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(54) **Device for exhaust gas recirculation**

(57) An exhaust gas recirculation device comprises an exhaust gas recirculation conduit for feeding exhaust gases to an intake air channel of said engine, an exhaust gas recirculation valve arranged in said exhaust gas recirculation conduit for controlling the amount of exhaust gases fed into said intake air channel, and an exhaust gas cooler arranged in said exhaust gas re-circulation

conduit for cooling the exhaust gas fed into said intake air channel, said exhaust gas cooler comprising a cooling circuit for a cooling fluid. According to the invention, the exhaust gas recirculation valve comprises at least one cooling circuit for a cooling fluid, said cooling circuit of said exhaust gas recirculation valve being connected to said cooling circuit of said exhaust gas cooler.

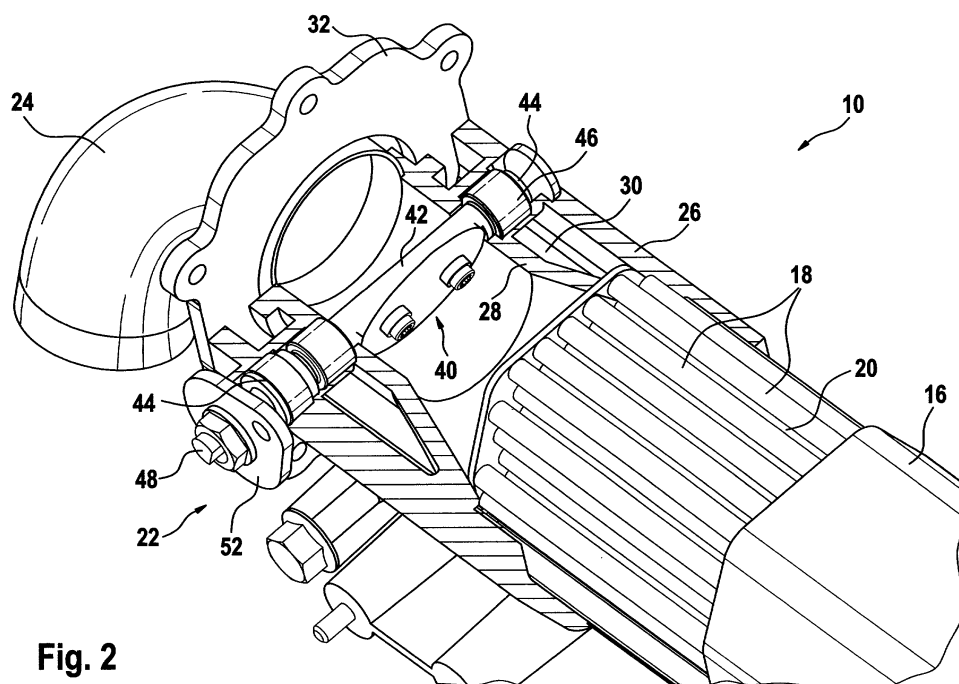


Fig. 2

Description

[0001] The present invention relates to a device for exhaust gas recirculation for an internal combustion engine, especially to a cooler and a valve for exhaust gas recirculation.

[0002] Exhaust gas recirculation is a technique commonly used for controlling the generation of undesirable pollutant gases and particulate matter in the operation of internal combustion engines. This technique has proven particularly useful in diesel internal combustion engines used in motor vehicles such as passenger cars, trucks, and other on-road or off-road motor equipment. The exhaust gas recirculation technique primarily involves the recirculation of exhaust gas by-products into the intake air supply of the internal combustion engine. This exhaust gas thus reintroduced to the engine cylinder reduces the concentration of oxygen therein, which in turn lowers the maximum combustion temperature within the cylinder and slows the chemical reaction of the combustion process, decreasing the formation of oxides of nitrogen NO_x. Furthermore, the exhaust gases typically contain a portion of unburned hydrocarbon which is burned on its reintroduction into the engine cylinder, which further reduces the emission of exhaust gas by-products which would be emitted as undesirable pollutants from the internal combustion engine.

[0003] A device for exhaust gas recirculation generally includes an intake air tube, an intake air control valve and an exhaust gas re-circulation valve. The intake air control valve allows for the throttling the intake airflow in the intake air tube. The exhaust gas re-circulation valve meters the flow of exhaust gases re-circulated into the intake air tube. In order to further reduce the combustion temperature of the engine, an exhaust gas cooler is moreover provided for cooling the exhaust gases to be fed into the engine air intake.

[0004] In heavy duty diesel engines, the exhaust gas recirculation device is often mounted upstream of the EGR cooler, i.e. on the hot gas side of the cooler. This requires that the EGR valve is made of special heat-resistant materials able to withstand exhaust gas temperatures up to 800°C. It is clear that the use of such heat-resisting materials considerably increases the costs of the EGR valve.

Object of the invention

[0005] The technical problem underlying the present invention is to provide an exhaust gas re-circulation device for an internal combustion engine, which is less expensive.

General description of the invention

[0006] This problem is overcome by the exhaust gas recirculation device for an internal combustion engine according to the present invention. This exhaust gas re-

circulation device comprises an exhaust gas recirculation conduit for feeding exhaust gases to an intake air channel of said engine, an exhaust gas recirculation valve arranged in said exhaust gas recirculation conduit for controlling the amount of exhaust gases fed into said intake air channel, and an exhaust gas cooler arranged in said exhaust gas re-circulation conduit for cooling the exhaust gas fed into said intake air channel, said exhaust gas cooler comprising a cooling circuit for a cooling fluid. According to the invention, the exhaust gas recirculation valve comprises at least one cooling circuit for a cooling fluid, said cooling circuit of said exhaust gas recirculation valve being connected to said cooling circuit of said exhaust gas cooler.

[0007] During the operation of the device, a cooling fluid is flooded through the cooling circuit of the exhaust gas cooler. The cooling circuit of the exhaust gas cooler being connected to the cooling circuit of the exhaust gas recirculation valve, this cooling fluid is also flooded through the cooling circuit of the exhaust gas recirculation valve. It follows that the components of the exhaust gas recirculation valve are cooled during the operation of the device, thus allowing the specification of cheaper materials. Furthermore, by using the cooling fluid directly from the exhaust gas cooler, the use of supplementary pipework is reduced to a minimum.

[0008] It has to be noted that the direction of the flow of the cooling fluid may depend on the cooling requirements for the exhaust gas recirculation valve. If improved cooling of the exhaust gas recirculation valve is required, the cooling fluid can be fed into the cooling circuit of the exhaust gas recirculation valve before entering the cooling circuit of the exhaust gas cooler. Alternatively, the flow of cooling fluid can first enter the cooling circuit of the exhaust gas cooler before entering the exhaust gas recirculation valve.

[0009] Traditionally, the EGR cooler and the EGR valve are supplied as separate components, each being provided with two mounting flanges. The EGR cooler and valve are then mounted together, either directly or by means of supplementary pipework. In a preferred embodiment of the invention, said exhaust gas recirculation valve and said exhaust gas cooler are integrated into one single housing. Such an integration of the valve and cooler provides for a very compact exhaust gas recirculation device. Furthermore, this embodiment eliminates the need for later assembly of two separate parts and accordingly the risk of defects in assembling. In addition, the number of parts like joints, bolts etc. is reduced. It follows that this embodiment reduces the costs of the exhaust gas recirculation device and at the same time improves the quality of the product. It will be further appreciated that component costs, size and weight are important considerations in automotive vehicle applications. An exhaust gas re-circulation device that is more compact in size can be of advantage, because of limitations on available space in a vehicle engine compartment. Weight reductions of components help of course

to reduce fuel consumption of the vehicle.

[0010] The exhaust gas cooler usually comprises a housing defining a flow path for said exhaust gases, said flow path having an enlarged central portion and two tapered end portions. In this case, the integration of the valve and the cooler is preferably achieved by integrating said exhaust gas recirculation valve into one of said end portions of said flow path of said exhaust gas cooler.

[0011] A further advantage of the integrated design of the valve and the cooler is that the interconnection of the respective cooling circuits of the exhaust gas recirculation valve and exhaust gas cooler is simplified. In fact, the transfer of coolant between the two cooling circuits can be achieved by a simple duct. In a first embodiment, this duct can comprise an external coolant duct which extends outside of said single housing. The external duct can simply be connected to respective fittings on the exhaust gas recirculation valve cooling circuit and the exhaust gas cooler cooling circuit. In an alternative embodiment, the duct may be an internal coolant duct, which is arranged inside said single housing.

[0012] The exhaust gas recirculation valve comprises an actuatable valve member, which is rotatably mounted into a flow path for said exhaust gas by means of bearings. In order to provide an adequate cooling of the exhaust gas recirculation valve, the cooling circuit of said exhaust gas recirculation valve preferably at least partially surrounds said flow path and/or said bearings of said actuatable valve member.

[0013] It will be further appreciated that component costs, size and weight are important considerations in automotive vehicle applications. An exhaust gas recirculation device that is more compact in size can be of advantage, because of limitations on available space in a vehicle engine compartment. Weight reductions of components help of course to reduce fuel consumption of the vehicle.

Detailed description with respect to the figures

[0014] The present invention will be more apparent from the following description of a not limiting embodiment with reference to the attached drawings, wherein

Fig.1: shows an end portion of an embodiment of an exhaust gas recirculation device according to the present invention; and

Fig.2: shows an inside view of the device of fig. 1.

[0015] An embodiment of an exhaust gas recirculation device 10 according to the present invention is represented in fig. 1 and 2. These figures show an end portion of an integrated exhaust gas recirculation cooler and valve, i.e. an exhaust gas cooler 12 having an exhaust gas recirculation valve 14 integrated therein.

[0016] The exhaust gas cooler 12 typically comprises a housing 16 having a plurality of hollow tubes 18 arranged therein in a substantially parallel relationship.

These hollow tubes 18 define a plurality of flow paths for the exhaust gas to be transferred through the exhaust gas cooler. The areas surrounding the hollow tubes define a coolant circuit 20 for a cooling fluid supplied by a (non shown) coolant fluid source. Fittings 21 (only one is shown) are mounted in the housing 16 of the exhaust gas cooler 12 for connecting the coolant circuit 20 to a coolant feeding or discharge conduit.

[0017] At each end, the exhaust gas cooler further comprises an end portion 22 having a tapered inner form. The taper of the end portions reduces the diameter of the flow path for the exhaust gases to the diameter of an exhaust gas recirculation conduit 24, and thus enables the exhaust gas cooler to be connected to said exhaust gas recirculation conduit 24.

[0018] In the shown embodiment, the end portion 22 of the exhaust gas cooler is designed as a double walled housing having an outer wall 26 and a coaxial inner wall 28, the inner wall 28 being tapered towards the end of the cooler. The two coaxial walls 26 and 28 confine an annular cooling channel 30, which at least partially surrounds the flow path defined by the inner wall 28. At the end of the exhaust gas cooler, the cooling channel 30 is closed by an end plate 32, which is sealingly mounted onto the front end of the end portion 22 of the exhaust gas cooler 12. The end plate can be bolted onto the front end of cooler 12.

[0019] Two fittings 34 and 36 are mounted into the outer wall 26 of the end portion 22. These fittings are used to connect the cooling channel 30 to a coolant feeding or discharge conduit. In the shown embodiment, fitting 34 is connected to fitting 21 of the coolant circuit 20 by means of conduit. It follows that a coolant fluid, which is supplied to the exhaust gas recirculation device 10 subsequently flows through the two cooling circuits 20 and 30.

[0020] In the exhaust gas recirculation device 10 of fig. 1 and 2, an exhaust gas recirculation valve 14 is integrated into the end portion 22 of the exhaust gas cooler 12. The exhaust gas recirculation valve 22, e.g. a butterfly valve, comprises an actuatable member 40, which is arranged into the flow path defined by the inner wall 28 of end portion 22 of the exhaust gas cooler 12. The valve member 40 is mounted on a shaft 42, which is rotatably mounted into the housing by means of bearings 44. The bearings are preferably arranged in bushings 46, which radially extend through the cooling circuit 30. It follows that the cooling circuit 30 at least partially surrounds bushings 46. In operation, the bushings 46 are fully exposed to the flow of coolant fluid circulating in the cooling circuit 30. This results in an effective cooling of the bearings 44 located inside the bushings 46, since the different elements are preferably made of thermally conductive metal.

[0021] Shaft 42 comprises an actuating end 48, which extends outside wall 26. This actuating end 48 can be connected to an actuator 50 for actuating the valve member 40. In the shown embodiment, actuator 50 is

mounted on the housing of exhaust gas cooler adjacent to actuating end 48. The (non shown) connection between the actuator and the actuating end may be achieved by a cam means 52 mounted on the actuating end 48 of shaft 42, cam means mounted on a shaft of the actuator and a connecting rod for coupling the two cam means.

Claims

1. Exhaust gas recirculation device for an internal combustion engine, comprising

an exhaust gas recirculation conduit for feeding exhaust gases to an intake air channel of said engine,

an exhaust gas recirculation valve arranged in said exhaust gas recirculation conduit for controlling the amount of exhaust gases fed into said intake air channel, and

an exhaust gas cooler arranged in said exhaust gas re-circulation conduit for cooling the exhaust gas fed into said intake air channel, said exhaust gas cooler comprising a cooling circuit for a cooling fluid,

characterized in that

said exhaust gas recirculation valve comprises at least one cooling circuit for a cooling fluid, said cooling circuit of said exhaust gas recirculation valve being connected to said cooling circuit of said exhaust gas cooler.

2. Exhaust gas recirculation device according to claim 1, wherein said exhaust gas recirculation valve and said exhaust gas cooler are integrated into one single housing.

3. Exhaust gas recirculation device according to claim 2, wherein said exhaust gas cooler comprises a housing defining a flow path for said exhaust gases, said flow path having an enlarged central portion and two tapered end portions, and wherein said exhaust gas recirculation valve is integrated into one of said end portions of said flow path of said exhaust gas cooler.

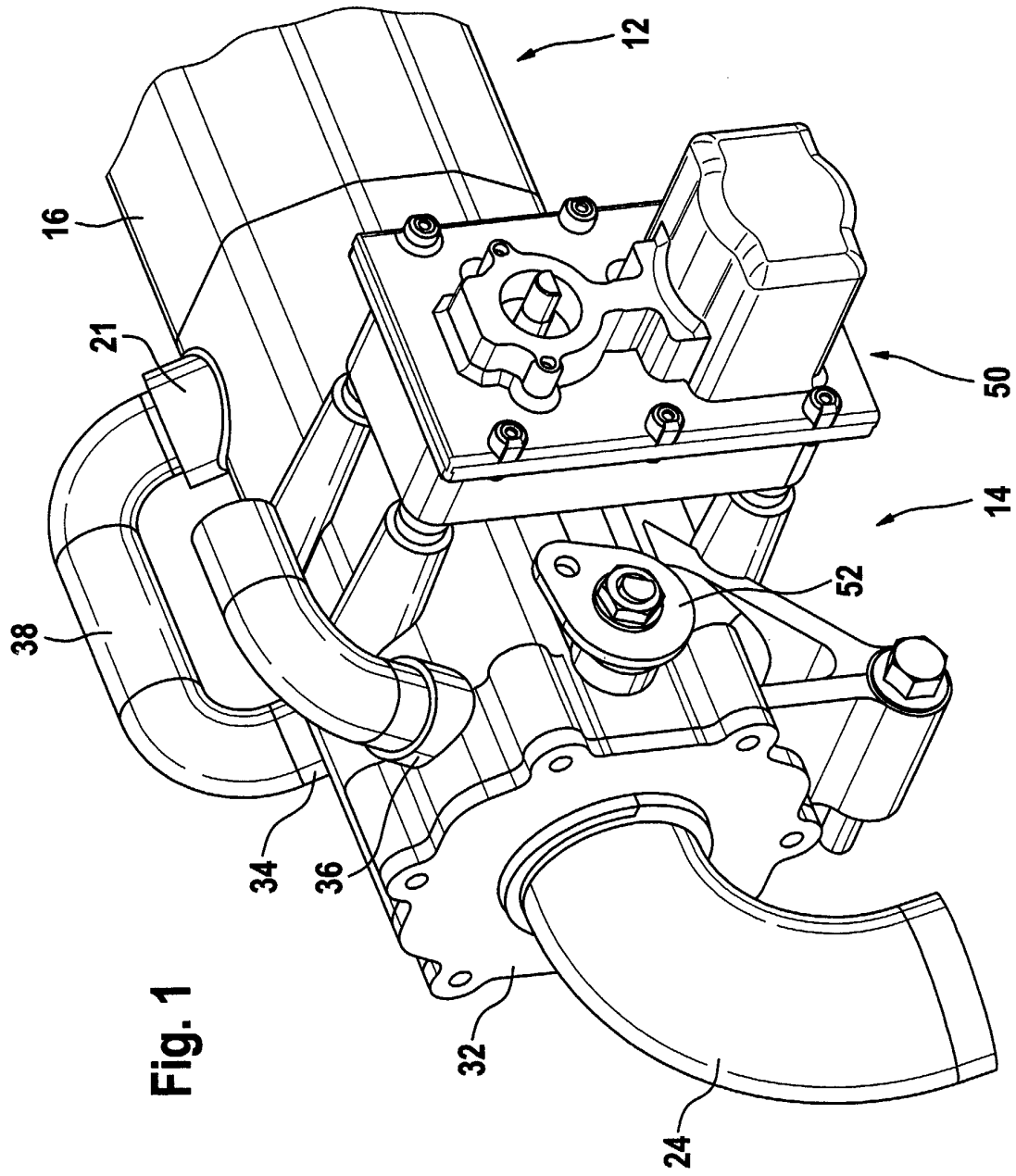
4. Exhaust gas recirculation device according to claim 2 or 3, wherein said cooling circuit of said exhaust gas recirculation valve and said cooling circuit of said exhaust gas cooler are connected by an external coolant duct, said external coolant duct extending outside of said single housing.

5. Exhaust gas recirculation device according to claim 2 or 3, wherein said cooling circuit of said exhaust gas recirculation valve and said cooling circuit of said exhaust gas cooler are connected by an inter-

nal coolant duct, said internal coolant duct being arranged inside said single housing.

6. Exhaust gas recirculation device according to any one of the preceding claims, wherein said exhaust gas recirculation valve comprises an actuatable valve member, which is mounted into a flow path for said exhaust gas, and wherein said cooling circuit of said exhaust gas recirculation valve at least partially surrounds said flow path.

7. Exhaust gas recirculation device according to any one of the preceding claims, wherein said exhaust gas recirculation valve comprises an actuatable valve member, which is rotatably mounted into a flow path for said exhaust gas by means of bearings, and wherein said cooling circuit of said exhaust gas recirculation valve at least partially surrounds said bearings of said actuatable valve member.



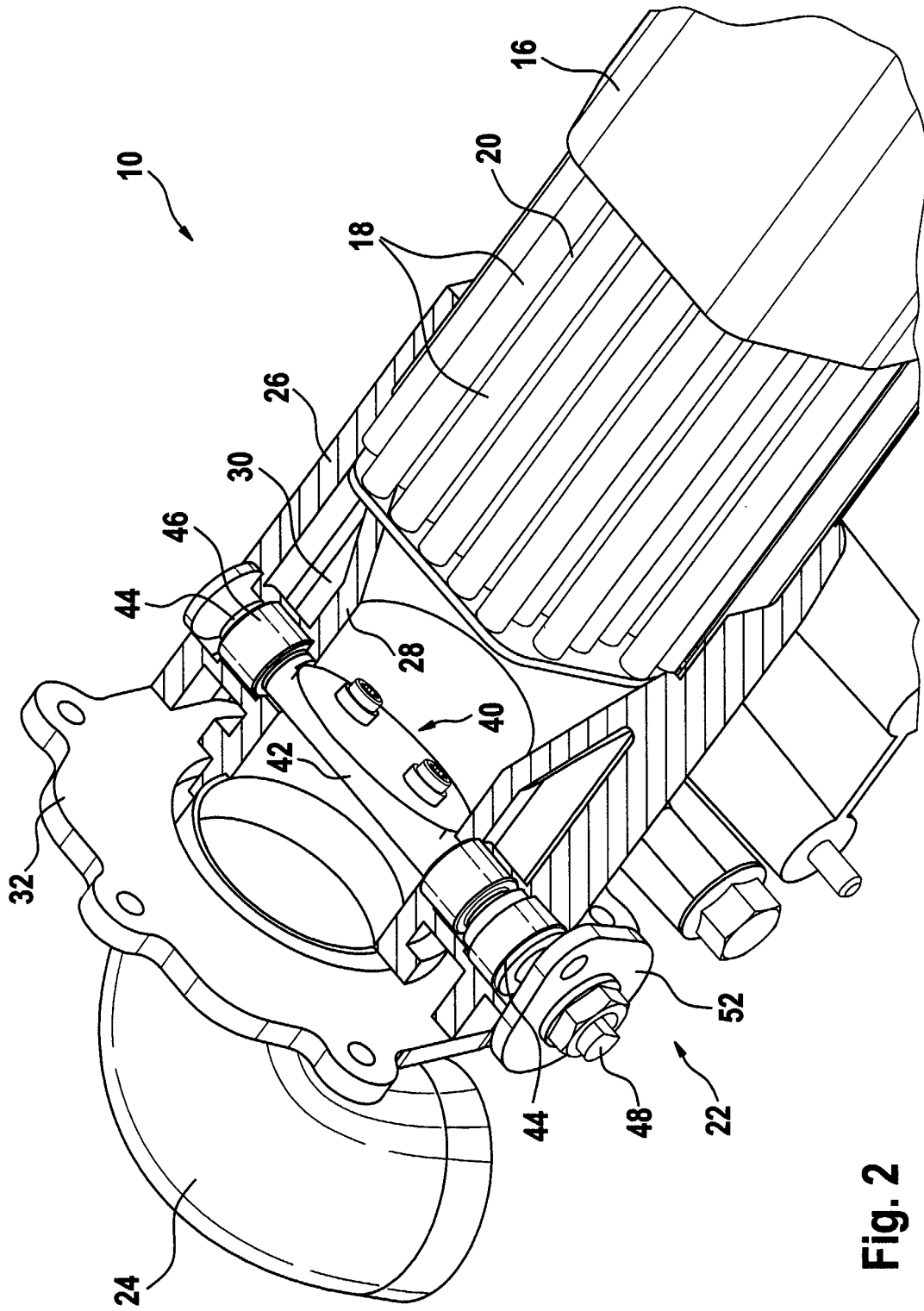


Fig. 2