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(54) **EXHAUST GAS COOLING DEVICE**

(57) The invention relates to an exhaust gas cooling device (1) for a large internal combustion engine and an internal combustion engine. The exhaust gas cooling device (1) comprises a precooling jet tube (2), an outflow tube (3) and an absorber unit (4), The absorber unit (4) has a height (h), a maximal width (w) and a maximal length (l), wherein the maximal length (l) is longer than the maximal width (w). The exhaust gas cooling device (1) further comprises an inflow deflector housing (6) tapering along the length (l) of the absorber unit (4) and fluidly connected with the precooling jet tube (2) and the absorber unit (4), and an outflow deflector housing (7) tapering along the length (l) of the absorber unit and fluidly connected with the absorber unit (4) and with the outflow tube (3).

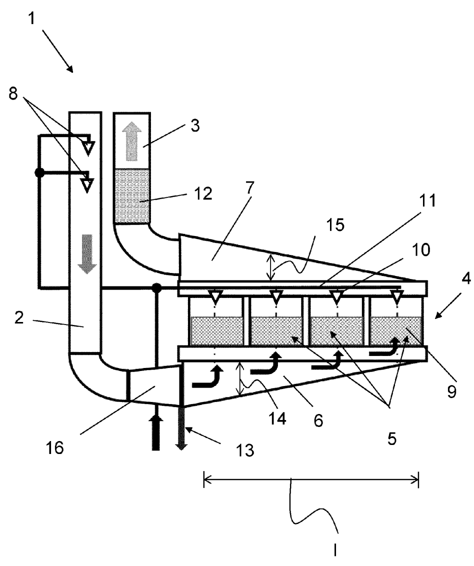

Fig. 2

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Description

[0001] The invention relates to an exhaust gas cooling device for an internal combustion engine and an internal combustion engine.

[0002] The present invention preferably relates to an internal combustion engine like a large marine or ship engine or a stationary engine whose cylinders have an inner diameter of at least 200 mm. The engine preferably is a two-stroke engine or a two-stroke cross head engine. The engine can be a diesel or a gas engine, a dual fuel or a multi fuel engine. Burning of liquid and or gaseous fuels in such engines is possible as well as self-igniting or forced igniting.

[0003] The internal combustion engine can be a longitudinally flushed two-stroke engine.

[0004] The term internal combustion engine also refers to large engines which can be operated not only in diesel mode, which is characterized by the self-ignition of the fuel, but also in Otto mode, which is characterized by the positive ignition of the fuel, or in mixtures of the two. Furthermore, the term internal combustion engine includes in particular dual-fuel engines and large engines in which the self-ignition of the fuel is used for the positive ignition of another fuel.

[0005] Engine speed is preferably below 800 RPM, especially for 4-stroke engines, and more preferably below 200 RPM, especially for 2-stroke engines, which indicates the designation of low-speed engines.

[0006] Fuel can be diesel or marine diesel oils or heavy fuel oils or emulsions or slurries or methanol or ethanol as well as gases like liquid natural gas (LNG) liquid petrol gas (LPG) and so on. Further possible fuels which might be added on request are: LBG (Liquefied Biogas), biological fuels (e. g. oil made from algae or seaweed), ammonia, hydrogen, synthetic fuels from CO2 (e. g. made by Power-To-Gas or Power-To-Liquid).

[0007] Large ships, in particular vessels for transport of goods, usually are powered by internal combustion engines, in particular diesel and/or gas engines, mostly two-stroke, cross head engines.

[0008] To reduce the reactivity of gas/air mixture and methane slip, it is known to provide exhaust gas recirculation (EGR), in particular low pressure exhaust gas recirculation (EGR) as shown for example in EP 3 722 572 A1. A part of the exhaust gas is recirculated into the cylinder, while another part of the exhaust gas is guided to a funnel and is released into the environment.

[0009] Whereas a high pressure EGR path is more or less directly interposed between an exhaust manifold and an intake manifold, the low pressure EGR path may be branched off downstream a turbine of a turbocharger, and recirculated exhaust gas may be guided through a compressor of the turbocharger together with fresh air.

[0010] Typically, the low pressure EGR path is provided with a low pressure EGR cooling device. The low pressure EGR cooler may have a size that is too big to mount it close to or on-engine.

[0011] When the EGR cooler is arranged outside the cylinder block, there arises a problem of interference with other auxiliaries. Furthermore, the supporting strength of heavy objects must be cleared.

[0012] EP2853726B1 discloses a specific engine design which allows downsizing the low pressure cooler.

[0013] JP2000248936A2 disclose an engine with an EGR cooler having a small installation space. The EGR cooler is arranged close to the rear end of the engine body. The EGR cooler is supported by a single mounting stay that is coupled to a portion of the engine body and a portion of the intake pipe.

[0014] However, when the EGR cooler has a considerable volume and weight, the engine itself becomes large and cannot be compactly installed in a small engine room. In particular, due to the low pressure and the low velocity in the low pressure EGR cooler, a cooling absorber providing cooling with a cascade of water has a size such big that it is not possible to mount it at a long side of the engine. The absorber exceeds the space available between engine and engine room wall.

[0015] US 10,100,787 B2 and DE 102014115453 A1 disclose EGR coolers with channels arranged in parallel, operating as heat exchangers, through which the EGR gas is guided.

[0016] The invention is based on the task of providing an exhaust gas cooling device and an internal combustion engine which avoid the disadvantages of the known, in particular to propose an EGR cooling device with higher variability for arrangement in order to provide an engine with an on-engine EGR cooling device.

[0017] The object is achieved by the characteristics of the independent claims.

[0018] According to the invention an exhaust gas cooling device for a large internal combustion engine comprises a precooling jet tube, an outflow tube and an absorber unit.

[0019] The precooling jet tube provides an exhaust gas inlet, whereas the outflow tube provides an exhaust gas outlet. The absorber unit is fluidly arranged between the precooling jet tube and the outflow tube.

[0020] Standard tube type cooling absorbers have a diameter of 1-6m. The absorber unit has a height, a maximal width, and a maximal length, wherein the maximal length is longer than the maximal width. Preferably, the maximal width is less than 50% of the diameter of comparable standard tube type absorbers. Preferably, the maximal width is smaller than 3m.

[0021] The exhaust gas cooling device further comprises an inflow deflector housing tapering along the lengths of the absorber unit. The inflow deflector housing is fluidly connected with the precooling jet tube and the absorber unit.

[0022] The exhaust gas cooling device further comprises an outflow deflector housing tapering along the lengths of the absorber unit. The outflow deflector housing is fluidly connected with the absorber unit and with the outflow tube.

[0023] The inflow deflector housing and the outflow deflector housing each are arranged adjacent to the absorber unit.

[0024] The tapered form of the inflow deflector housing allows a homogenous flow of exhaust gas to the flow area of the absorber unit, whereas the tapered form of the outflow deflector housing allows a homogenous flow of exhaust gas from the flow area of the absorber unit. This also applies when the exhaust gas has a low pressure, for example in a low pressure exhaust gas recirculation system.

[0025] Flow area means the cross-sectional area of the absorber unit or of the single absorber, which is perpendicular to the flow direction and through which the exhaust gas flows.

[0026] Hence, also for the absorber unit with an asymmetric flow area the pressure of the exhaust gas can be distributed evenly. In this context an asymmetric flow area means a flow area that does not have a circular or quadratic symmetry of the flow area, because the maximal width is smaller than the maximal length.

[0027] An absorber unit with an asymmetric flow area provides for more variety for positioning the cooler. The necessary flow area for cooling can be realized with a sufficient small width, which may be adapted to the space available around the engine and/or between engine and room wall.

[0028] The precooling jet tube, the outflow tube, the absorber unit, the inflow deflector housing and the outflow deflector housing preferably are separate construction components, each of which may be combined in a selectable orientation with respect to one another, as long as exhaust gas may first flow through the precooling jet tube, then through the inflow deflector housing, through the absorber unit, through the outflow deflector housing and finally through the outflow tube. Thus, the exhaust gas cooling device may be adapted to specific spatial conditions.

[0029] The precooling jet tube, the inflow deflector housing, the outflow deflector housing, the walls of the absorber unit and the outflow tube may be made out of stainless or coated steel to resist the acid cooling water. The thickness of the walls can be 3-8mm.

[0030] Alternatively, the walls can also be made of a synthetic material, which can withstand temperatures up to 100°C.

[0031] The absorber unit may comprise at least one single absorber. Preferably, the absorber unit comprises at least two single absorbers arranged in parallel along the lengths of the absorber unit.

[0032] The total flow area of the absorber unit is defined by the flow area of the single absorbers.

[0033] The single absorbers typically have a closed wall.

[0034] The parallel single absorbers may be of the same functional type and/or may each have an identical, preferably cylindrical, shape with an identical flow area and an identical height.

[0035] The height may range from 0.5 to 5m, the lengths from 2 to 10m and the diameter from 0.5 to 3m.

[0036] For the single absorbers arranged in parallel the width of the absorber unit is typically given by the width of the single absorbers. The length of the absorber unit is given by the sum of the lengths of the single absorbers and by the distances between the single absorbers.

[0037] The single absorber may comprise a cylindrical shape with a rectangular flow area.

[0038] Single absorbers arranged in parallel may each comprise a cylindrical shape with a circular or a rectangular flow area.

[0039] Single absorbers may have any flow area contour, for example elliptical, as long as the width of the absorber unit is smaller than the lengths of the absorber unit.

[0040] A rectangular flow area provides a larger area content of the flow area within the absorber unit. A circular or elliptic flow area provides for a better pressure resistance, which may be needed in case of a misfiring event in the cylinder, when the pressure may rise up to 0.5bar in the cooler.

[0041] The absorber unit, in particular each single absorber, may comprise cooling layers. Cooling layers may comprise rolled sheets or strips of stainless steel which are provided as bulk material. Stainless steel typically resists any aggressive pollutants which may be contained in the exhaust gas.

[0042] The exhaust gas may flow through the bulk material and gives off its heat to the rolled sheets.

[0043] At least one water nozzle is arranged in the precooling jet tube. Preferably the nozzle is arranged to spray to the inner wall of the precooling jet tube. Hence, exhaust gas flowing through the pipe gives off heat to the pipe, which in turn is cooled by the water.

[0044] Preferably, exhaust may be cooled from a temperature of approximately 230°C-280°C to a temperature of approximately 80-90°C along the precooling jet tube. The length depends on the cooling power and is preferably equal to or larger than the height of the absorber unit.

[0045] Preferably, the precooling jet tube has a J-shape to direct the exhaust gas and to guide the cooling water. The precooling jet tube as well as the outflow tube typically have a circular cross section.

[0046] The diameter preferably is equal to the width of the absorber unit.

[0047] Preferably, the open diameter of the tapered inflow deflector housing decreases along the flow path of the exhaust gas, such that the pressure remains more or less constant along the length of the absorber unit, while more and more exhaust leaves the inflow deflector housing to the absorber unit.

[0048] A similar amount of exhaust gas may be guided to each of the parallel single absorbers.

[0049] Preferably, the open diameter of the tapered outflow deflector housing decreases against the flow path of the exhaust gas or increases along the flow path of the exhaust gas. Hence, the pressure remains more or less constant along the length of the absorber unit, while more and more exhaust is added to the outflow deflector housing from the absorber unit.

[0050] Preferably, the inflow deflector housing is arranged below the absorber unit and/or the outflow deflector housing is arranged above the absorber unit. Thus, the exhaust gas flows through the absorber unit from bottom to top. This is particular advantageous, if water is provided for cooling in the absorber unit.

[0051] The absorber unit may comprise at least one water spray nozzle.

[0052] Preferably, the absorber unit comprises single absorbers arranged in parallel and at least one water spray nozzle for each single absorber.

[0053] Preferably the spray nozzle is arranged above the cooling layer and is directed to the cooling layer. Thus, the cooling layer absorbing heat from the exhaust gas is cooled by the water. The temperature of the cooling water provides for a sufficient cooling of the exhaust gas. In particular, the spray nozzle is arranged not to be directed to the wall of the absorber unit, since in this case the cooling water would run off the wall.

[0054] Exhaust gas may be cooled from a temperature of 80-90°C to a temperature of 30-35°C in the absorber unit.

[0055] Preferably, the spray nozzle produces a water shower like rain with droplets having a diameter of 1-2mm.

[0056] A plurality of spray nozzles may be connected by a common rail. The common rail may branch off a water supply pipe which also provides cooling water for the precooling jet tube.

[0057] The outflow tube may comprise a demister. The demister reduces the size of water droplets contained in the exhaust gas, preferably to a diameter of below 40 microns.

[0058] A cooling water return line may be connected to the inflow deflector housing, preferably at the lowest point. Due to the tapered form of the inflow deflector housing water may be guided to the cooling water return line.

[0059] Cooling water from the precooling jet tube and from the absorber unit may be collected in the inflow deflector housing and may be guided to the cooling water return line.

[0060] The cooling water return line may be fluidly connected to a circulation water tank. Circulated water may be brought to an adequate temperature, in particular may be cooled, and/or may be cleaned and may be used again as cooling water in the precooling jet tube and/or in the absorber unit.

[0061] According to the invention an internal combustion engine, namely a large vessel engine or a stationary engine, preferably is a two-stroke engine or a two-stroke cross head engine. The internal combustion engine comprises at least one cylinder having an inner diameter of at least 200mm.

[0062] The internal combustion engine comprises an exhaust gas cooling device as described above.

[0063] The internal combustion engine preferably comprises at least one turbocharger, the turbocharger comprising a turbine and a compressor.

[0064] The internal combustion engine may further comprise a system for exhaust gas recirculation with at least a low-pressure EGR path fluidly arranged between an exhaust outlet and an air inlet of the cylinder. By a low-pressure EGR path exhaust gas may be guidable via the turbine of the turbocharger. At least a part of the exhaust gas may be guidable to the air inlet of the cylinder through the compressor of the turbocharger. The exhaust gas cooling device may be arranged in the low-pressure EGR path between turbine and compressor.

[0065] The exhaust gas cooling device may be mounted to the cylinder jacket and/or to an engine frame and/or to an engine platform.

[0066] The cylinder jacket is the holding structure of the cylinders. The engine platform is connected to the cylinder jacket. Cylinder jacket, engine frame and engine platform usually are made from cast iron to provide stability.

[0067] Thus, the exhaust gas cooling device may be mounted "on engine" rather than to a part of a ship or an engine house.

[0068] Further advantageous aspects of the invention are explained in the following by means of exemplary embodiments and the figure. In the drawing, in a schematic manner:

Figure 1:	shows a schematic illustration of an internal combustion engine;
Figure 2:	shows a schematic illustration of a first example of an exhaust gas cooling device in a first side view;
Figure 3:	shows a schematic illustration of the first example of an exhaust gas cooling device in a second side view;
Figure 4:	shows a schematic illustration of the first example of an exhaust gas cooling device in a perspective view;
Figure 5:	shows a schematic illustration of a second example of an exhaust gas cooling device in a perspective view;
Figure 6:	shows a schematic illustration of a third example of an exhaust gas cooling device in a perspective view;
Figure 7:	shows a schematic illustration of a fourth example of an exhaust gas cooling device in a perspective view;
Figure 8:	shows a schematic illustration of a first example of an internal combustion engine with a second example of an exhaust gas cooling device in a first perspective view;
Figure 9:	shows a schematic illustration of the first example of an internal combustion engine in a second perspective view;
Figure 10:	shows a schematic illustration of a second

example of an internal combustion engine with a second example of an exhaust gas cooling device in a first perspective view;

Figure 11: shows a schematic illustration of the second example of an internal combustion engine in a second perspective view.

[0069] Figure 1 shows a schematic illustration of an internal combustion engine 100.

[0070] The internal combustion engine 100 comprises at least one cylinder 101 having an inner diameter 102 of at least 200mm.

[0071] The internal combustion engine 100 comprises a turbocharger 103, with a turbine 104 and a compressor 105. The internal combustion engine 100 further comprises a system 106 for exhaust gas recirculation (EGR) with a low-pressure EGR path 107 fluidly arranged between an exhaust outlet 108 and an air inlet 109 of the cylinder 101. Exhaust gas is guided via the turbine 104 of the turbocharger 103. A part of the exhaust gas is guided to the air inlet 109 of the cylinder 101 through the compressor 105 of the turbocharger 103 which also sucks fresh air FA.

[0072] Fresh air or the mixture of fresh air and recirculated exhaust has is guided to a scavenge air receiver 110. When the reciprocating piston is in lower position, fresh air or the mixture of fresh air and recirculated exhaust may enter the cylinder 101.

[0073] An EGR valve 112 is arranged in the EGR path 107. The pressure in the EGR path 107 may be regulated by a back pressure valve 113.

[0074] An exhaust gas cooling device 1 is arranged in the low-pressure EGR path 107, in this example downstream the EGR valve 112.

[0075] Figure 2 shows a schematic illustration of a first example of an exhaust gas cooling device 1 in a first side view.

[0076] The exhaust gas cooling device 1 comprises a precooling jet tube 2 having a J-shape. Two water nozzles 8 are arranged in the precooling jet tube 2. The exhaust gas cooling device 1 comprises an outflow tube 3 with a demister 12. The exhaust gas cooling device 1 further comprises an absorber unit 4.

[0077] Exhaust gas enters the precooling jet tube 2 of the exhaust gas cooling device 1, passes the absorber unit 4 and leaves the exhaust gas cooling device 1 after having passed the outflow tube 3.

[0078] The absorber unit 4 has a height h, a maximal width w (see figure 6) and a maximal length 1, wherein the maximal length 1 is longer than the maximal width w.

[0079] The exhaust gas cooling device 1 comprises an inflow deflector housing 6 tapering along the length 1 of the absorber unit 4, which is fluidly connected with the precooling jet tube 2 and the absorber unit 4. The open diameter 14 in vertical direction of the tapered inflow deflector housing 6 decreases along the flow path of the exhaust gas.

[0080] In this example, the outflow end 16 of the precooling jet tube 2 widens to connected to the absorber unit 4. The lowest position in the system is connected to a cooling water return system.

[0081] The exhaust gas cooling device 1 comprises an outflow deflector housing 7 tapering along the length 1 of the absorber unit 4. The outflow deflector housing 7 is fluidly connected with the absorber unit 4 and with the outflow tube 3. The open diameter 15 in vertical direction of the tapered outflow deflector housing 7 decreases against the flow path of the exhaust gas. The open diameter 15 increases along the flow path of the exhaust gas.

[0082] The inflow deflector housing 6 is arranged below the absorber unit 4 and the outflow deflector housing 7 is arranged above the absorber unit 4.

[0083] The absorber unit 4 comprises four single absorbers 5, which are arranged in parallel along the length 1 of the absorber unit 4.

[0084] Each single absorber 5 comprises cooling layers 9. For each single absorber 5 a water spray nozzle 10 is arranged to spray water on the cooling layer 9. The water spray nozzles 10 are connected by a common rail 11.

[0085] A cooling water return line 13 for collecting cooling water of the absorber unit 4 and of the precooling jet tube 2 is connected to the inflow deflector housing 6 at the lowest point.

[0086] Figure 3 shows a schematic illustration of the first example of an exhaust gas cooling device 1 in a second side view. The exhaust gas cooling device 1 has a slim design having single absorbers with a small width 2 such that the exhaust gas cooling device 1 may be arranged between the internal combustion engine 100 and the wall of the engine room (not shown in the figure).

[0087] Figure 4 shows a schematic illustration of a part of the first example of an exhaust gas cooling device 1 in a perspective view. The exhaust gas cooling device 1 comprises four single absorbers 5 with a circular flow area.

[0088] The tapered inflow deflector housing 6 and the tapered outflow deflector housing 7 are oriented such that the precooling jet tube 2 and the outflow tube 3 are arranged adjacent to each other.

[0089] Figure 5 shows a schematic illustration of a second example of an exhaust gas cooling device 1 in a perspective view. The tapered inflow deflector housing 6 and the tapered outflow deflector housing 7 are oriented such that the precooling jet tube 2 and the outflow tube 3 are arranged opposite to each other with respect to the absorber unit 4.

[0090] Figure 6 shows a schematic illustration of a third example of an exhaust gas cooling device 1 in a perspective view. The absorber unit 4, having a height h, a length 1 and a width w, comprises only one the single absorber 5 with a rectangular flow area.

[0091] Figure 7 shows a schematic illustration of a fourth example of an exhaust gas cooling device 1 in a perspective view. The absorber unit 4 comprises two single absorbers 5, each with a rectangular flow area and arranged in parallel.

[0092] Figure 8 shows a schematic illustration of a part of a first example of an internal combustion engine 100 with a second example of an exhaust gas cooling device 1 in a first perspective view.

[0093] Figure 9 shows a schematic illustration of a part of the first example of an internal combustion engine 100 in a second perspective view. The exhaust gas cooling device 1 is fixed at an engine platform or by supports to an engine housing at the free end or at the driving end of the engine in a direction, wherein the length 1 of the absorber unit 4 (see figure 8) is directed across to the direction 17 of the engine crankshaft.

[0094] Figure 10 shows a schematic illustration of a part of a second example of an internal combustion engine 100 with a second example of an exhaust gas cooling device 1 in a first perspective view.

[0095] Figure 11 shows a schematic illustration of a part of the second example of an internal combustion engine 100 in a second perspective view. The second example of an exhaust gas cooling device 1 is placed on the long side of the engine 1 close to the turbocharging unit, wherein the length 1 of the absorber unit 4 is oriented along the direction 17 of the crankshaft (see figure 10). The exhaust gas cooling device 1 may be mounted on a platform 111 or by a support on the engine housing (not explicitly shown in the figure).

Claims

1. Exhaust gas cooling device (1) for a large internal combustion engine (100), comprising

   - a precooling jet tube (2),
   - an outflow tube (3),
   - an absorber unit (4), the absorber unit having a height (h), a maximal width (w) and a maximal length (1), the maximal length (1) being longer than the maximal width (w),
   - an inflow deflector housing (6) tapering along the length (1) of the absorber unit (4) and being fluidly connected with the precooling jet tube (2) and the absorber unit (4), and
   - an outflow deflector housing (7) tapering along the length (1) of the absorber unit (4) and being fluidly connected with the absorber unit (4) and with the outflow tube (3).

2. Exhaust gas cooling device (1) according to claim 1, wherein the absorber unit comprises at least one single absorber (5), preferably at least two single absorbers (5) arranged in parallel along the length (1) of the absorber unit.

3. Exhaust gas cooling device (1) according to claim 2, wherein the single absorber (5) comprise a rectangular flow area or single absorbers (5) arranged in parallel comprise a circular flow area.

4. Exhaust gas cooling device (1) according to at least one of the preceding claims, wherein at least one water nozzle (8) is arranged in the precooling jet tube (2).

5. Exhaust gas cooling device (1) according to at least one of the preceding claims, wherein the precooling jet tube (2) has a J-shape.

6. Exhaust gas cooling device (1) according to at least one of the preceding claims, wherein the open diameter (14) of the tapered inflow deflector housing (6) decreases along the flow path of the exhaust gas.

7. Exhaust gas cooling device (1) according to at least one of the preceding claims, wherein the open diameter (15) of the tapered outflow deflector housing (7) decreases against the flow path of the exhaust gas.

8. Exhaust gas cooling device (1) according to at least one of the preceding claims, wherein the inflow deflector housing (6) is arranged below the absorber unit (4) and/or the outflow deflector housing (7) is arranged above the absorber unit (4).

9. Exhaust gas cooling device (1) according to at least one of the preceding claims, wherein the absorber unit (4) comprises cooling layers (9).

10. Exhaust gas cooling device (1) according to at least one of the preceding claims, wherein the absorber unit (4) comprises at least one water spray nozzle (10), the water spray nozzles (10) preferably being connected by a common rail (11), preferably the absorber unit (4) comprises single absorbers and at least one water spray nozzle for each single absorber.

11. Exhaust gas cooling device (1) according to at least one of the preceding claims, wherein the outflow tube (3) comprises a demister (12).

12. Exhaust gas cooling device (1) according to at least one of the preceding claims, wherein a cooling water return line (13) is connected to the inflow deflector housing (6), preferably at the lowest point.

13. Internal combustion engine (100), namely a large vessel engine or a stationary engine, preferably a two-stroke engine or a two-stroke cross head engine, the internal combustion engine (100) comprising at least one cylinder (101) having an inner diameter (102) of at least 200mm, wherein the internal combustion engine (100) com-

prises an exhaust gas cooling device (1) according to at least one of the preceding claims.

14. An internal combustion engine (100) according to claim 13, wherein the internal combustion engine (100) comprises at least one turbocharger (103), the turbocharger (103) comprising a turbine (104) and a compressor (105),
the internal combustion engine (100) further comprises a system (106) for exhaust gas recirculation with at least a low-pressure EGR path (107) fluidly arranged between an exhaust outlet (108) and an air inlet (109) of the cylinder (101); wherein exhaust gas is guidable via the turbine (104) of the turbocharger (103) and at least a part of the exhaust gas is guidable to the air inlet (109) of the cylinder (101) through the compressor (105) of the turbocharger (103), and wherein the exhaust gas cooling device (1) is arranged in the low-pressure EGR path (107).

15. Internal combustion engine (100) according to claim 14, wherein the exhaust gas cooling device (1) is mounted to the cylinder jacket and/or to an engine frame and/or to an engine platform.

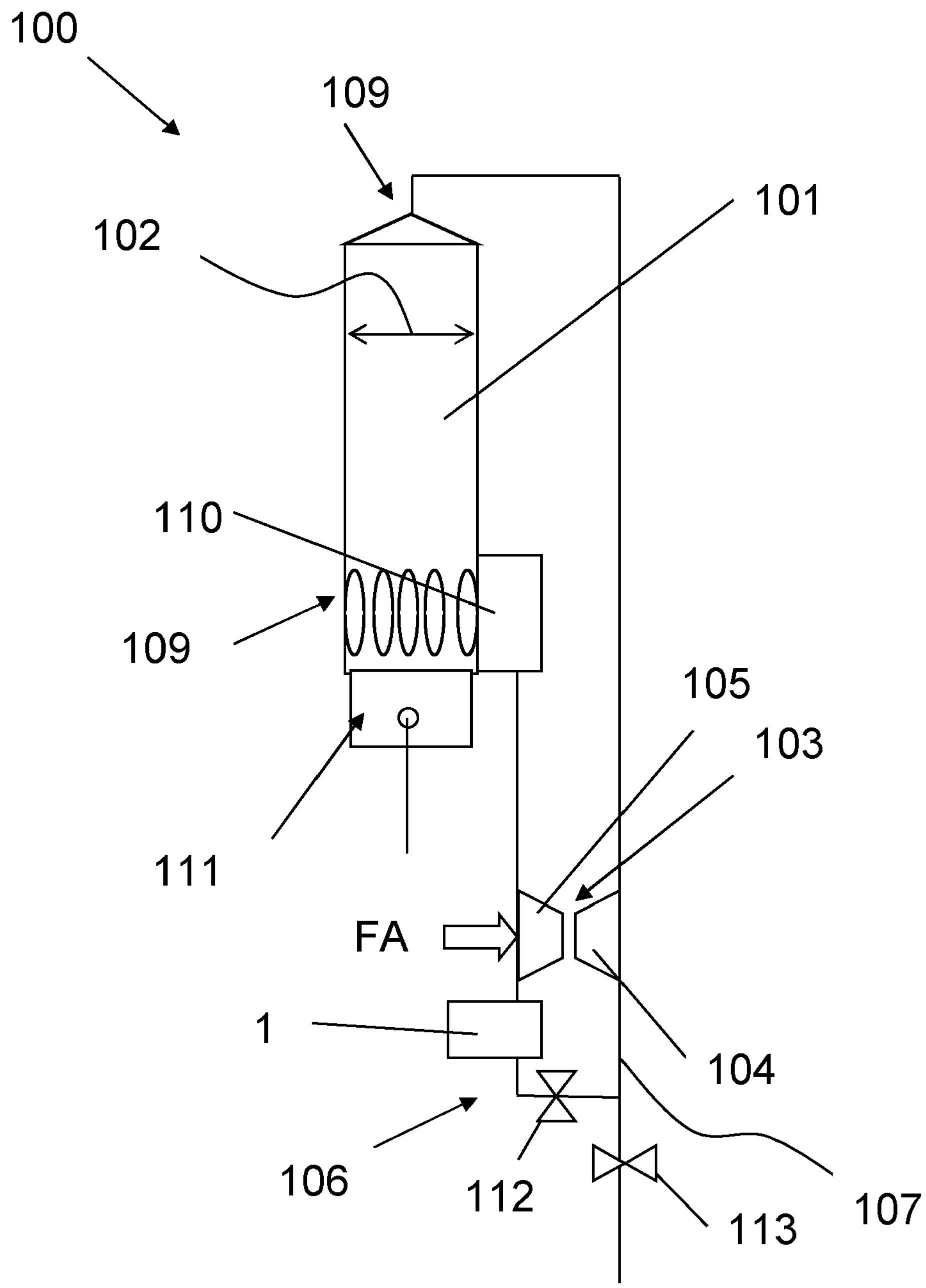

Fig. 1

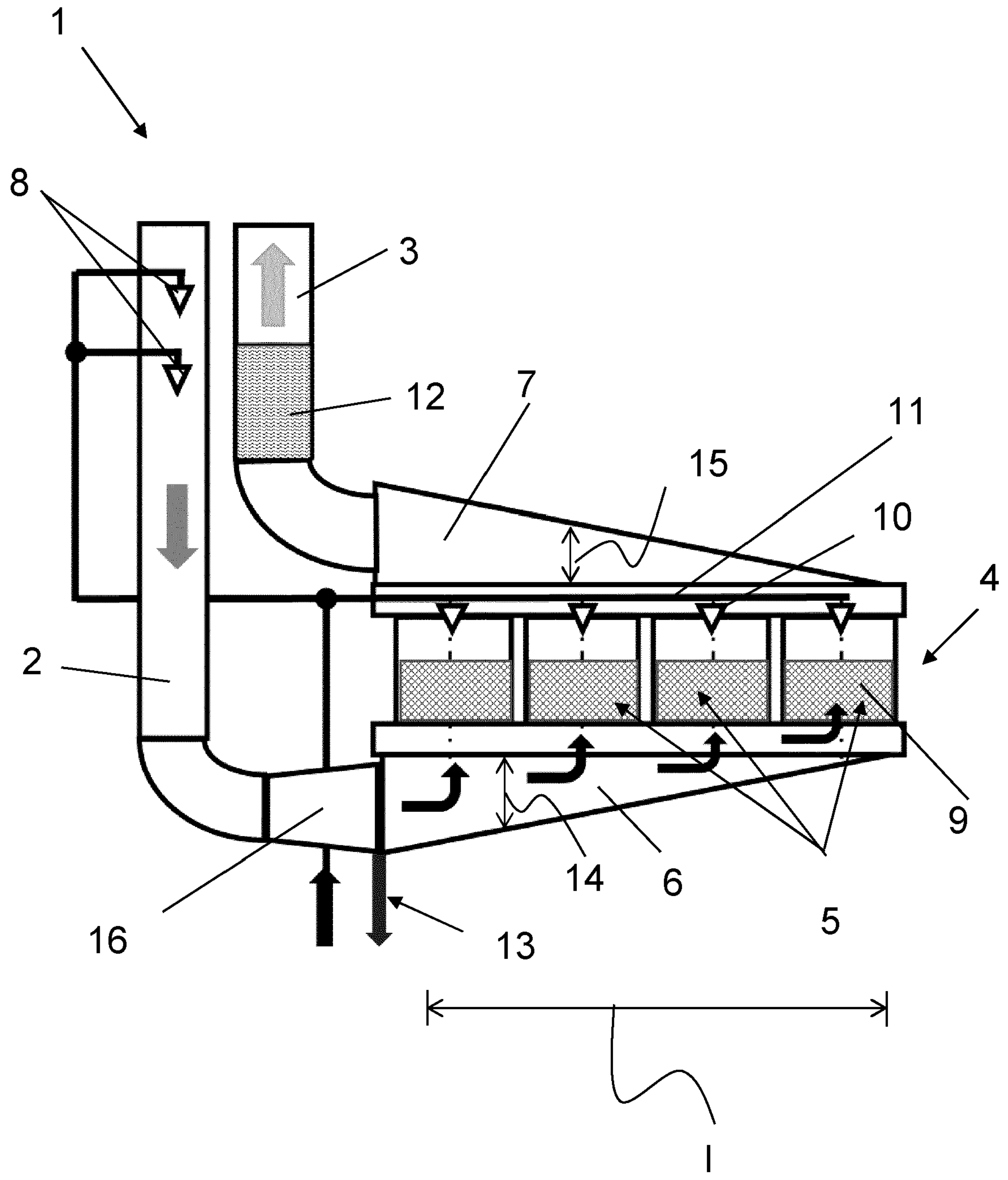

Fig. 2

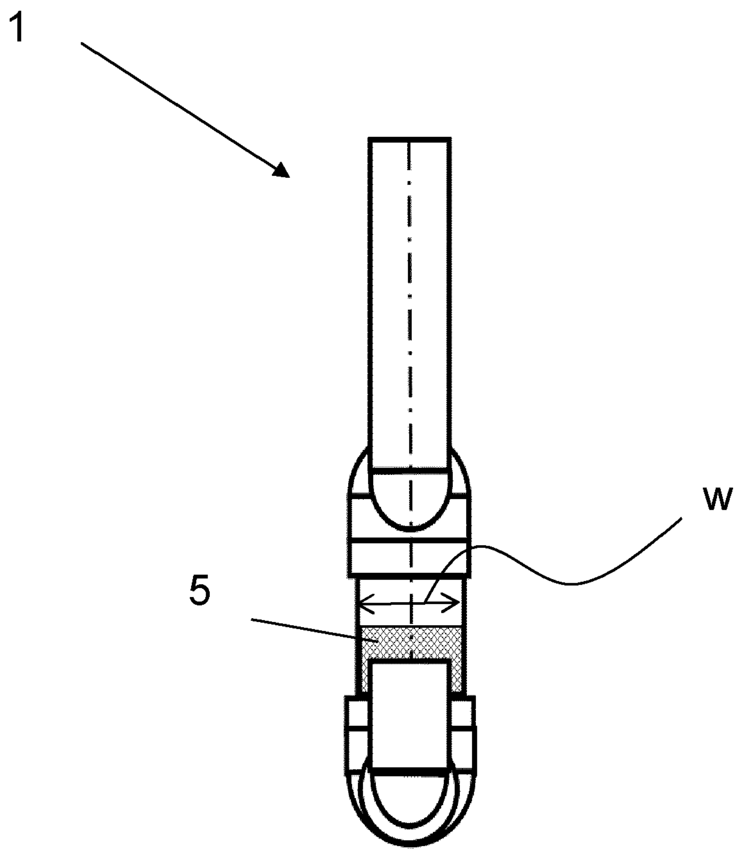

Fig. 3

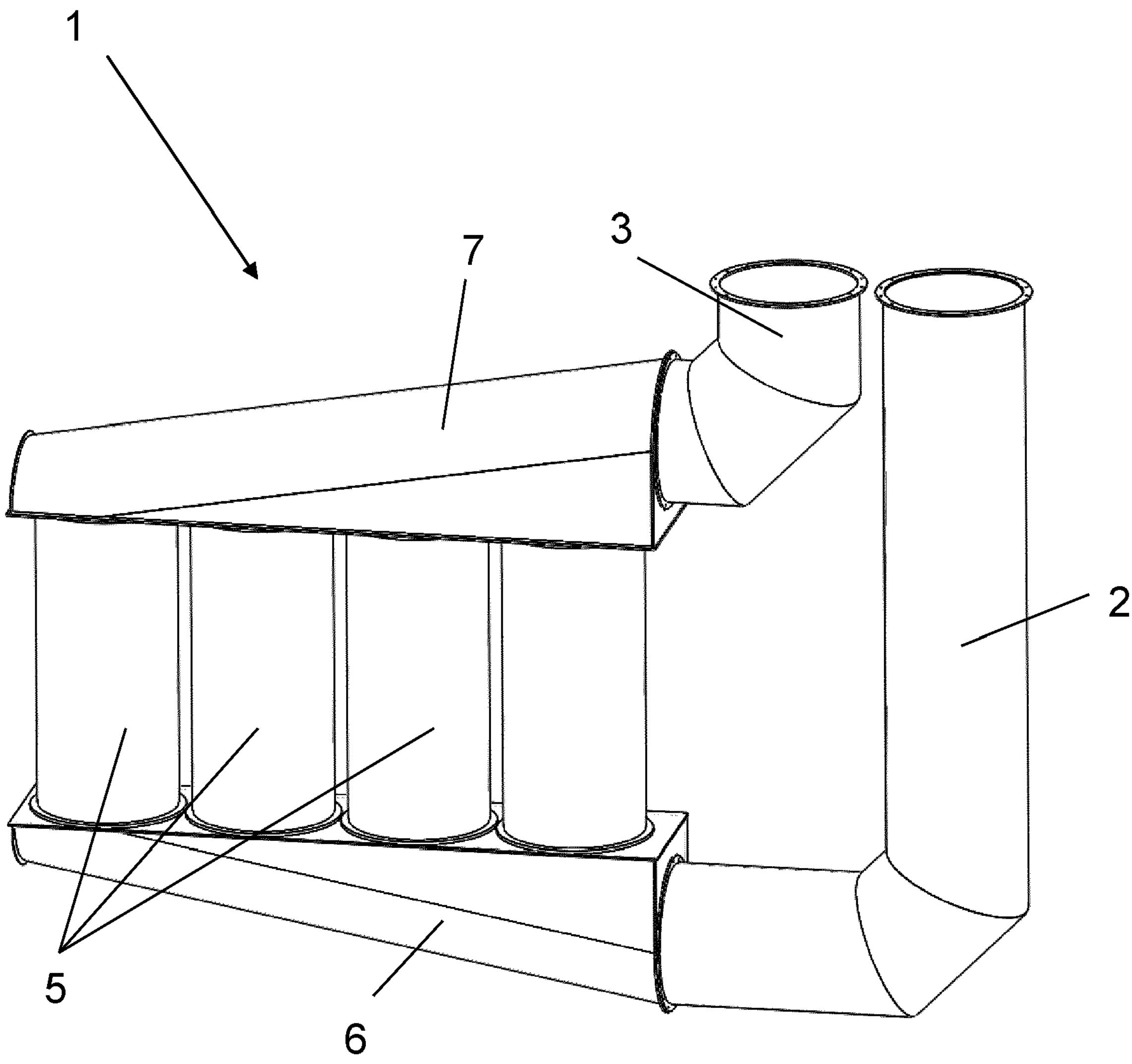

Fig. 4

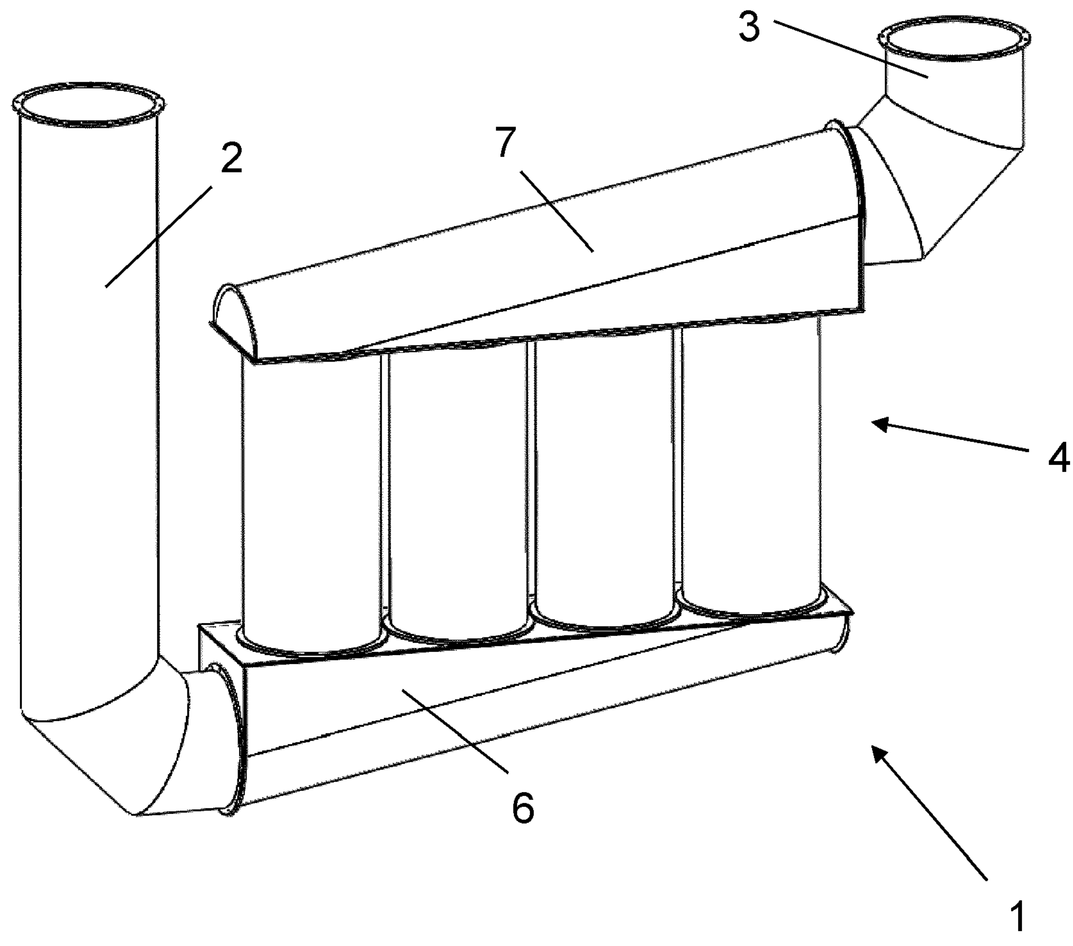

Fig. 5

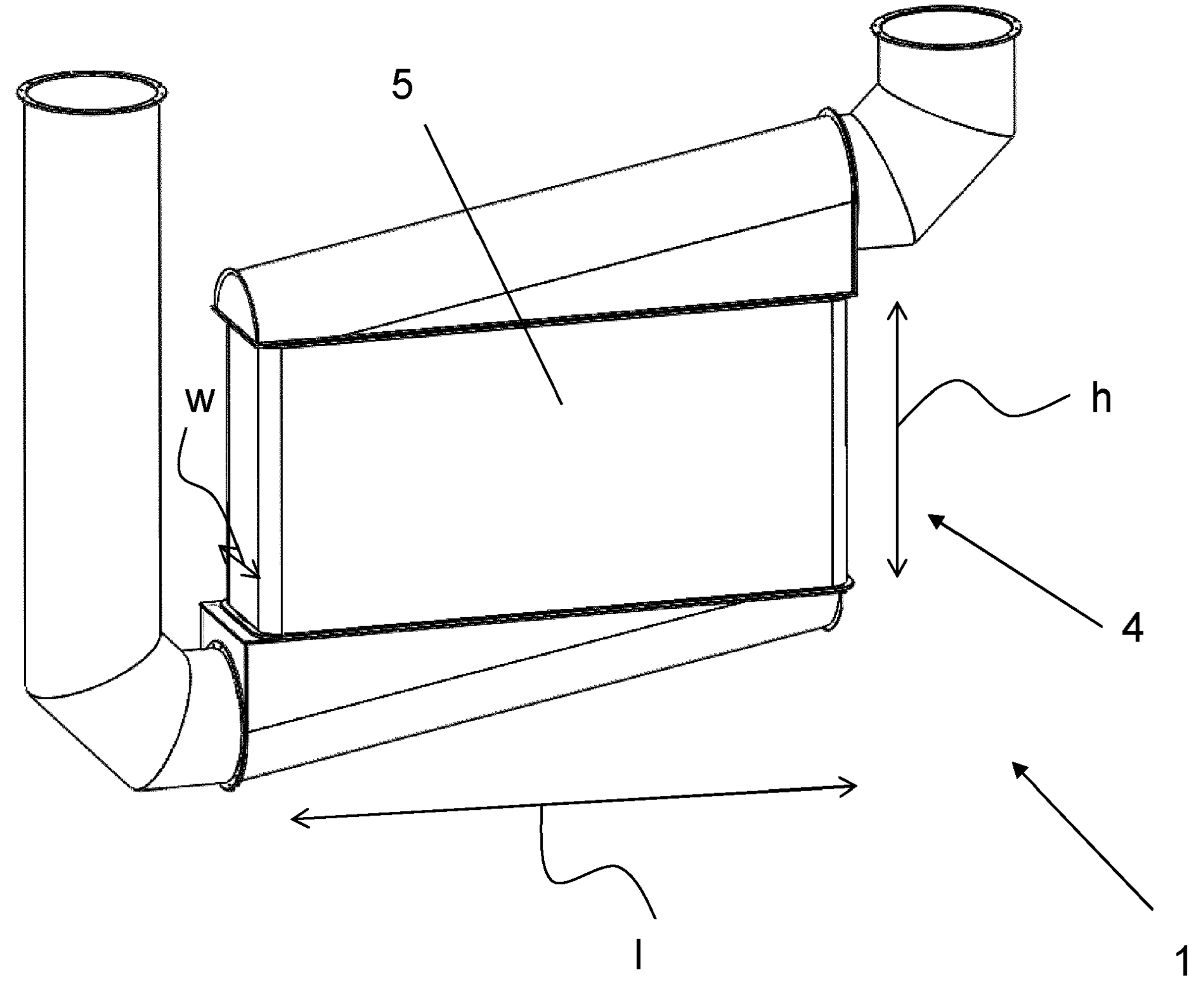

Fig. 6

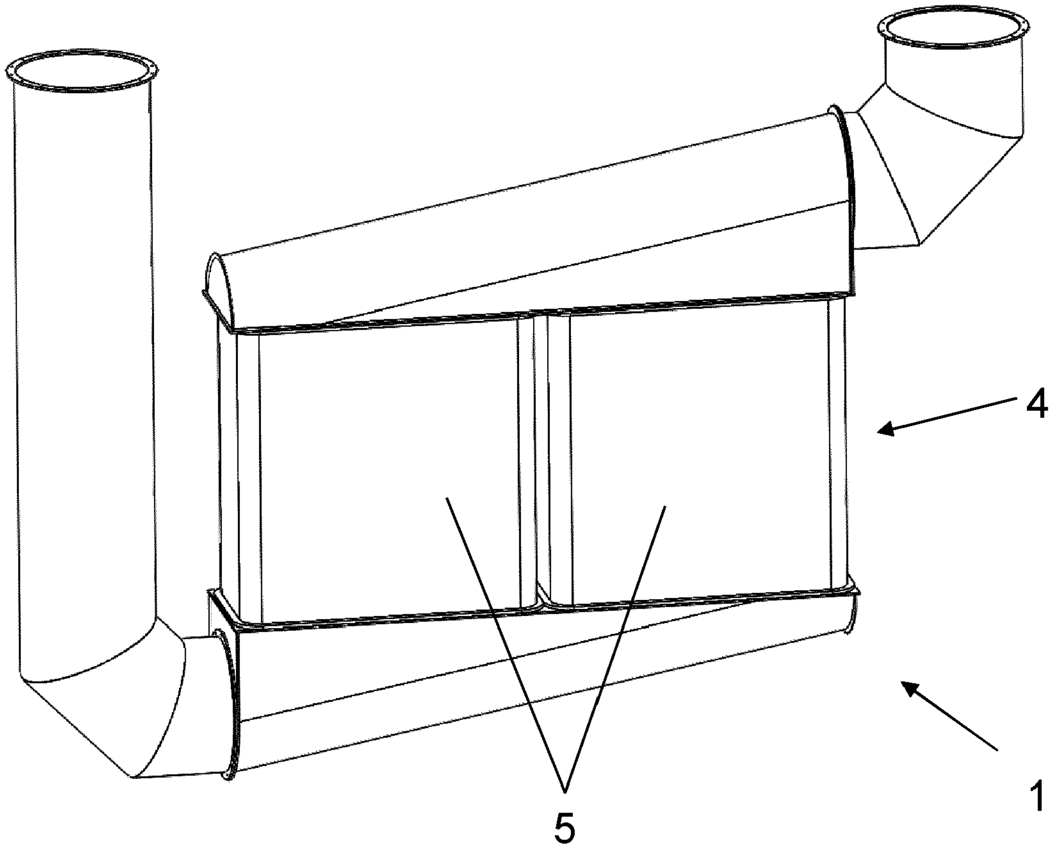

Fig. 7

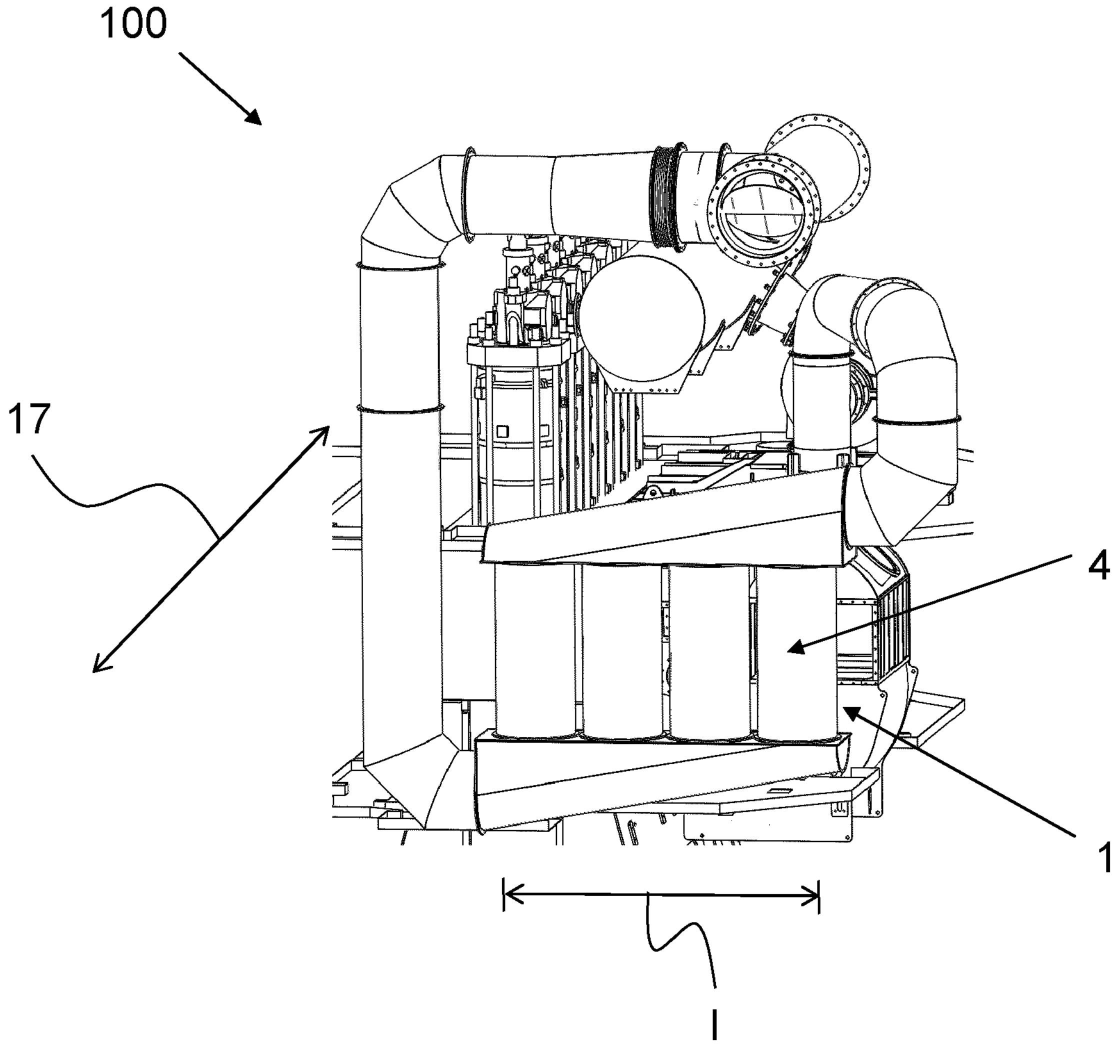

Fig. 8

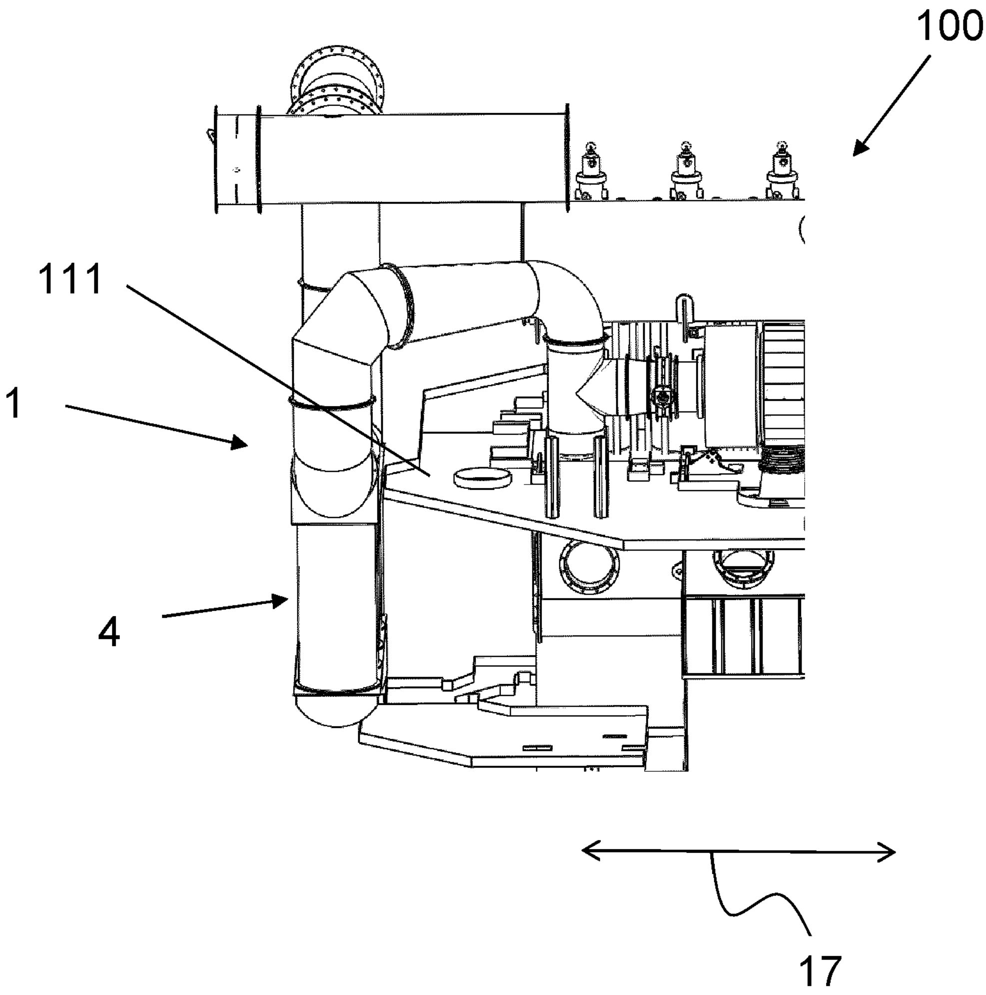

Fig. 9

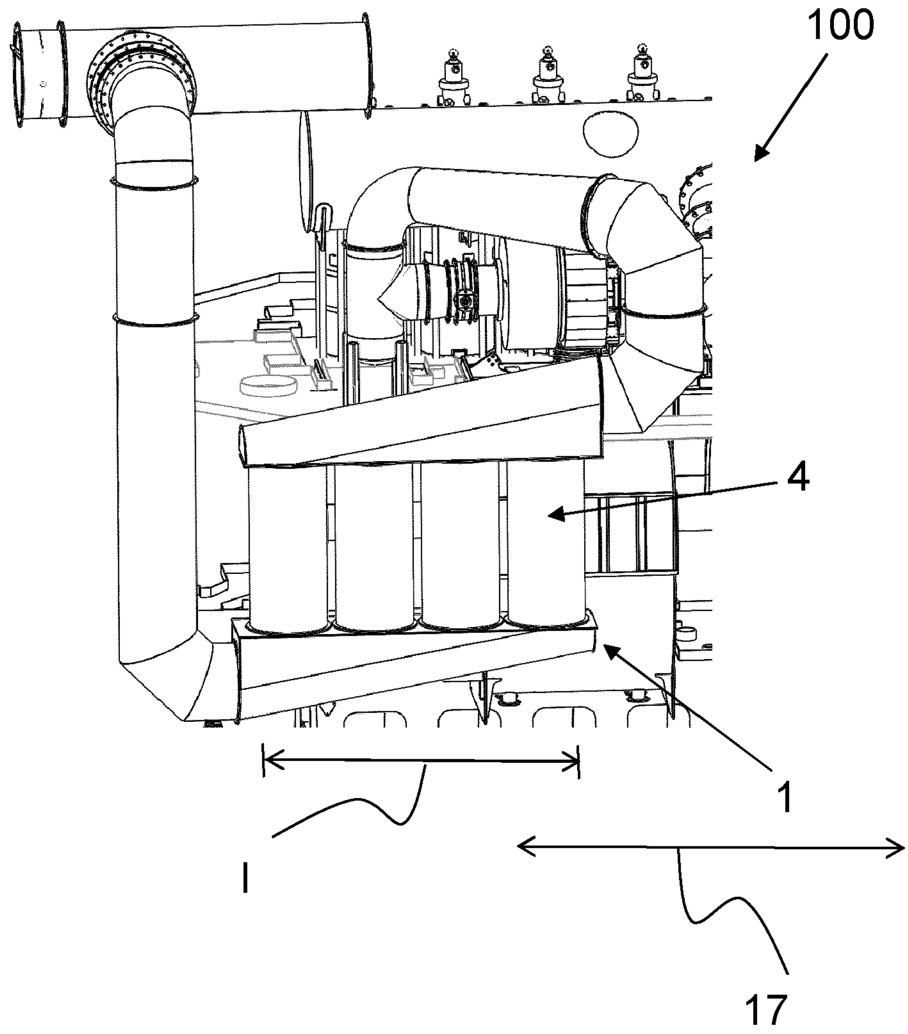

Fig. 10

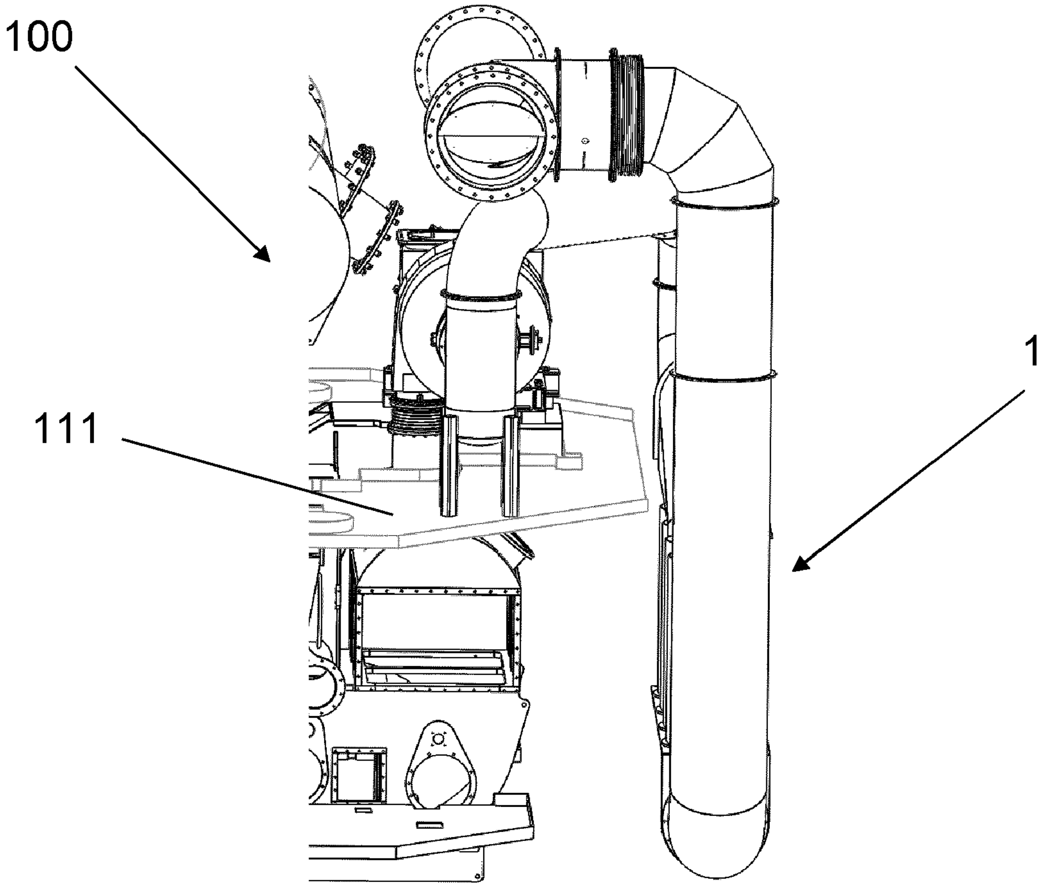

Fig. 11

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EUROPEAN SEARCH REPORT

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Place of search	Date of completion of the search	Examiner
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