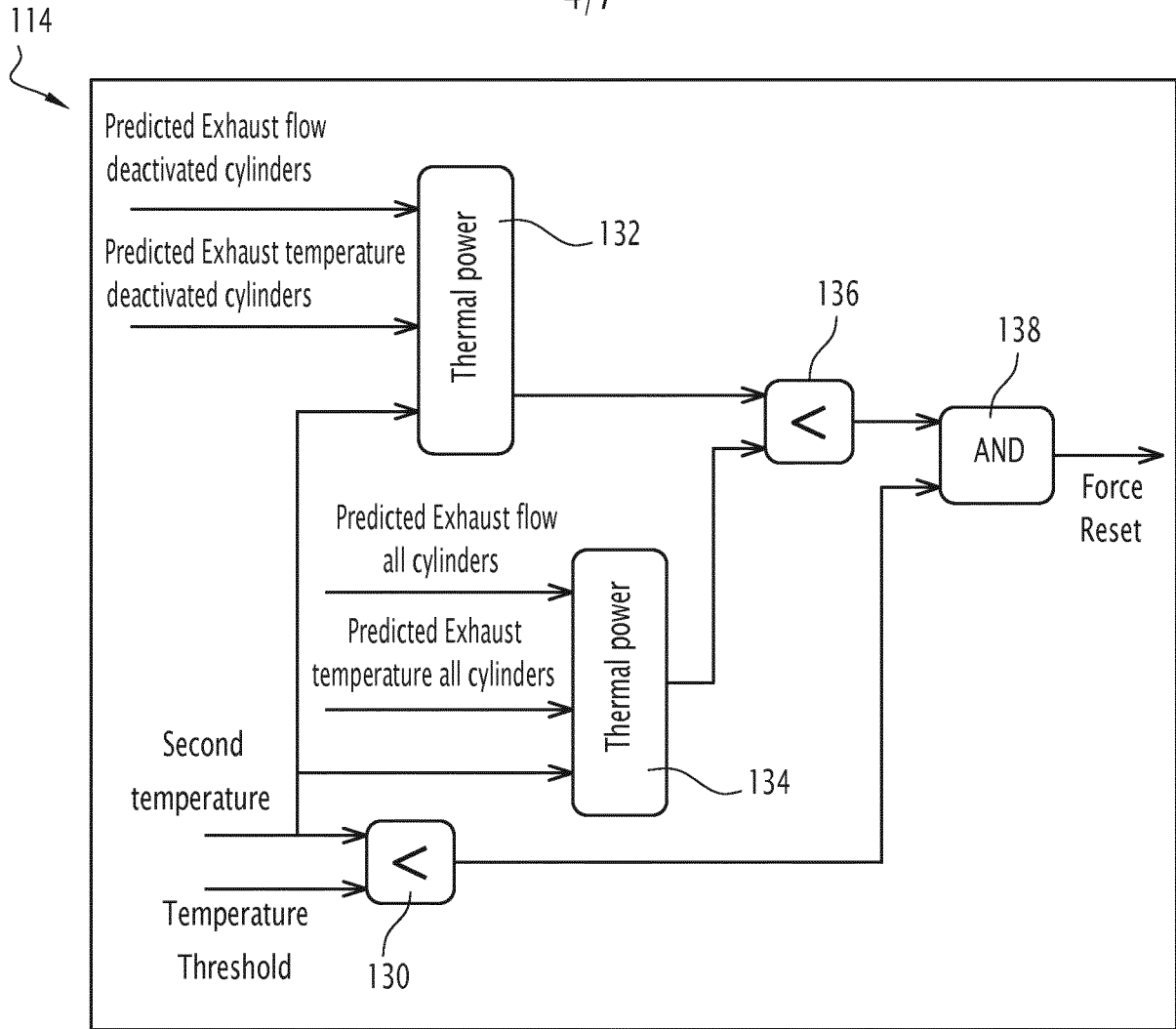
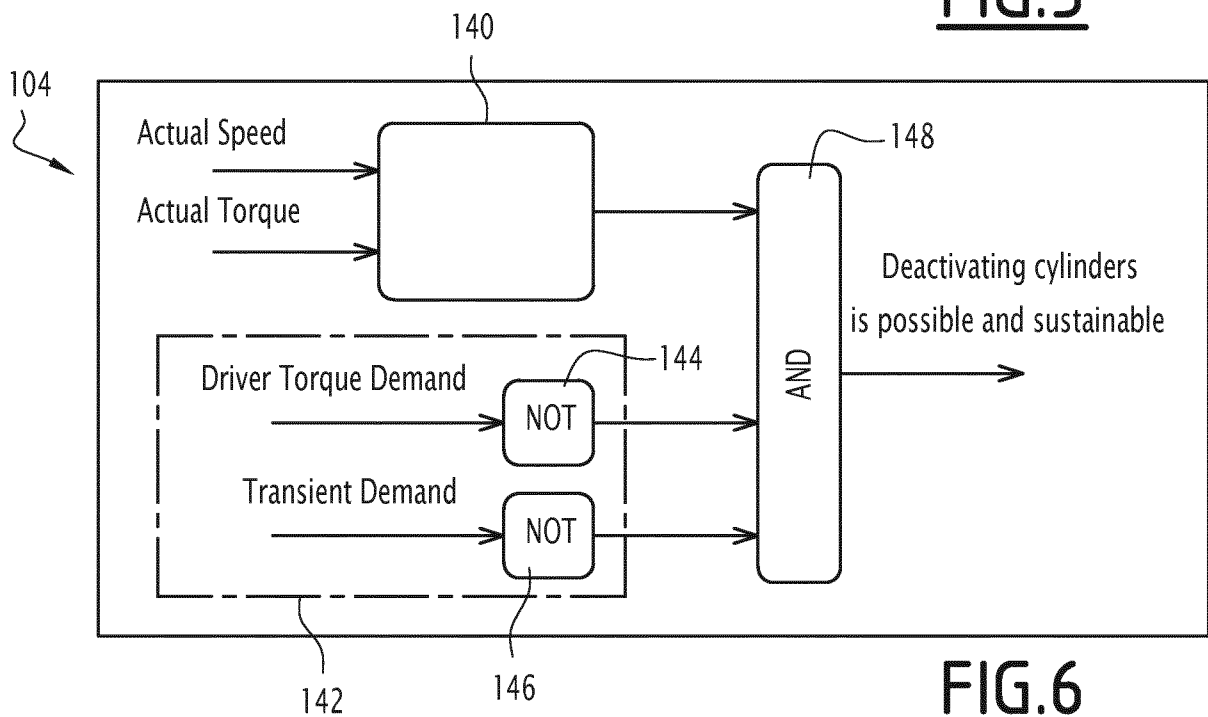


FIG. 2

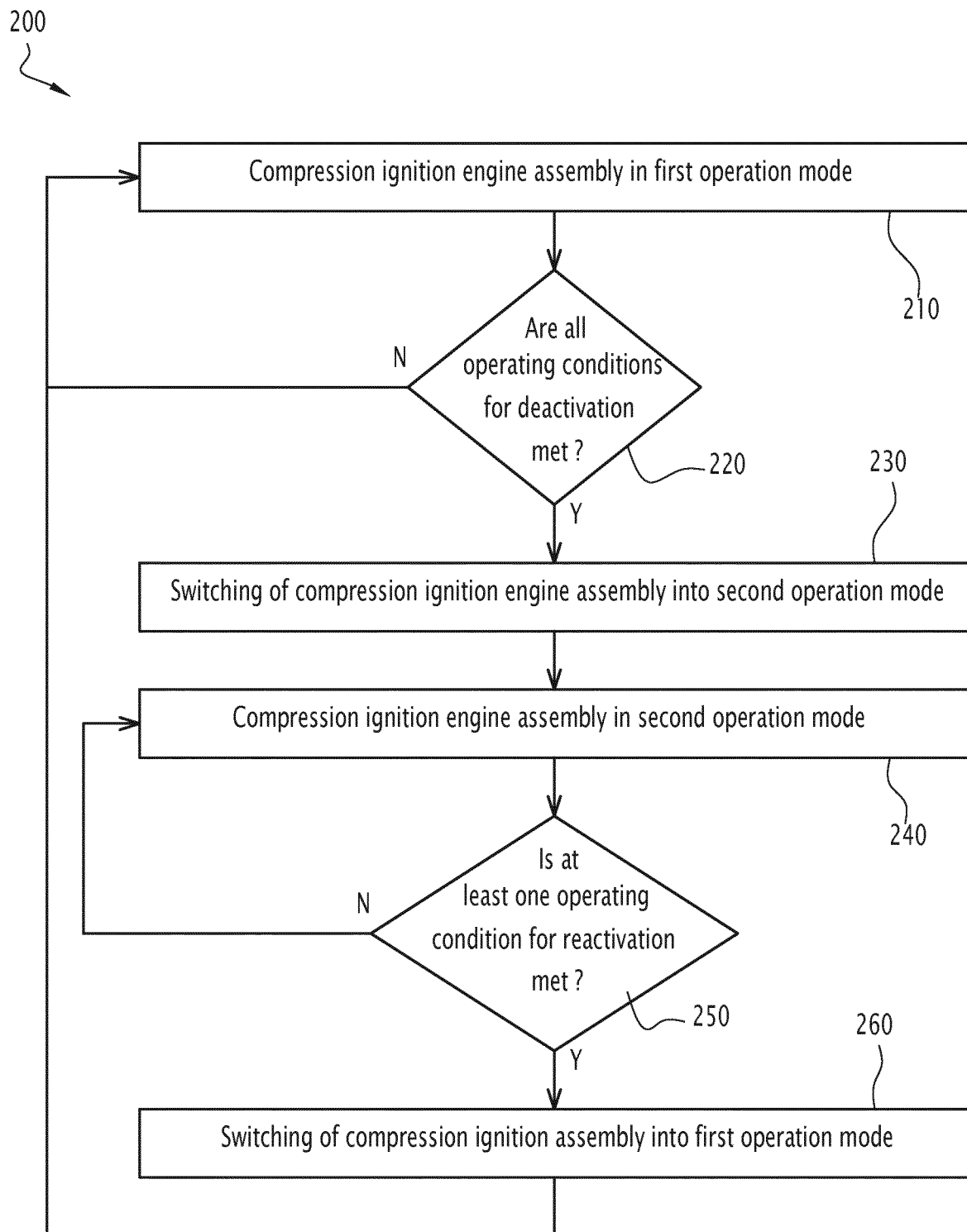
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**FIG. 3****FIG. 4**

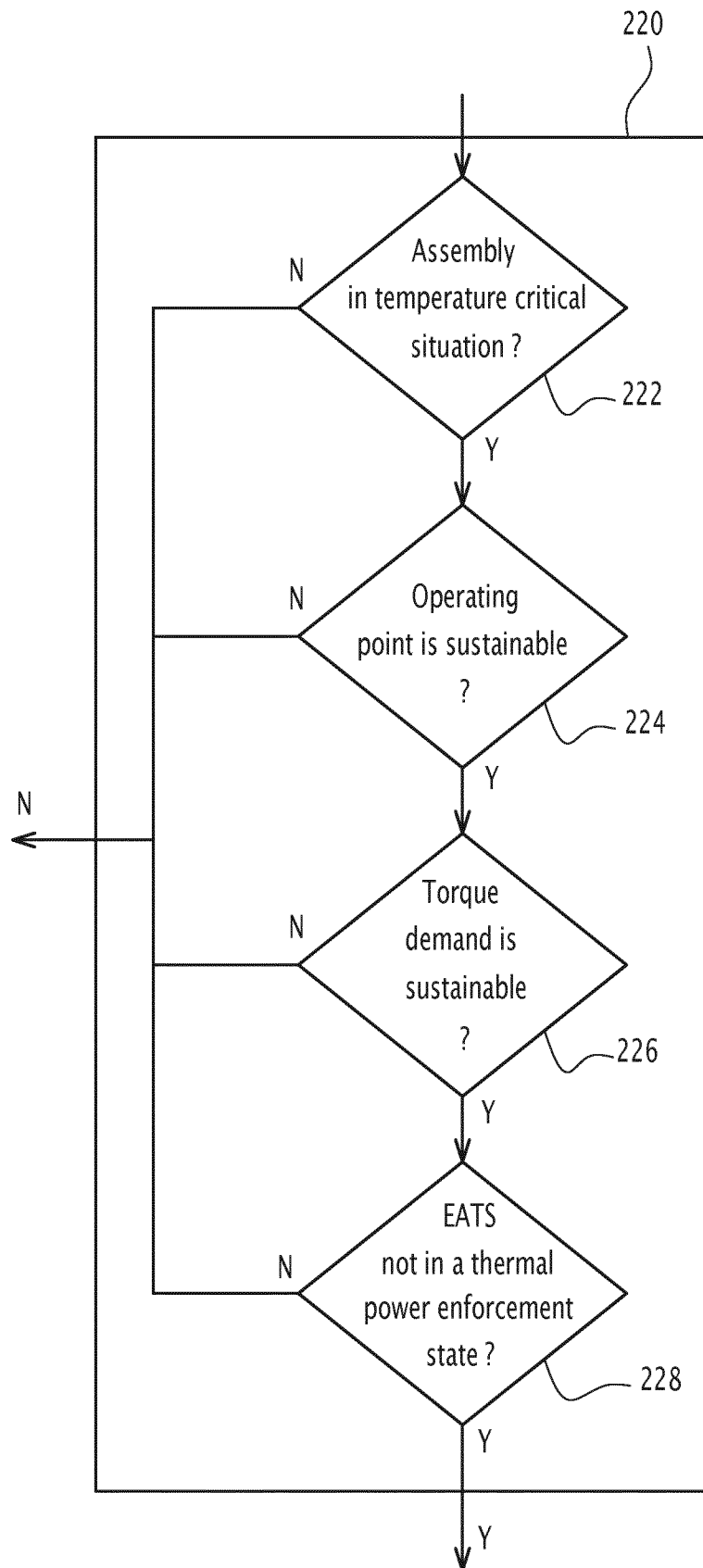
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FIG.5FIG.6

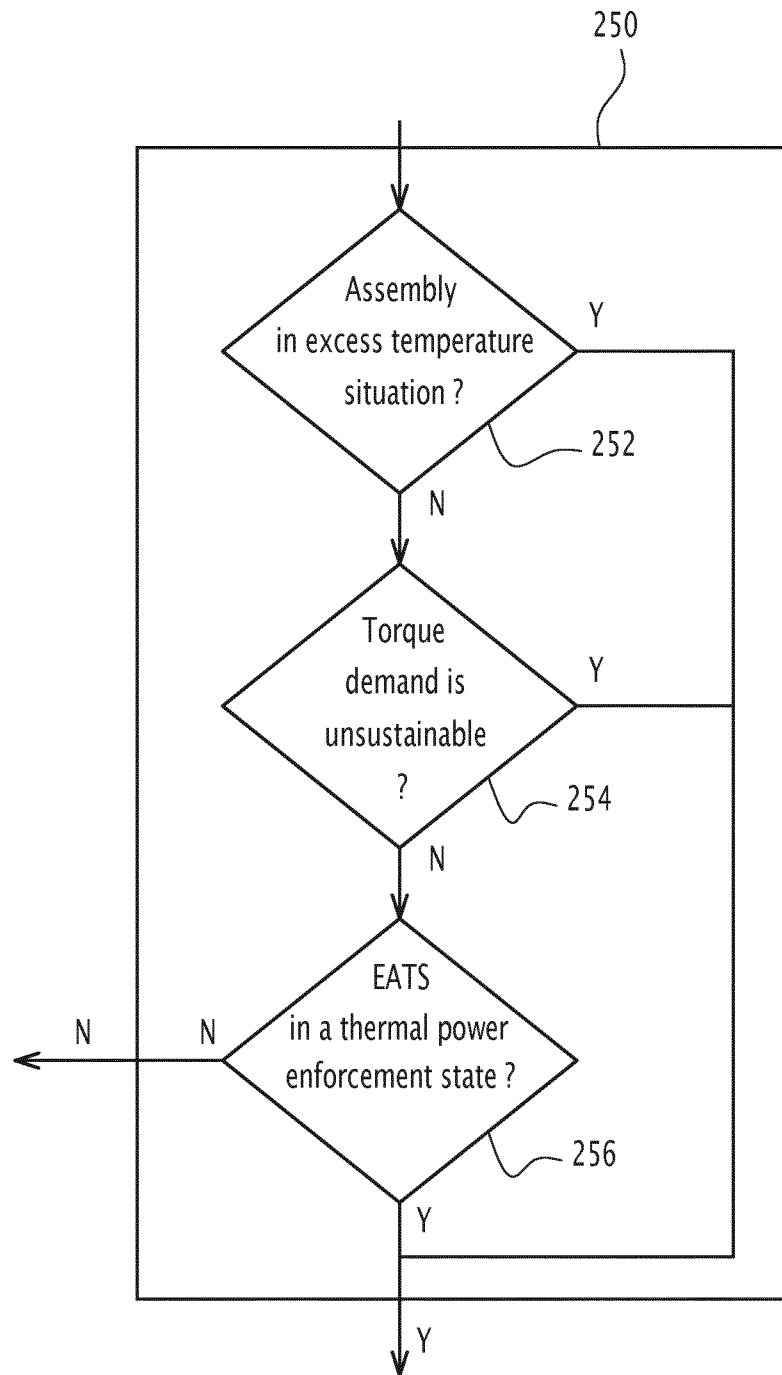
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**FIG.7**

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**FIG.8**

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FIG.9

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/076157

A. CLASSIFICATION OF SUBJECT MATTER INV. F02M26/05 F02D41/00 F02M26/10 F02M26/14 F02M26/41 F02M26/43 F02M26/42 F02B37/22 F02M26/51 ADD. According to International Patent Classification (IPC) or to both national classification and IPC														
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) F02M F02D F02B Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data														
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Category*</th> <th style="width: 70%;">Citation of document, with indication, where appropriate, of the relevant passages</th> <th style="width: 20%;">Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; vertical-align: top;">X</td> <td>WO 2014/005127 A2 (CUMMINS INC [US]; GECKLER SAMUEL C [US]; GANDIKOTA MADHURI [US]; SUBRA) 3 January 2014 (2014-01-03) page 4, line 9 - line 13 page 10, line 15 - page 22, line 7; figures 1, 4 -----</td> <td style="text-align: center; vertical-align: top;">1-12</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">X</td> <td>DE 10 2015 221546 A1 (FORD GLOBAL TECH LLC [US]) 4 May 2017 (2017-05-04) paragraph [0024] - paragraph [0028]; figure 1 -----</td> <td style="text-align: center; vertical-align: top;">1-12</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">X</td> <td>US 2014/360461 A1 (ULREY JOSEPH NORMAN [US] ET AL) 11 December 2014 (2014-12-11) paragraph [0010] - paragraph [0028]; figure 2 ----- -/-</td> <td style="text-align: center; vertical-align: top;">1-7</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X	WO 2014/005127 A2 (CUMMINS INC [US]; GECKLER SAMUEL C [US]; GANDIKOTA MADHURI [US]; SUBRA) 3 January 2014 (2014-01-03) page 4, line 9 - line 13 page 10, line 15 - page 22, line 7; figures 1, 4 -----	1-12	X	DE 10 2015 221546 A1 (FORD GLOBAL TECH LLC [US]) 4 May 2017 (2017-05-04) paragraph [0024] - paragraph [0028]; figure 1 -----	1-12	X	US 2014/360461 A1 (ULREY JOSEPH NORMAN [US] ET AL) 11 December 2014 (2014-12-11) paragraph [0010] - paragraph [0028]; figure 2 ----- -/-	1-7
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Date of the actual completion of the international search 6 November 2018		Date of mailing of the international search report 15/11/2018												
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Rauch, Vincent												

INTERNATIONAL SEARCH REPORT

International application No
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Information on patent family members

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