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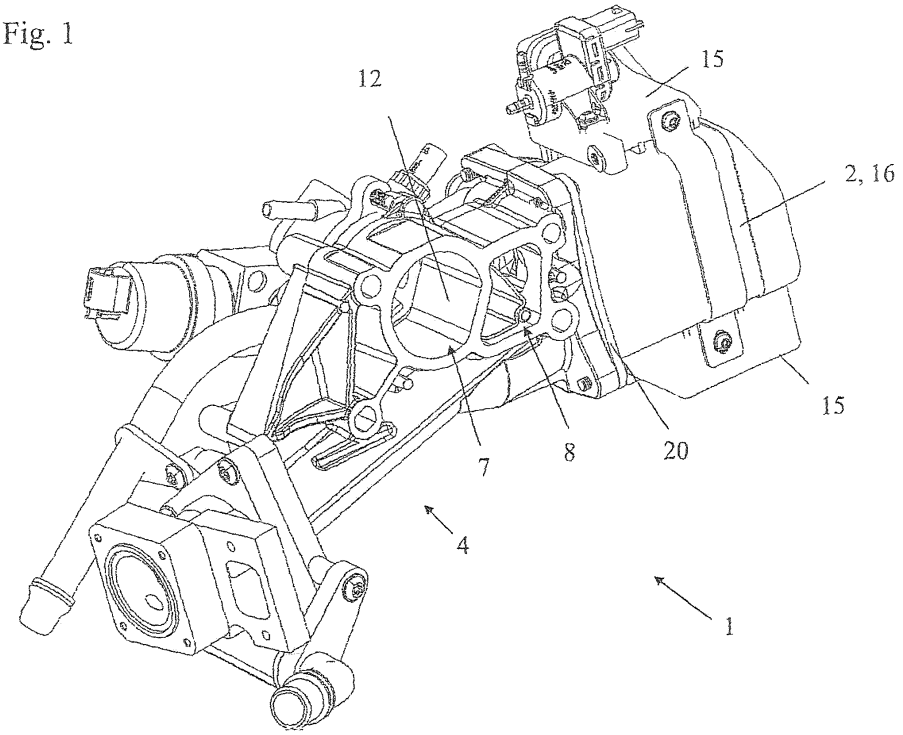
(54) **Multifunctional module for an internal combustion engine**

(57) This invention relates to a multifunctional module for an internal-combustion engine, forming a structural assembly and incorporating the functions of cooling the exhaust gases, regulating the re-injection of the exhaust gases and regulating, at least in part, the circulation flows in the cooling circuit of the said engine; the structural assembly is made in the form of a structural and operational unit (1), intended to be mounted on the engine block and incorporating at least a part of an exhaust-gas recirculation circuit, a heat exchanger (2) for cooling the said gases and at least a part of the engine-cooling circuit, incorporating at least the water-outlet housing. The exhaust-gas recirculation circuit part and the engine-cooling circuit part are incorporated in separate structural elements.

Fig. 1



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Description

[0001] The present invention concerns the field of parts and equipment for motor vehicles, more particularly the peripheral or accessory systems of internal-combustion engines of such vehicles, and its subject matter concerns a multifunctional module.

[0002] The space available under the bonnet of vehicles nowadays is more and more restricted, particularly around the engine block, encouraging the move towards incorporating the functions to be performed with a view to reducing the space occupied while maintaining their quality and their sustained operation, on which the operational reliability of the vehicle depends.

[0003] Furthermore, in terms of equipping and manufacturing internal-combustion-engine vehicles, the current trend consists in thinking, no longer in terms of isolated elements, namely components or parts, but in terms of assemblies, units or modules, each fulfilling a global function or a plurality of interdependent functions.

[0004] Moreover, in order to achieve a compact assembly, requiring no special support structure to hold it under the vehicle's bonnet, it would be advantageous to fix such a unit directly to the engine block

[0005] Lastly, it is also advantageous, for economical reasons, to make at least some constituent parts of such a unit of a plastics material, the latter requiring, however, to be protected against temperatures that are too high.

[0006] This object of this invention is to meet at least some of the expectations described above.

[0007] For this purpose, the subject matter of the present invention concerns a multifunctional module for an internal-combustion engine, forming a structural assembly and incorporating the functions of cooling the exhaust gases, regulating the re-injection of the exhaust gases and regulating, at least in part, the circulation flows in the cooling circuit of the said engine, the said structural assembly being made in the form of a structural and operational unit, intended to be mounted on the engine block and incorporating at least a part of an exhaust-gas recirculation circuit, a heat exchanger for cooling the said gases and at least a part of the engine-cooling circuit, incorporating at least the water-outlet housing, characterised in that the exhaust-gas recirculation circuit part and the engine-cooling circuit part are incorporated in separate structural elements of the said structural and operational unit.

[0008] Further features and advantages of the invention will emerge from the following description of a preferred embodiment which is shown by way of a non-limiting example in the accompanying drawings, in which:

Figures 1 and 2 are perspective views from two different angles of a multifunctional module according to the invention;

Figure 3 is a view similar to that shown in Figure 2, showing more particularly the circulation of the coolant in the multifunctional module according to the invention;

Figure 4 is a diagram showing the exhaust-gas circulation circuit in the multifunctional module according to the invention;

Figure 5 is a view similar to that of Figure 1, showing more particularly the circulation circuit of gases not cooled by the heat exchanger according to the invention;

Figure 6 is a view similar to that of Figure 1, showing more particularly the circulation circuit of the gases cooled by the heat exchanger as well as the bundle of tubes thereof;

Figure 7 is a view similar to that of Figure 1, showing the multifunctional module according to the invention on fitting the heat exchanger; and

Figure 8 is a view similar to that of Figure 1, showing the multifunctional module according to the invention on fitting the module forming a reserve vacuum on the heat exchanger tank.

[0009] As shown in Figures 1 and 2, the multifunctional module for an internal-combustion engine according to the invention forming a structural assembly incorporating the functions of cooling the exhaust gases, regulating the re-injection of the exhaust gases and regulating, at least in part, the circulation flow in the cooling circuit of the said engine, is made in the form of a structural and operational unit 1, intended to be mounted on the engine block, and incorporates at least a part of an exhaust-gas recirculation circuit, a heat exchanger 2 for cooling the said gases and at least a part of the engine-cooling circuit, incorporating at least the water-outlet housing 3.

[0010] This multifunctional module 1 is characterised in that the exhaust-gas recirculation circuit part and the engine-cooling circuit part are incorporated in separate structural elements 4, 3, 5, 6 of the said structural and operational unit 1.

[0011] This invention provides a multifunctional module forming a structural and operational unit 1 incorporating, on the one hand, the functions of cooling and regulating the re-injection of exhaust gases and, on the other, the function of adjusting the circulation flow in the cooling circuit of the said engine. This multifunctional module 1 is of a limited size and can be mounted directly on the engine, as will be explained below. Furthermore, the exhaust-gas recirculation and cooling circuits are separate and incorporated in different structural elements, so that the latter can be made of different materials.

[0012] For this purpose, and according to the invention, the exhaust-gas recirculation circuit part can be incorporated in a central metal element 4 of the structural

and operational unit 1 and the exhaust-gas or engine-cooling circuit part can be made of a thermoplastic synthetic material and be mounted on the said central element 4. The metal used to make the central element 4 may be stainless steel, for example. Using a synthetic material to make part of the cooling circuit increases the weight of the structural and operational unit on the one hand and, on the other, cuts its production costs, and also increases its flexibility, which is particularly advantageous when assembling together the elements that form the said structural and operational unit 1.

[0013] According to a first variation of the invention, not shown, the engine-cooling circuit part can be made in the form of a one-piece structural subassembly 3, 5, 6 formed by assembling two parts made by injection-moulding thermoplastic synthetic material.

[0014] According to a second variation of the invention, the engine-cooling circuit part can be made by assembling at least two parts 3, 5, 6. As shown in the accompanying Figures, parts 3, 5, 6 can be made in the form of tubular elements or pipes optionally connected together by vibration welding. Furthermore, the arrangement thereof forms the water outlet housing 3.

[0015] The accompanying Figures show that the structural and operational unit 1 can be of a substantially elongated shape and essentially made by assembling three elements, namely:

- the central one-piece element 4, on a first side of which part 3, 5, 6 of the engine-cooling circuit is mounted, and notably having, on the other side, a coolant-inlet opening 7 and an exhaust-gas inlet opening 8 connected to the engine-cooling circuit and gas recirculation circuit respectively so as to mount the module 1 directly onto the engine block;
- the heat exchanger 2, and
- a gas flow adjustment device 9, the heat exchanger 2 and the gas flow adjustment device 9 each being mounted at opposite ends of the central element 4.

[0016] This structure of separate elements simplifies the manufacture of such a multifunctional module 1 and thus reduces its cost. Furthermore, the presence of coolant-inlet openings 7 and an exhaust-gas inlet opening 8 enables the module to be mounted directly onto the engine.

[0017] Characteristically, and as emerges more particularly from Figure 3, the heat exchanger 2 can be made in the form of a metal tank 16 having an inlet opening 10 for the coolant and an outlet opening 11 for the coolant, a bundle 13 of tubes 14 in which the exhaust gases circulate being mounted and located in said tank 16. Here too, stainless steel may be used to make the tank 16.

[0018] This Figure also shows the circulation of the coolant in the multifunctional module 1 by means of arrows. The arrows shown by a thicker line correspond to the flow of liquid that has passed through the tank 16, and which has therefore recovered some of the calories of the exhaust gases in the heat exchanger 2, so that it has a higher temperature on leaving the heat exchanger 2 than on entering it.

[0019] The heat exchanger 2 is preferably located near the gas-inlet opening 8, so that the hot exhaust gases do not pass through the multifunctional module 1 over a long distance, thus avoiding too great an increase in temperature due to the exhaust gases leaving the engine being directly admitted into the said multifunctional module 1.

[0020] In order further to reduce the volume occupied by the structural and operational unit 1 according to the invention, a module 15 forming a reserve vacuum, made of a thermoplastic synthetic material and capable of being used to control or supply power or pneumatic energy to a regulating device 9 and/or to a gas-flow diversion device 17 of a pneumatic or electro-pneumatic type can be mounted on the tank 16 of the heat exchanger 2. The need to incorporate a specific vacuum reservoir, in the bonnet, by means of special fixing devices, is thus avoided.

[0021] Module 15 forming a reserve vacuum can be made in a general U shape in which the internal surfaces of the wings and the core have elements or a protrusion 21 that engage with the corresponding faces of the tank 16 of the heat exchanger 2 when the said module 15 is in its assembled position. As shown in Figure 7, these protruding elements 21 can be made in the form of ribs. The latter allow heat insulation to be achieved between the metal tank 16 of the heat exchanger 2 and the module 15 made of synthetic material by creating insulating air spaces between the walls thereof.

[0022] According to the invention, the coolant inlet opening 7 can be connected fluidly to the water-outlet housing 3 by means of a pipe 12 formed in and passing through the central element 4 perpendicular to the longitudinal axis thereof and the water outlet housing 3 can be connected to the inlet opening 10 of the tank 16 of the heat exchanger 2 by means of a pipe 5, formed in the one-piece sub-assembly 3, 5, 6 constituting the engine-cooling circuit part or corresponding to one 5 of the pieces 3, 5, 6 assembled to create the engine-cooling circuit part.

[0023] In the same way, a pipe 6, formed in the one-piece sub-assembly 3, 5, 6 constituting the engine-cooling circuit part or corresponding to one 6 of the parts 3, 5, 6 assembled to create the engine-cooling circuit part, can be connected to the outlet opening 11 of the tank 16 of the heat exchanger 2 to evacuate the water from the said tank 16.

[0024] Considering now the heat exchanger 2, it may comprise a bundle 13 of tubes 14 mounted in the tank 16 of the heat exchanger 2 by means of a supporting body 20 creating a seal at the assembly interface between the tank 16 and the central element 4 and closing the said tank 16 of the heat exchanger 2, and the bundle 13 of tubes 14 can form a U-shaped circulation path for the exhaust gases in the tank 16 and may be made up of a first group of feed tubes 14, in which the exhaust gases circulate from the first end 14' of the tubes 14 lo-

cated at the opening of the tank 16 and the supporting body 20 towards the second end 14" of the tubes 14 located at the bottom of the tank 16, and of a second group of return tubes 14, in which the exhaust gases circulate from the second end 14" of the tubes 14 located at the bottom of the tank 16 towards the first end 14' of the tubes 14 located at the opening of the tank 6 and the supporting body 20.

[0025] The second ends 14" of the tubes 14 may emerge into a common volume ensuring fluid communication between the first group and the second group of tubes 14, the said volume comprising for example a capsule shut off by a plate, the said plate being passed through by the second ends 14" of the tubes 14.

[0026] Clearly, the tubes 14 of the heat exchanger 2 may be made in one piece and bent into a U-shape or may each be formed by two portions of straight tubes connected together by a portion of bent tube.

[0027] According to the invention, the exhaust-gas inlet opening 8 may be in fluid communication with the inlet ends of the tubes 14 by means of a channel made in the central element 4 and with a gas-outlet opening 19 located in the central element 4 via a gas through-passage 18, also made in the central element 4, and a device 17 for diverting the flow of gas may be mounted in the gas-inlet opening 8.

[0028] In this way, the exhaust gases arriving at the inlet opening 8 are directed either towards the tank 16, or towards the outlet opening 19. Figure 4 shows in solid lines the situation in which the exhaust gases are directed towards the tank 16 of the heat exchanger 2 to achieve cooling thereof. The flow of these gases is also shown in Figure 6 in which the arrows with the thicker line represent the exhaust gases before they pass into the heat exchanger 2.

[0029] The multifunctional module 1 makes it possible to achieve, without cooling the exhaust gases, rapid heating of the engine after a cold start. Under these conditions, the path followed by the exhaust gases corresponds to that indicated by the arrows shown in Figure 5. In the circuit shown in Figure 4, the path followed is that shown by the dotted lines.

[0030] Advantageously, the outlet opening 19 can be arranged level with the structural and operational unit 1 so that when the latter is mounted on an engine, the said outlet opening 19 is in position to be mounted directly on the inlet manifold of the engine.

[0031] According to the invention, the multifunctional module 1 may comprise a device for thermostatically adjusting the flow of fluid into the water outlet housing 3. This device can thus adjust the circulation of the coolant between the multifunctional module circuit 1, the passenger-compartment exchanger and the radiator.

[0032] By means of the invention, it is possible to create a multifunctional module whose manufacturing cost is reduced by making some elements thereof of a thermoplastic synthetic material while making optimum use of the space occupied under the bonnet, given that the multifunctional module 1 incorporates part of the exhaust-gas recirculation circuit as well as part of the engine-cooling circuit.

[0033] Clearly, the invention is not limited to the embodiment described and shown in the accompanying drawings. Modifications may be made, particularly as regards the make-up of the various elements or by substituting technical equivalents, without departing from the scope of protection of the invention.

Claims

1. Multifunctional module for an internal-combustion engine, forming a structural assembly and incorporating the functions of cooling the exhaust gases, regulating the re-injection of the exhaust gases and regulating, at least in part, the circulation flows in the cooling circuit of the said engine, the said structural assembly being made in the form of a structural and operational unit (1), intended to be mounted on the engine block and incorporating at least a part of an exhaust-gas recirculation circuit, a heat exchanger (2) for cooling the said gases and at least a part of the engine-cooling circuit, incorporating at least the water outlet housing (3),
characterised in that the exhaust-gas recirculation circuit part and the engine-cooling circuit part are incorporated in separate structural elements (4, 5, 6) of the said structural and operational unit (1).

2. Module according to claim 1, **characterised in that** the exhaust-gas recirculation circuit part is incorporated in a central metal element (4) of the structural and operational unit (1), and **in that** the engine-cooling circuit part is made of a thermoplastic synthetic material and is mounted on the said central element (4).

3. Module according to claim 2, **characterised in that** the engine-cooling circuit part is made in the form of a one-piece structural subassembly (3, 5, 6) formed by assembling two parts made by injection-moulding thermoplastic synthetic material.

4. Module according to claim 2, **characterised in that** the engine-cooling circuit part is made by assembling at least two parts (3, 5, 6).

5. Module according to any one of the preceding claims 2, 3 and 4, **characterised in that** the structural and operational unit (1) is of a substantially elongated shape and basically made by assembling three elements, namely:

    - the central one-piece element (4), on a first side of which part (3, 5, 6) of the engine-cooling circuit is mounted, and notably having, on the

other side, a coolant-inlet opening (7) and an exhaust-gas inlet opening (8) connected to the engine-cooling circuit and gas recirculation circuit respectively so as to mount the module (1) directly onto the engine block;
- the heat exchanger (2), and
- a gas-flow adjustment device (9), the heat exchanger (2) and the gas-flow adjustment device (9) being mounted at opposite ends of the central element (4).

6. Module according to claim 5, **characterised in that** the heat exchanger (2) is made in the form of a metal tank (16) having an inlet opening (10) for the coolant and an outlet opening (11) for the coolant, a tank (16) in which a bundle (13) of tubes (14) in which the exhaust gases circulate is mounted and located.

7. Module according to claim 6, **characterised in that** a module (15) forming a reserve vacuum, made of a thermoplastic synthetic material and capable of being used to control or supply power or pneumatic energy to a regulating device (9) and/or to a gas-flow diversion device (17) of a pneumatic or electro-pneumatic type is mounted on the tank (16) of the heat exchanger (2).

8. Module according to claim 7, **characterised in that** the module (15) is made in a general U shape in which the internal surfaces of the wings and the core have elements or a protrusion (21) that engage with the corresponding faces of the tank (16) of the heat exchanger (2) when the said module (15) is in its assembled position.

9. Module according to any one of claims 6 to 8, to the extent that it relates to claim 3 or 4, **characterised in that** the coolant inlet opening (7) is connected fluidly to the water-outlet housing (3) by means of a pipe (12) formed in and passing through the central element (4) perpendicular to the longitudinal axis thereof and the water-outlet housing (3) is connected to the inlet opening (10) of the tank (16) of the heat exchanger (2) by means of a pipe (5), formed in the one-piece sub-assembly (3, 5, 6) constituting the engine-cooling circuit part or corresponding to one (5) of the pieces (3, 5, 6) assembled to create the engine-cooling circuit part.

10. Module according to claim 9, **characterised in that** a pipe (6), formed in the one-piece sub-assembly (3, 5, 6) constituting the engine-cooling circuit part or corresponding to one (6) of the parts (3, 5, 6) assembled to create the engine-cooling circuit part, is connected to the outlet opening (11) of the tank (16) of the heat exchanger (2) to evacuate the water from the said tank (16).

11. Module according to any one of claims 6 to 10, **characterised in that** the bundle (13) of tubes (14) is mounted in the tank (16) of the heat exchanger (2) by means of a supporting body (20) creating a seal at the assembly interface between the tank (16) and the central element (4) and closing the said tank (16) of the heat exchanger (2), and **in that** the bundle (13) of tubes (14) forms a U-shaped circulation path for the exhaust gases in the tank (16) and is made up of a first group of feed tubes (14), in which the exhaust gases circulate from the first end (14') of the tubes (14) located at the opening of the tank (16) and the supporting body (20) towards the second end (14") of the tubes (14) located at the bottom of the tank (16), and of a second group of return tubes (14), in which the exhaust gases circulate from the second end (14") of the tubes (14) located at the bottom of the tank (16) towards the first end (14') of the tubes (14) located at the opening of the tank (6) and the supporting body (20).

12. Module according to claim 11, **characterised in that** the second ends (14") of the tubes (14) emerge into a common volume ensuring fluid communication between the first group and the second group of tubes (14), the said volume comprising for example a capsule shut off by a plate, the said plate being passed through by the second ends (14") of the tubes (14).

13. Module according to any one of claims 7 to 12, **characterised in that** the exhaust-gas inlet opening (8) is in fluid communication with the inlet ends of the tubes (14) by means of a channel made in the central element (4) and with a gas-outlet opening (19) located in the central element (4) via a gas through-passage (18), also made in the central element (4), and **in that** a device (17) for diverting the flow of gas may be mounted in the gas-inlet opening (8).

14. Module according to claim 13, **characterised in that** the outlet opening (19) is arranged level with the structural and operational unit (1) so that when the latter is mounted on an engine, the said outlet opening (19) is in position to be mounted directly on the inlet manifold of the engine.

15. Module according to any one of claims 1 to 14, **characterised in that** it has a device for thermostatically adjusting the flow of fluid into the water-outlet housing (3).

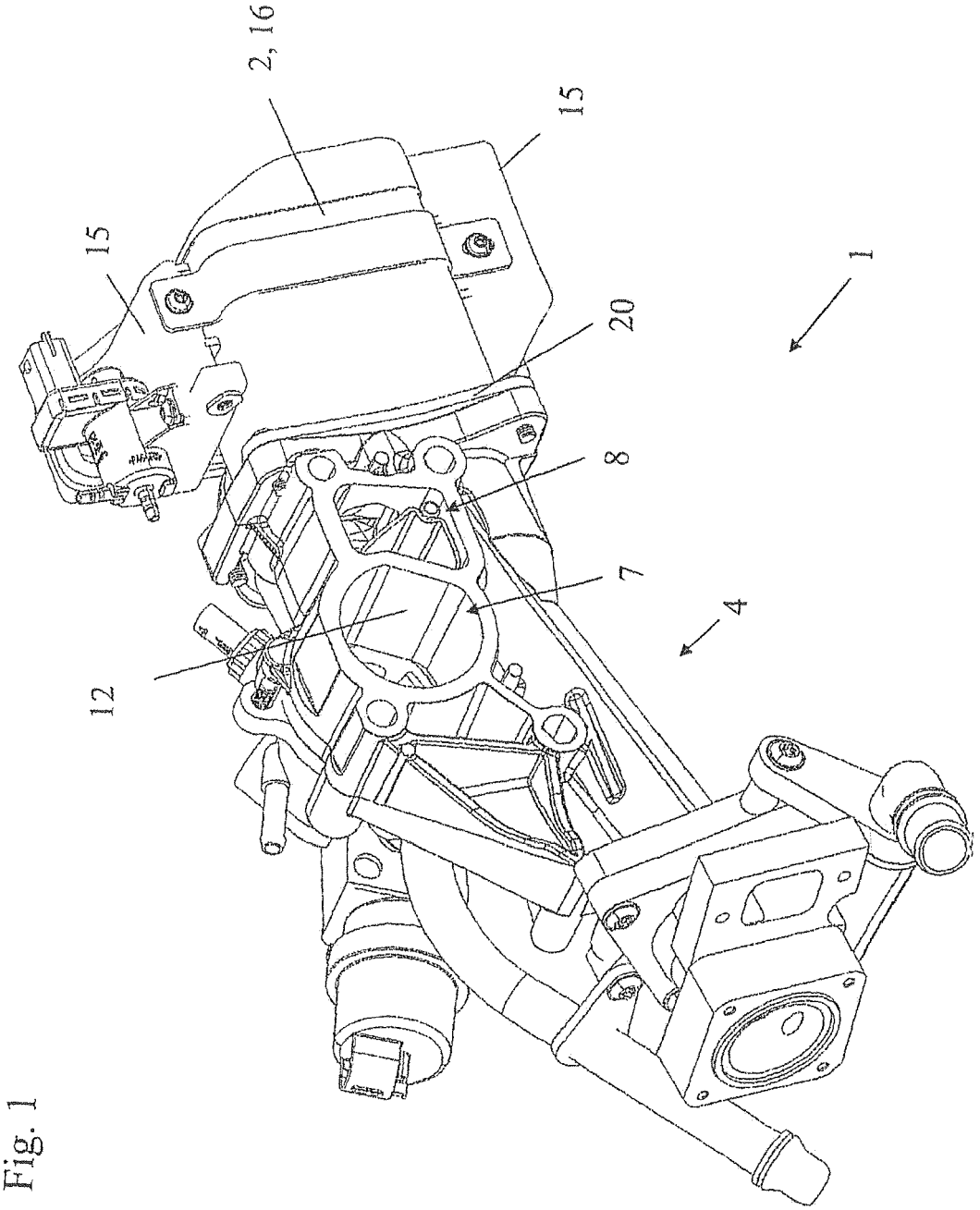


Fig. 1

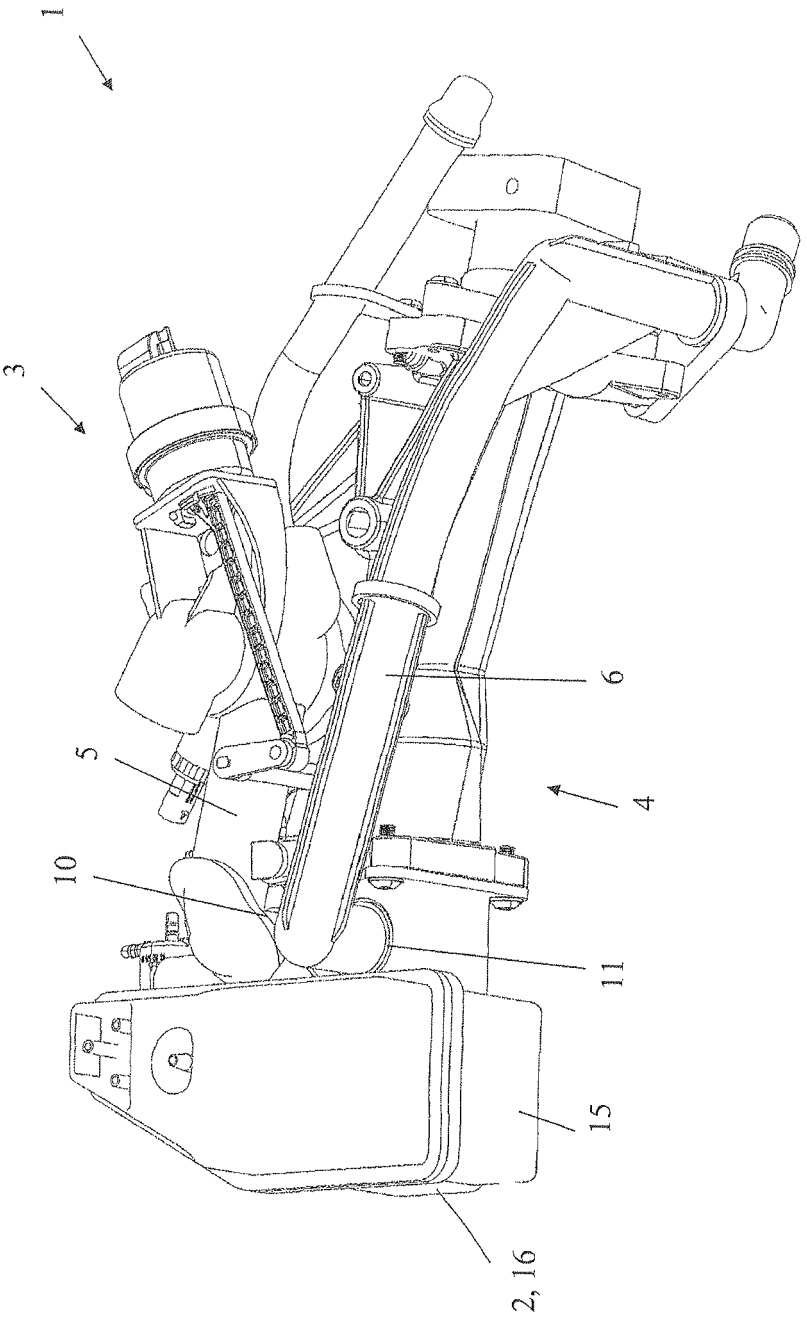


Fig. 2

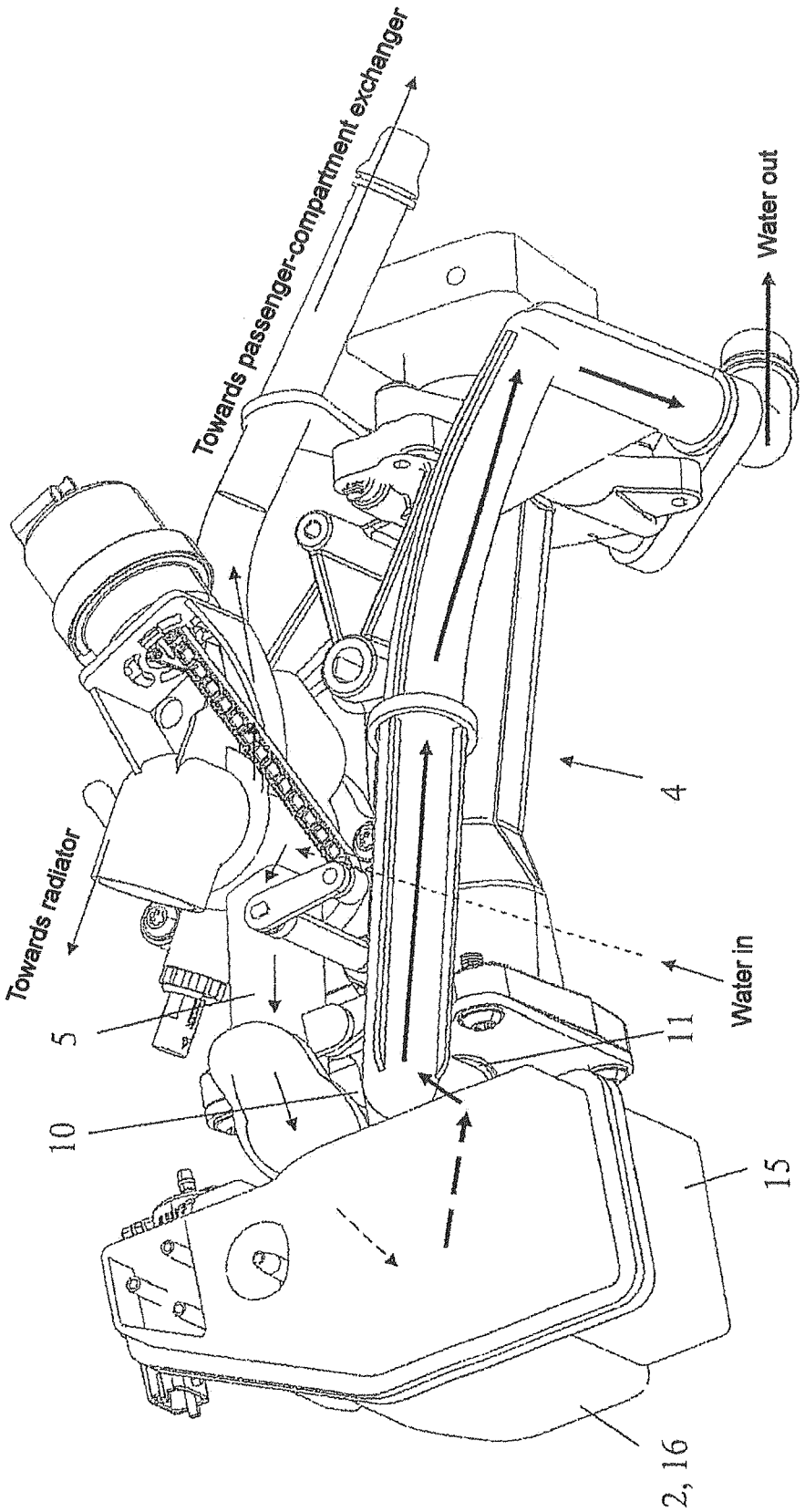
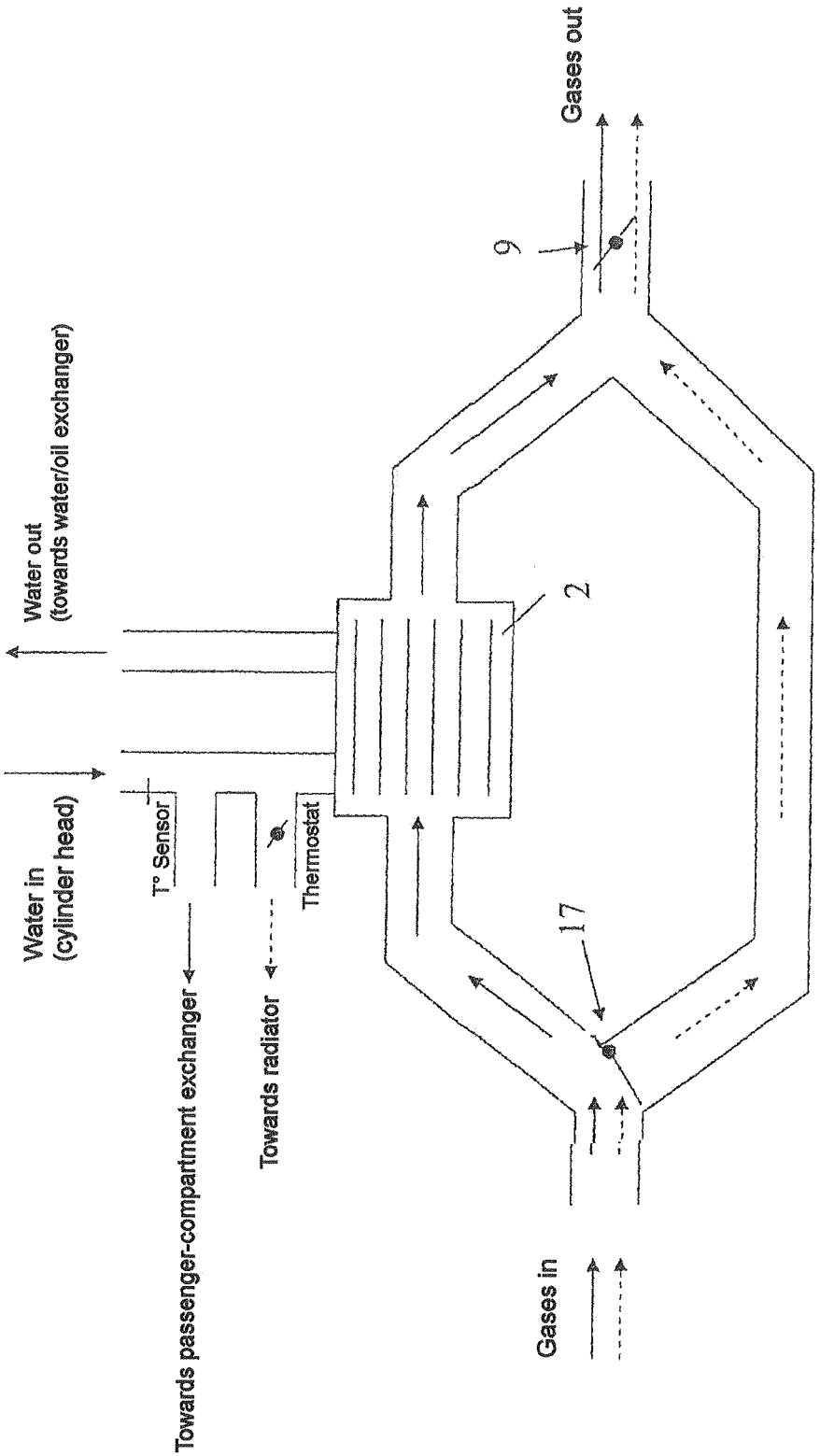

Towards passenger-compartment exchanger
Water out
Towards radiator
4
Water in
5
11
10
15
2, 16

Fig. 3

Fig. 4


Gases out
9
Water out
(towards water/oil exchanger)
2
Water in
(cylinder head)
T° Sensor
Thermostat
17
Towards passenger-compartment exchanger
Towards radiator
Gases in

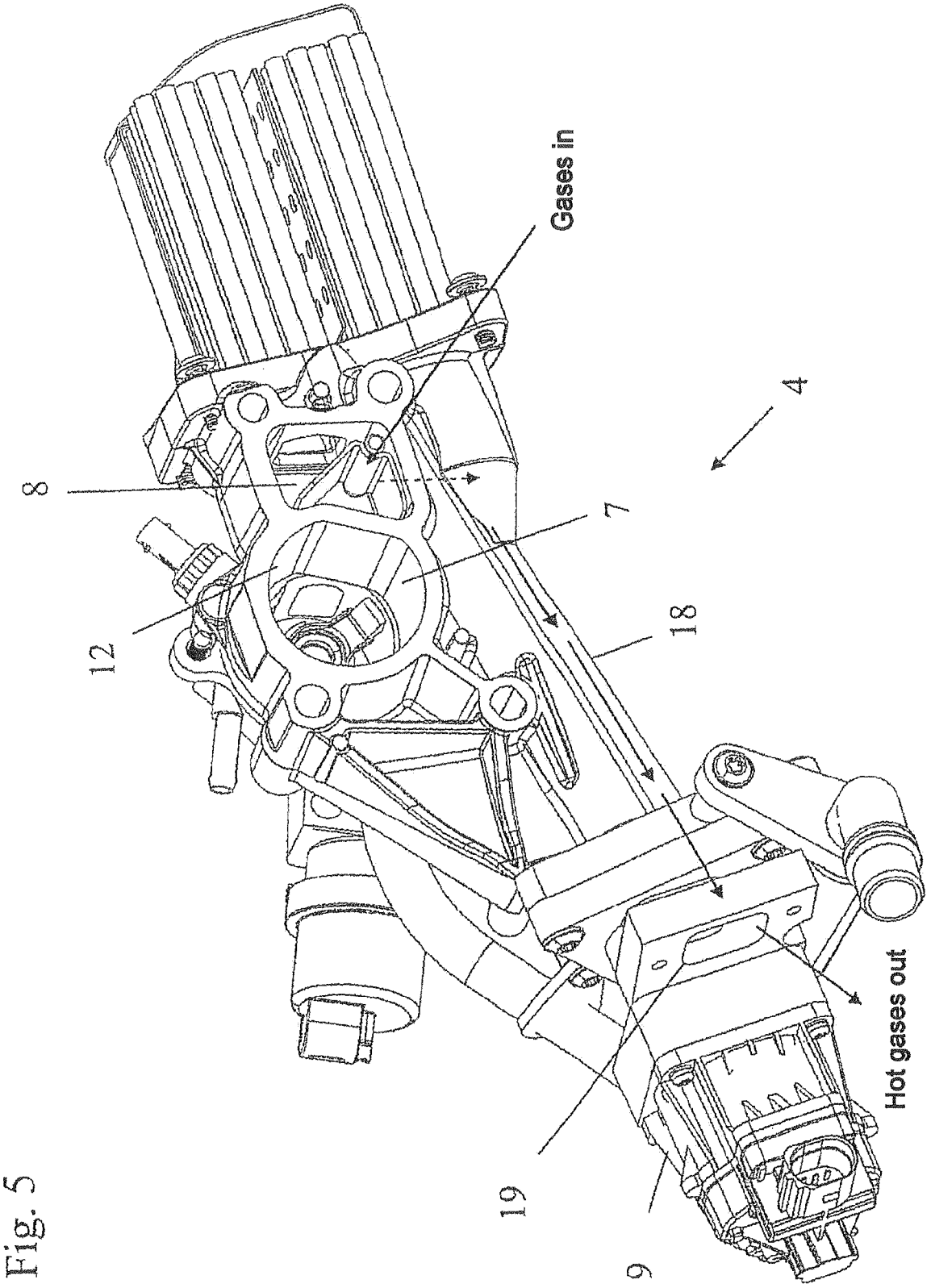


Fig. 5

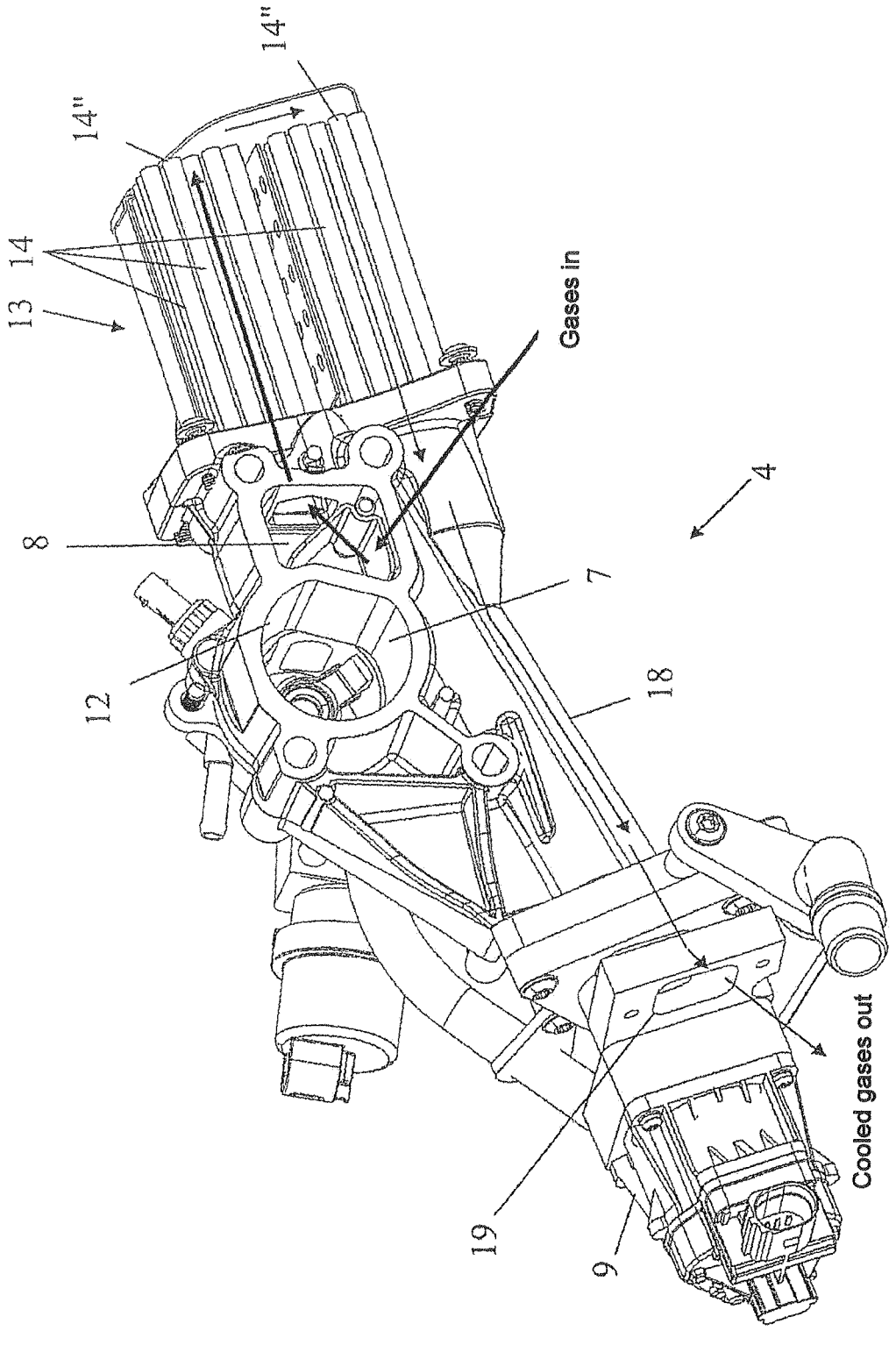


Fig. 6

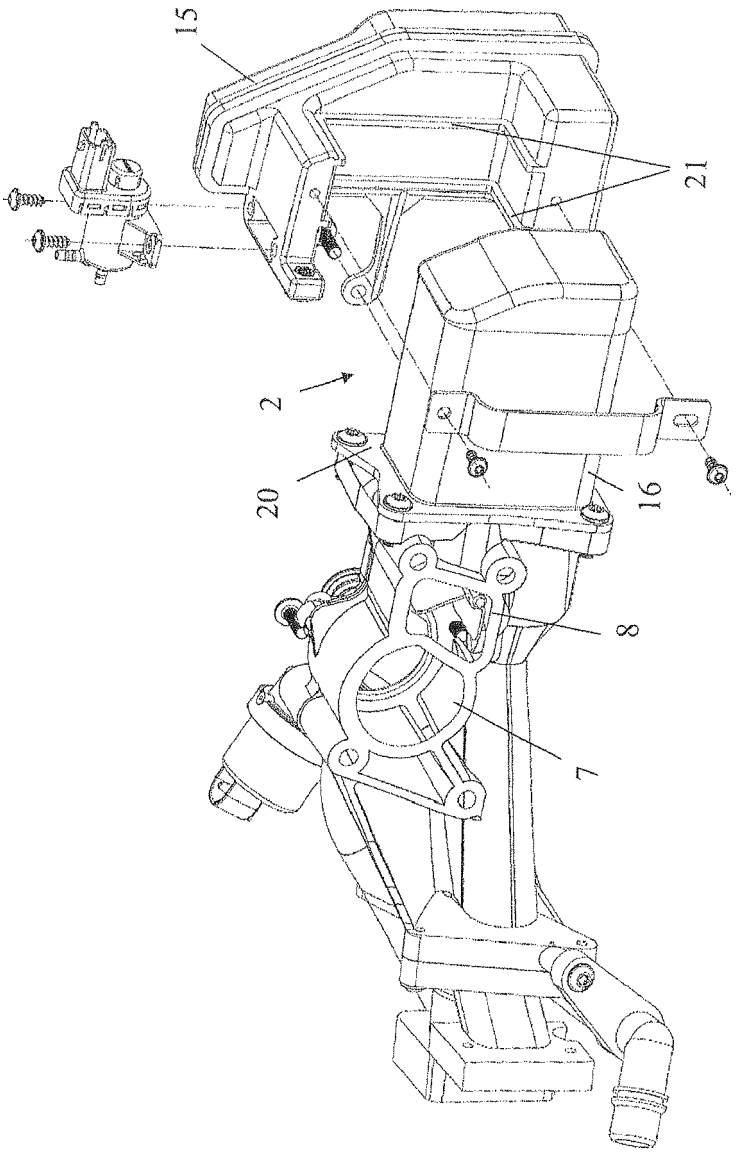


Fig. 7

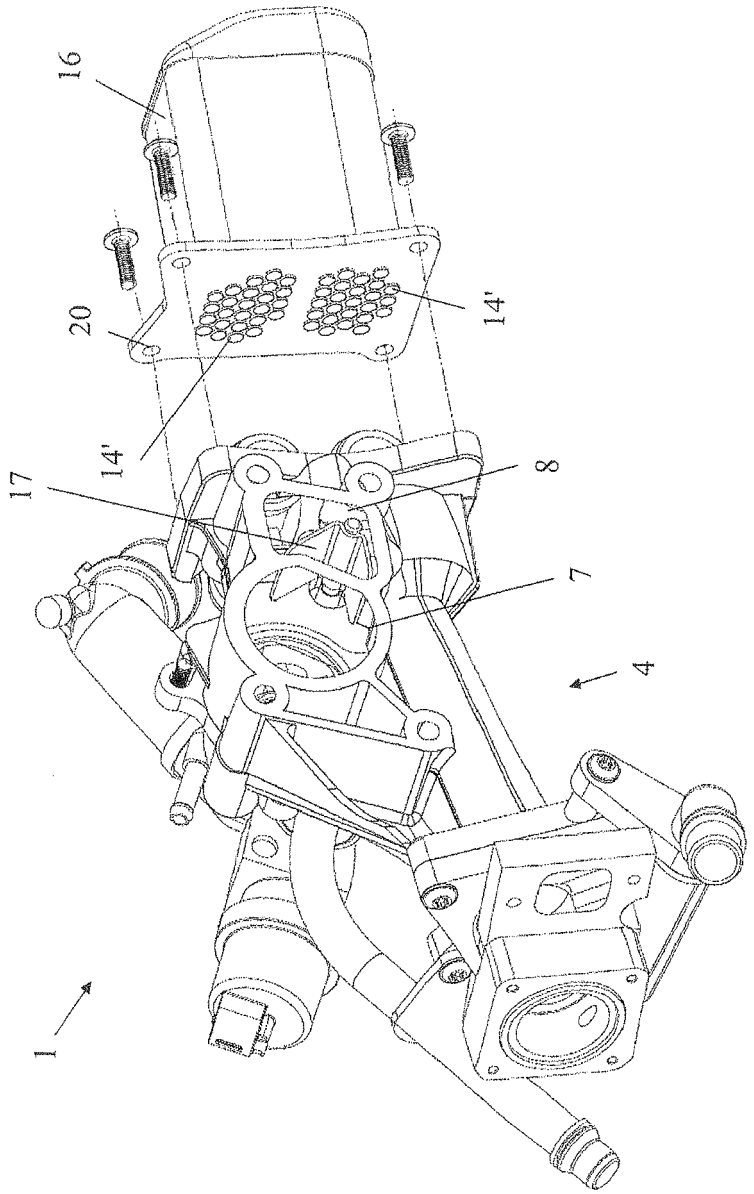


Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	11 December 2008	Wilson, Mark

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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