



(51) International Patent Classification:
F02M 25/07 (2006.01) *F01P 5/08* (2006.01)

(21) International Application Number:
PCT/SE2009/051358

(22) International Filing Date:
1 December 2009 (01.12.2009)

(25) Filing Language: Swedish

(26) Publication Language: English

(30) Priority Data:
0802536-3 8 December 2008 (08.12.2008) SE

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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(54) Title: ARRANGEMENT FOR COOLING RECIRCULATED EXHAUST GASES AT A COMBUSTION ENGINE

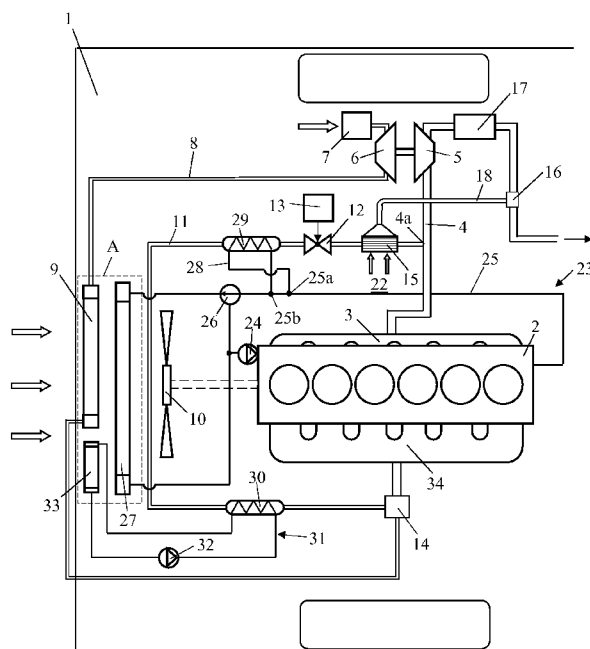


Fig 1

(57) Abstract: The present invention relates to an arrangement for cooling of recirculating exhaust gases of a combustion engine (2). The arrangement comprises a first EGR cooler (15) in which the exhaust gases in the return line (11) are intended to undergo a first step of cooling, and at least a second EGR cooler (29) in which the exhaust gases in the return line (11) are intended to undergo a second step of cooling. The arrangement comprises an ejector pump device (16) situated in the exhaust line (4) and an air line (18) which extends between the first EGR cooler (15) and the ejector pump device (16). The ejector pump device (16) is adapted to drawing air through the EGR cooler (15) and the air line (18) to the exhaust line (4) by means of the exhaust gases which flow through the ejector pump device (16).



Published:

— *with international search report (Art. 21(3))*

Arrangement for cooling of recirculated exhaust gases at a combustion engine**5 BACKGROUND TO THE INVENTION, AND STATE OF THE ART**

The present invention relates to an arrangement for cooling of recirculating exhaust gases of a combustion engine according to the preamble of claim 1.

10 The technique called EGR (exhaust gas recirculation) is a known way of recirculating part of the exhaust gases in an exhaust line of a combustion engine. The recirculating exhaust gases are led through a return line and mixed with inlet air for the combustion engine before the mixture is led to the cylinders of the combustion engine. Adding exhaust gases to the air causes a lower combustion temperature resulting inter alia in a reduced content of nitrogen
15 oxides NO_x in the exhaust gases. This technique is used both for Otto engines and for diesel engines.

The amount of exhaust gases which can be supplied to a combustion engine depends on the pressure and temperature of the exhaust gases. Supplying as large an amount of exhaust
20 gases to the combustion engine as possible entails effective cooling of the exhaust gases before they are led to the combustion engine. A known practice is to cool the recirculating exhaust gases in one or more EGR coolers before they are led to the combustion engine. The recirculating exhaust gases may in that case undergo a first step of cooling in an EGR cooler which is cooled by coolant from the combustion engine's cooling system and a second step of
25 cooling in an EGR cooler which is cooled by coolant from a low-temperature cooling system. The exhaust gases may thus be cooled to a temperature close to the temperature of the surroundings.

During operation of the combustion engine, the exhaust gases will be at a temperature
30 ranging from 150°C to 600°C. The temperature of the recirculating exhaust gases will be highest when the combustion engine is under great load. In cases where the combustion engine's cooling system is used for cooling the recirculating exhaust gases, the cooling system will thus be subject to high load peaks at times when the combustion engine is under great load. In heavy vehicles, the combustion engine's cooling system is commonly used

also for other cooling requirements in the vehicle, e.g. cooling the oil of a hydraulic retarder. It is therefore desirable to reduce the load on the combustion engine's cooling system.

SUMMARY OF THE INVENTION

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The object of the present invention is to provide an arrangement for cooling of recirculating exhaust gases whereby the recirculating exhaust gases can be subjected to a first step of cooling in a relatively simple but functional first EGR cooler.

10 This object is achieved with the arrangement of the kind mentioned in the introduction which is characterised by the features indicated in the characterising part of claim 1. The exhaust gases led out from a combustion engine in an exhaust line have kinetic energy and pressure energy. According to the invention, an ejector pump device is applied in a suitable portion of the exhaust line. Such an ejector pump device can be used, when the exhaust gases are
15 flowing through it, to create a suction force which draws air into the exhaust line from an air line and the first EGR cooler. With such a cooling airflow, the first EGR cooler can effect good cooling of the exhaust gases. The load on the second EGR cooler which subjects the exhaust gases to a second step of cooling is thereby markedly reduced. The first EGR cooler thus need not be provided with any energy-demanding fan or similar component to achieve a
20 cooling airflow through the EGR cooler. The first EGR cooler may therefore be of relatively simple construction.

According to a preferred embodiment of the present invention, the ejector pump device comprises a converging nozzle with an outlet aperture which has a smaller cross-sectional
25 area than the cross-sectional area in the exhaust line upstream of the nozzle, and the air line has an outlet aperture situated in the exhaust line at a location radially external to the outlet aperture of the nozzle. Such a converging nozzle provides the exhaust gases with a narrowing flow passage resulting in a correspondingly increased velocity. The exhaust gases are led out from the outlet aperture of the nozzle at high velocity, thereby creating low
30 pressure in a region round the outlet aperture of the nozzle. As the air line has an outlet aperture close to this low-pressure region, an ample amount of air is drawn into the exhaust line from the air line. When air is drawn into the exhaust line from the air line, the result is a corresponding airflow through the first EGR cooler, which airflow cools the exhaust gases in the EGR cooler. The ejector pump device comprises with advantage a converging portion

with a decreasing cross-sectional area which is situated downstream of the outlet aperture of the nozzle with respect to the intended direction of exhaust gas flow in the exhaust line. The air drawn into the exhaust line thus acquires an increased velocity downstream of the nozzle, thereby further increasing the capacity of the ejector pump device for drawing air into the exhaust line and hence the air flow which passes through the first EGR cooler.

According to a preferred embodiment of the present invention, the first EGR cooler comprises a plurality of parallel exhaust ducts which lead the recirculating exhaust gases through the EGR cooler and a plurality of parallel air ducts which lead air through the EGR cooler. The ducts may be defined by pipelines with external surfaces which are with advantage planar so that optimum contact surfaces can be provided between the pipelines which convey the exhaust gases and the pipelines which convey the air. The exhaust gases may be led in the exhaust ducts in the EGR cooler in a first direction and the air may be led in the EGR cooler in the air ducts in a second direction which is perpendicular to the first direction. The EGR cooler may also be so constructed that air and exhaust gases are led in opposite directions through the EGR cooler or in the same direction. Each exhaust duct and/or air duct of the first EGR cooler may comprise thermally conducting elements which increase the heat-absorbing surface within the respective ducts. Such thermally conducting elements may take the form of folded metal plates, so-called ranks, which divide the duct into a plurality of parallel flow passages. The result is a larger contact surface between the exhaust gases and the pipeline which defines the exhaust duct and/or between the air and the pipeline which defines the air duct. The presence of such thermally conducting elements results in a more effective heat exchange between the air and the exhaust gases in the first EGR cooler.

According to an embodiment of the present invention, the EGR cooler comprises an inlet aperture adapted to drawing air into the EGR cooler from a region situated in the immediate vicinity of the EGR cooler. The return line for recirculation of exhaust gases has normally a main extent close to the combustion engine. The first EGR cooler is therefore normally also located in the vicinity of the combustion engine, in which case air will thus be drawn into the EGR cooler from a region in the engine space close to the combustion engine. The air will here normally be at a temperature which is definitely higher than that of surrounding air but definitely lower than the temperature of the exhaust gases. This air is therefore usable with good results for subjecting the exhaust gases to a first step of cooling in the first EGR cooler.

According to an alternative embodiment, the EGR cooler comprises an air line which has an extent between the first EGR cooler and an air inlet which is adapted to drawing air in from a region situated at a distance from the EGR cooler. Such an air line may run to a region where there is good access to cold air, in which case air at a significantly lower temperature can be used for subjecting the exhaust gases to the first step of cooling, thereby further improving the cooling of the exhaust gases in the first EGR cooler.

According to another embodiment of the invention, the recirculating exhaust gases are intended to be subjected in the second EGR cooler to a second step of cooling by coolant from the combustion engine's cooling system. The cooling system which cools the combustion engine is an already existing cooling system which is also used with advantage for cooling the recirculating exhaust gases. During normal operation, the coolant in the combustion engine's cooling system will be at a temperature of 80-100°C. It is therefore possible to use the coolant in the combustion engine's cooling system for cooling the recirculating exhaust gases to a similar temperature. As the recirculating exhaust gases will have already undergone a first step of cooling in the first EGR cooler, the result in this case is a relatively moderate load on the combustion engine's cooling system. As the primary purpose of this cooling system is to cool the combustion engine, it should not be subjected to too much loading with other cooling functions which might result in impairment of the cooling of the combustion engine.

According to another preferred embodiment of the invention, the arrangement comprises a third EGR cooler in which the recirculating exhaust gases are intended to be subjected to a third step of cooling by a medium which will during normal operation of the combustion engine be at a lower temperature than the coolant in the combustion engine's cooling system. As the coolant in the combustion engine's cooling system has an operating temperature of 80-100°C, the exhaust gases can only be cooled to a temperature close to the coolant's temperature in the second EGR cooler. It is often desirable to cool the exhaust gases to a lower temperature. To this end, the recirculating exhaust gases may be cooled in a third EGR cooler by, for example, coolant in a low-temperature cooling system in which the coolant is at a lower temperature than the coolant in the combustion engine's cooling system. Such a low-temperature cooling system may comprise a radiator element in which the coolant in the cooling system is cooled by air at the temperature of the surroundings. The coolant in the low-temperature cooling system may thus acquire a temperature close to the temperature of

the surroundings. The exhaust gases can therefore be cooled to a relatively low temperature before they are mixed with air and led to the combustion engine. Alternatively, the exhaust gases may be subjected to a third step of cooling in a third EGR cooler which is air-cooled, in which case the recirculating exhaust gases are with advantage cooled by air at the

temperature of the surroundings.

According to another preferred embodiment of the invention, the exhaust line comprises a turbine and the return line receives exhaust gases from the exhaust line at a location upstream of the turbine with respect to the direction of exhaust gas flow in the exhaust line. Such a turbine may form part of a turbo unit which also comprises a compressor which compresses air which is led to the combustion engine. To facilitate the mixing of the recirculating exhaust gases with the compressed air, it is advantageous to recirculate exhaust gases from the exhaust line before they expand in the turbine.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention are described below by way of examples with reference to the attached drawings, in which:

Fig. 1 depicts an arrangement for cooling of recirculating exhaust gases of a diesel engine according to a first embodiment of the invention,

Fig. 2 depicts the ejector pump device in Fig. 1 in more detail,

Fig. 3 depicts the first EGR cooler in Fig. 1 in more detail and

Fig. 4 depicts an arrangement for cooling of recirculating exhaust gases of a diesel engine according to a second embodiment of the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

Fig. 1 depicts a combustion engine adapted to powering a schematically depicted vehicle 1.

The combustion engine is here exemplified as a diesel engine 2. The diesel engine 2 may be intended to power a heavy vehicle 1. The exhaust gases from the cylinders of the diesel engine 2 are led via an exhaust manifold 3 to an exhaust line 4. The exhaust gases in the exhaust line 4, which will be at above atmospheric pressure, are led to a turbine 5 of a turbo unit. The turbine 5 is thus provided with driving force which is transferred, via a connection,

to a compressor 6 of the turbo unit. The compressor 6 draws in and compresses air which is led into an inlet line 8 via an air filter 7. A charge air cooler 9 is provided in the inlet line 8. The purpose of the charge air cooler 9 is to cool the compressed air before it is led to the diesel engine 2. The compressed air is cooled in the charge air cooler 9 by surrounding air which is forced through the charge air cooler 9 by a radiator fan 10. The radiator fan 10 is driven by the diesel engine 2 via a suitable connection.

A return line 11 for recirculation of part of the exhaust gases in the exhaust line 4 has an extent between the exhaust line 4 and the inlet line 8 for the air which is led to the diesel engine 2. The return line 11 is connected to the exhaust line 4 at a location 4a upstream of the turbine 5. The exhaust gases will here be at high pressure and high temperature. The return line 11 comprises an EGR valve 12 by which the exhaust flow in the return line 11 can be shut off. The EGR valve 12 may also be used for steplessly controlling the amount of exhaust gases which are led to the diesel engine 2. A control unit 13 is adapted to controlling the EGR valve 12 on the basis of information about the current operating state of the diesel engine 2. The control unit 13 may be a computer unit provided with suitable software. The recirculating exhaust gases in the return line 11 are mixed with the compressed air in the inlet line 8 by a mixing device 14. In certain operating situations, the pressure of the exhaust gases in the exhaust line 4 of supercharged diesel engines 2 will be lower than the pressure of the compressed air in the inlet line 8. In such operating situations it is not possible to mix the exhaust gases in the return line 11 directly with the compressed air in the inlet line 8 without special auxiliary means. To this end it is possible to use, for example, a turbo unit with variable geometry. If the combustion engine is instead a supercharged Otto engine, the exhaust gases in the return line 11 can be led directly into the inlet line 8, since the exhaust gases in the exhaust line 4 of an Otto engine will in substantially all operating situations be at a higher pressure than the compressed air in the inlet line 8.

An arrangement for cooling the recirculating exhaust gases comprises a first EGR cooler 15 in which the recirculating exhaust gases undergo a first step of cooling in the return line 11. The first EGR cooler 15 is air-cooled. Airflow through the first EGR cooler 15 is provided by using an ejector pump device 16 applied in the exhaust line 4 at a location downstream of the turbine 5 and downstream of a silencer 17. The silencer 17 may also comprise a catalyst and a particle filter for cleaning the exhaust gases. An air line 18 connects the first EGR cooler 15 to the ejector pump device 16. In this case, air is drawn into the first EGR cooler 15 from a region 22 situated in the engine space close to the diesel engine 2.

The diesel engine 2 is cooled in a conventional manner by a cooling system 23 with a circulating coolant. A coolant pump 24 circulates the coolant in the cooling system 23. After the coolant has circulated through the diesel engine 2, it is led in a line 25 to a thermostat 26.

5 In situations where the coolant has reached a normal operating temperature, the thermostat 26 is adapted to leading the coolant to a radiator element 27 fitted in the region A in the vehicle at a location behind the charge air cooler 9. Part of the coolant in the line 25 is led into a line circuit 28 at a location 25a of the line 25. The coolant in the line circuit 28 is led through a second EGR cooler 29 in which the coolant subjects the recirculating exhaust gases in the
10 return line 11 to a second step of cooling. The coolant is thereafter led back to the line 25 at a location 25b situated downstream of the location 25a with respect to the intended direction of coolant flow in the line 25.

The recirculating exhaust gases proceed in the return line 11 to a third EGR cooler 30 in
15 which they are subjected to a third step of cooling by the coolant in a low-temperature cooling system 31. The low-temperature cooling system 31 contains a circulating coolant which will during operation of the diesel engine 2 be at a lower temperature than the coolant in the diesel engine's cooling system 23. A coolant pump 32 circulates the coolant in the low-temperature cooling system 31. The low-temperature cooling system 31 comprises a
20 radiator element 33 situated in a region A of the vehicle 1 at a location in front of the radiator 27. After the cooling in the three EGR coolers 15, 29, 30 the recirculating exhaust gases are led to the mixing device 14, in which they are mixed with the compressed air in the inlet line 8. Thereafter the mixture of air and exhaust gases is led to the respective cylinders of the diesel engine 2 via a manifold 34.

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Fig. 2 depicts the ejector pump device 16 in more detail. Upstream and downstream of the ejector pump device 16 the exhaust line 4 has a substantially constant internal cross-sectional area A_1 . The ejector pump device 16 comprises a nozzle 16a which defines a progressively decreasing cross-section for the exhaust gases when they flow through the ejector pump
30 device 16. The nozzle 16a has an outlet aperture 16a' for the exhaust gases which has a cross-sectional area A_2 which is considerably smaller than the cross-sectional area A_1 of the exhaust line upstream of the ejector pump device 16. The air line 18 is connected to the ejector pump device 16 via an outlet aperture 18a situated at a location radially external to the nozzle's outlet aperture 16a'. The outlet aperture 18a leads to a low-pressure region 16b of

the ejector pump device 16. The ejector pump device 16 comprises at a location downstream of the nozzle 16a a converging portion 16c with a cross-sectional area A_3 which decreases in the exhaust gas flow direction. The ejector pump device 16 comprises finally a diverging portion 16d with an increasing cross-sectional area A_4 in the exhaust gas flow direction.

5 Downstream of the diverging portion 16d the exhaust line 4 reverts to its original internal cross-sectional area A_1 .

Fig. 3 depicts the first EGR cooler 15 in more detail. When the recirculating exhaust gases reach the first EGR cooler 15, the return line 11 splits into a plurality of mutually parallel
10 exhaust ducts 19 which extend through the first EGR cooler 15. In this case the EGR cooler 15 comprises nine such exhaust ducts 19 situated in three planes with three exhaust ducts 19 in each plane. The exhaust ducts 19 are defined by pipelines which have a rectangular cross-section. The EGR cooler 15 comprises air ducts 20 which extend between the planes of exhaust ducts 19. The air ducts 20 are likewise defined by pipelines with a rectangular cross-
15 section. The pipelines which define the exhaust ducts 19 abut by relatively large planar contact surfaces against the pipelines which define the air ducts 20. The result is good heat transfer in the EGR cooler 15 between the exhaust gases in the exhaust ducts 19 and the air in the air ducts 20. The air is drawn into the air ducts 20 via inlet apertures 20a before it is led through the EGR cooler 15 in a direction perpendicular to the exhaust gas flow direction in
20 the exhaust ducts 19. The air which has passed through the EGR cooler 15 is gathered together in a gathering portion 18b before it is led into the air line 18 which leads the air to the ejector pump device 16. The air ducts 20 comprise folded metal plates 21 which divide the air ducts 20 into a large number of parallel flow passages. The metal plates may be made of aluminium. The metal plates 21 provide an extra contact surface in the air ducts 20,
25 thereby increasing the heat exchange between the air in the air ducts 20 and the exhaust gases in the exhaust ducts 19. The shape of the metal plates 21 may also be such as to promote turbulent flow of the air in the air ducts 20. Such flow increases further the heat exchange between the air and the exhaust gases in the first EGR cooler 15.

30 During operation of the diesel engine 2, exhaust gases flow out from the diesel engine 2 and into the exhaust line 4. During most operating states of the diesel engine 2, the control unit 13 will keep the EGR valve 12 open so that part of the exhaust gases in the exhaust line 4 are led into the return line 11. The exhaust gases led into the return line 11 will usually be at a temperature within the range 150°C - 600°C depending on the diesel engine's operating state.

The exhaust gases in the exhaust line 4 which reach the ejector pump device 16 acquire an increased velocity when they flow through the nozzle 16a, which thus defines a flow passage with a decreasing cross-sectional area. The exhaust gases therefore spray out through the nozzle's outlet aperture 16a' at high velocity, resulting in low static pressure in the low-
5 pressure region 16b situated round the exhaust flow. The low pressure in the low-pressure region 16b causes air to be drawn into the low-pressure region 16b from the air line 18, which has an outlet aperture 18a at a location radially external to the nozzle's outlet aperture 16a'. The air drawn into the low-pressure region 16b is carried by the exhaust flow into the converging portion 16c of the ejector pump device 16. In the converging portion 16c the air
10 acquires a velocity increase. The velocity increase in the converging portion 16c increases further the capacity of the ejector pump device 16 for drawing air into the exhaust line 4 and hence also the capacity for drawing air through the EGR cooler 15. The velocity of the exhaust gases and the air decreases thereafter in the diverging portion 16d of the ejector pump device 16. Thereafter the mixture of exhaust gases and air leaves the ejector pump
15 device 16 and is led back into the ordinary exhaust line 4, which has the cross-sectional area A_1 . The recirculating exhaust gases in the return line 11 are thus subjected to a first step of cooling in the first EGR cooler 15 by air which is drawn in from the engine space 22 by the ejector pump device 16 in the exhaust line 4. The recirculating exhaust gases may for example be cooled to a temperature within the range 150°C - 200°C when they leave the first
20 EGR cooler 15.

The recirculating exhaust gases are thereafter led to the second EGR cooler 29, in which they are cooled by coolant from the diesel engine's cooling system 23. The coolant will here normally be at a temperature within the range 80°C - 100°C. The recirculating exhaust gases
25 may thus be cooled to a temperature of about 100°C - 120°C in the second EGR cooler 29. The recirculating exhaust gases are led finally to the third EGR cooler 30, in which they are subjected to the third step of cooling by coolant from the low-temperature cooling system 31. The radiator element 33 in the low-temperature cooling system 31 is cooled by air at the temperature of the surroundings which is forced through the radiator element 33 by the
30 radiator fan 10. The coolant in the low-temperature cooling system may thus be at a temperature close to the temperature of the surroundings when it is led into the third EGR cooler 30. The third step of cooling may therefore cool the recirculating exhaust gases to a relatively low temperature in the third EGR cooler 30 before they are mixed with the

compressed air, which will with advantage have been cooled to a similar temperature in the charge air cooler 9, before the mixture of exhaust gases and air is led to the diesel engine 2.

In operating situations where the diesel engine 2 is under great load, it will need good cooling. The exhaust gases will also be at high temperature in such situations. The initial cooling of the recirculating exhaust gases by the first EGR cooler 15 reduces the temperature of the exhaust gases substantially before they are led to the second EGR cooler 29, in which they are subjected to a second step of cooling by the coolant in the diesel engine's cooling system 23. With such a first EGR cooler 15 the load on the diesel engine's cooling system 23 can be considerably reduced.

Fig. 4 depicts an alternative embodiment of the arrangement for cooling the recirculating exhaust gases. In this case an air line 35 is used to lead air into the first EGR cooler 15. The air line 35 comprises an inlet aperture 35a situated in a region 22a which is at a distance from the first EGR cooler 15 and which has good access to cold air. In this case air is thus drawn via the air line 35 from the region 22a to the first EGR cooler 15, in which it cools the recirculating exhaust gases. The air is thereafter led via the air line 18 to the ejector pump device 16 and out in the exhaust line 4. Taking air from a region 22a which contains relatively cold air makes it possible for the exhaust gases to undergo further improved cooling in the first EGR cooler. This embodiment uses a third EGR cooler 36 which is air-cooled. The third EGR cooler 36 is situated in the region A alongside the charge air cooler 9 and in front of the radiator element 27. The third EGR cooler 36 therefore has air at the temperature of the surroundings flowing through it. The recirculating exhaust gases can thus be subjected to a third step of cooling in the third EGR cooler 36 to a temperature close to the temperature of the surroundings before they mix with the compressed air and are led to the diesel engine 2. In other respects the embodiment in Fig. 4 corresponds to the embodiment in Fig. 1.

The invention is in no way limited to the embodiments described above but may be varied freely within the scopes of the claims. The recirculating exhaust gases therefore need not necessarily be subjected to three steps of cooling but may be cooled in two stages, a first being the cooling of the recirculating exhaust gases in the first EGR cooler 15.

Claims

1. An arrangement for cooling of recirculating exhaust gases of a combustion engine (2), which combustion engine comprises an exhaust line (4) intended to lead exhaust gases out
5 from the combustion engine (2) and a return line (11) adapted to recirculating part of the exhaust gases in the exhaust line (4) to the combustion engine (2), which arrangement comprises a first EGR cooler (15) in which the exhaust gases in the return line (11) are intended to undergo a first step of cooling, and at least a second EGR cooler (29) in which the exhaust gases in the return line (11) are intended to undergo a second step of cooling,
10 characterised in that the arrangement comprises an ejector pump device (16) situated in the exhaust line (4) and an air line (18) which extends between the first EGR cooler (15) and the ejector pump device (16), which ejector pump device (16) is adapted to drawing air through the EGR cooler (15) and the air line (18) to the exhaust line (4) by means of the exhaust gases which flow through the ejector pump device (16).
- 15
2. An arrangement according to claim 1, characterised in that the ejector pump device (16) comprises a converging nozzle (16a) with an outlet aperture (16a') which has a smaller cross-sectional area (A_2) than the cross-sectional area (A_1) in the exhaust line (4) upstream of the nozzle (16a), and that the air line (18) has an outlet aperture (18a) in the exhaust line (4) at a
20 location radially external to the outlet aperture of the nozzle (16a').
3. An arrangement according to claim 2, characterised in that the ejector pump device (16) comprises a converging portion (16c) with a decreasing cross-sectional area (A_3) which is situated downstream of the outlet aperture of the nozzle (16a') with respect to the intended
25 direction of exhaust gas flow in the exhaust line (4).
4. An arrangement according to claim 1, characterised in that the first EGR cooler (15) comprises a number of parallel exhaust ducts (19) which lead the recirculating exhaust gases through the EGR cooler (15) and a number of parallel air ducts (20) which lead air through
30 the EGR cooler (15).
5. An arrangement according to claim 4, characterised in that each exhaust gas duct (19) and/or air duct (20) of the first EGR cooler (15) comprises thermally conducting elements (21) which increase the heat-absorbing surface within the respective ducts (19, 20).

6. An arrangement according to claim 5, characterised in that the EGR cooler (15) comprises an inlet aperture (20a) adapted to drawing air into the EGR cooler (15) from a region (22) situated in the immediate vicinity of the EGR cooler (15).
- 5 7. An arrangement according to any one of the foregoing claims, characterised in that the EGR cooler (15) comprises an air line (35) which has an extent between the first EGR cooler (15) and an air inlet (35a) which is adapted to drawing air in from a region (22a) which is at a distance from the EGR cooler (15).
- 10 8. An arrangement according to claim 7, characterised in that the recirculating exhaust gases are intended to be subjected to a second step of cooling in the second EGR cooler (29) by coolant from the combustion engine's cooling system (14).
- 15 9. An arrangement according to claim 8, characterised in that the arrangement comprises a third EGR cooler (33, 36) in which the recirculating exhaust gases are intended to be subjected to a third step of cooling by a medium which during normal operation of the combustion engine is at a lower temperature than the coolant in the combustion engine's cooling system (14).
- 20 10. An arrangement according to any one of the foregoing claims, characterised in that the exhaust line (4) comprises a turbine (5) and that the return line (11) receives exhaust gases from the exhaust line (4) at a location upstream of the turbine (5) with respect to the direction of exhaust gas flow in the exhaust line (4).

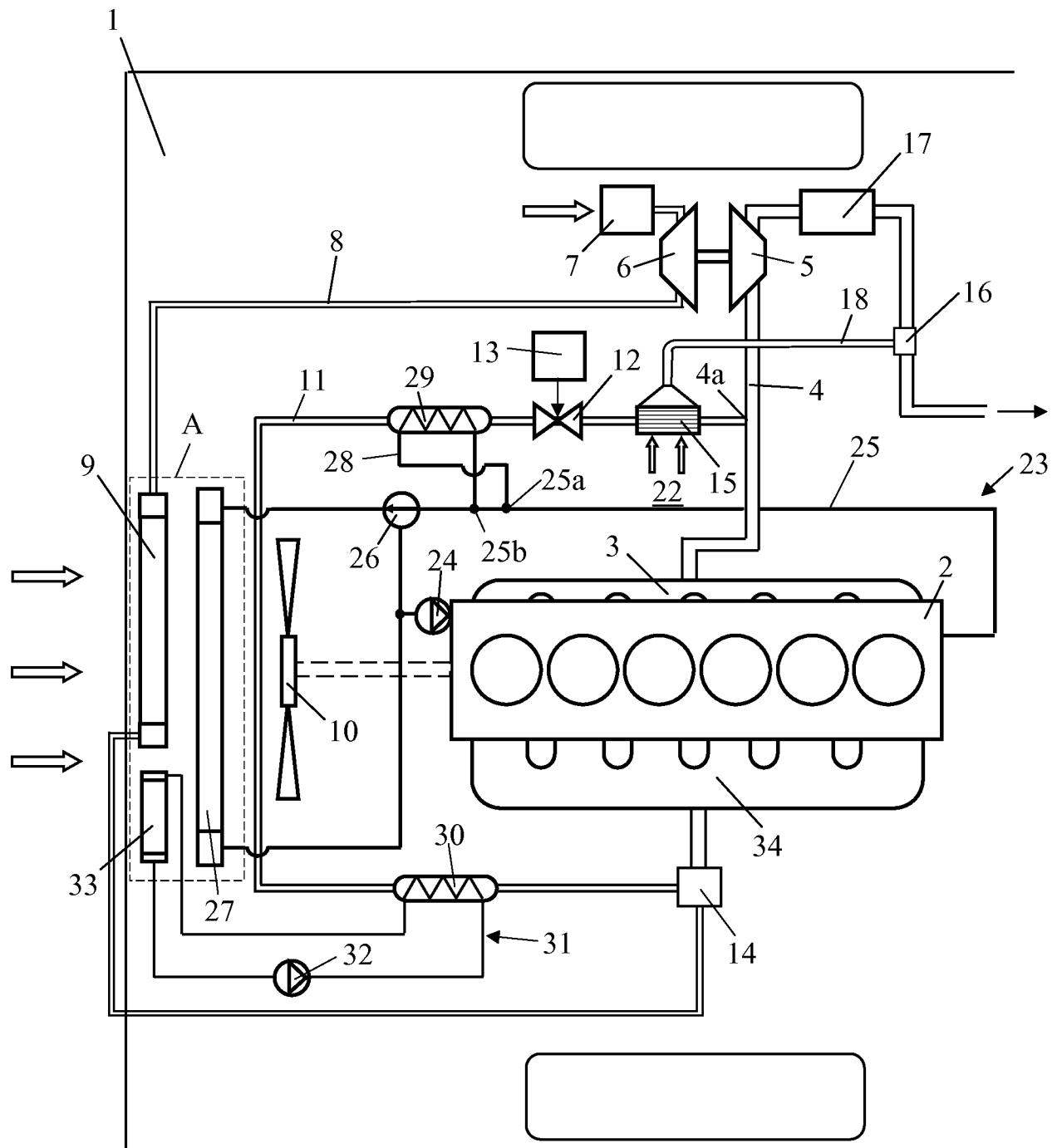


Fig 1

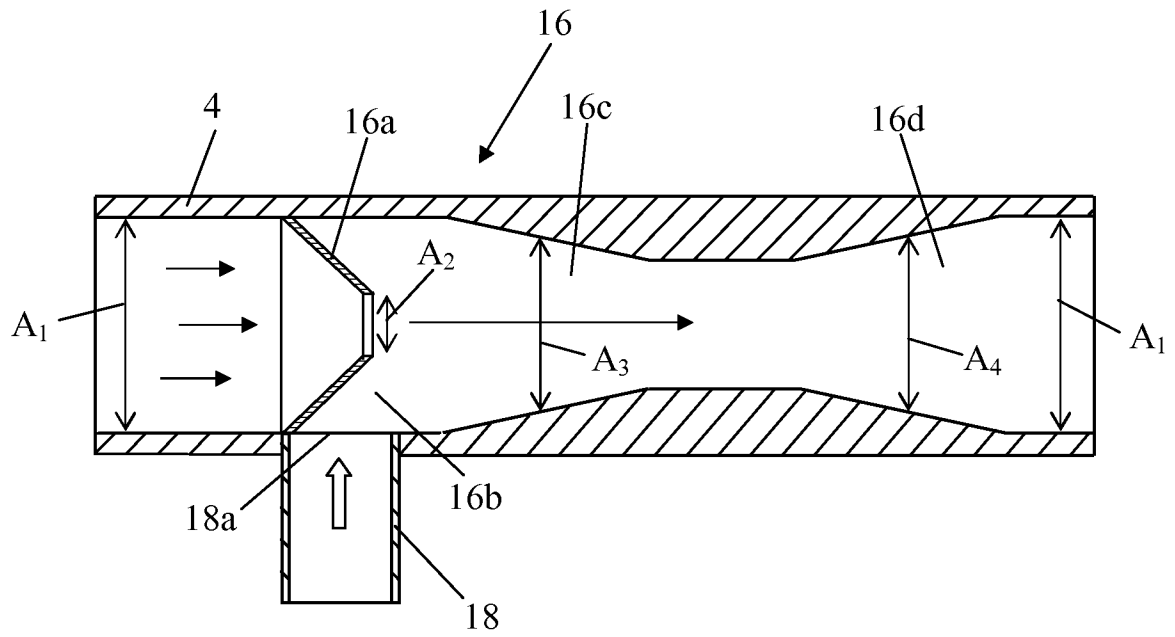


Fig 2

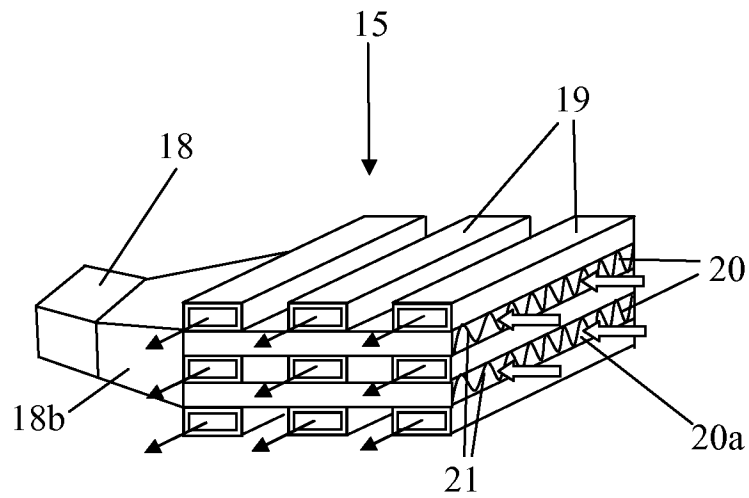


Fig 3

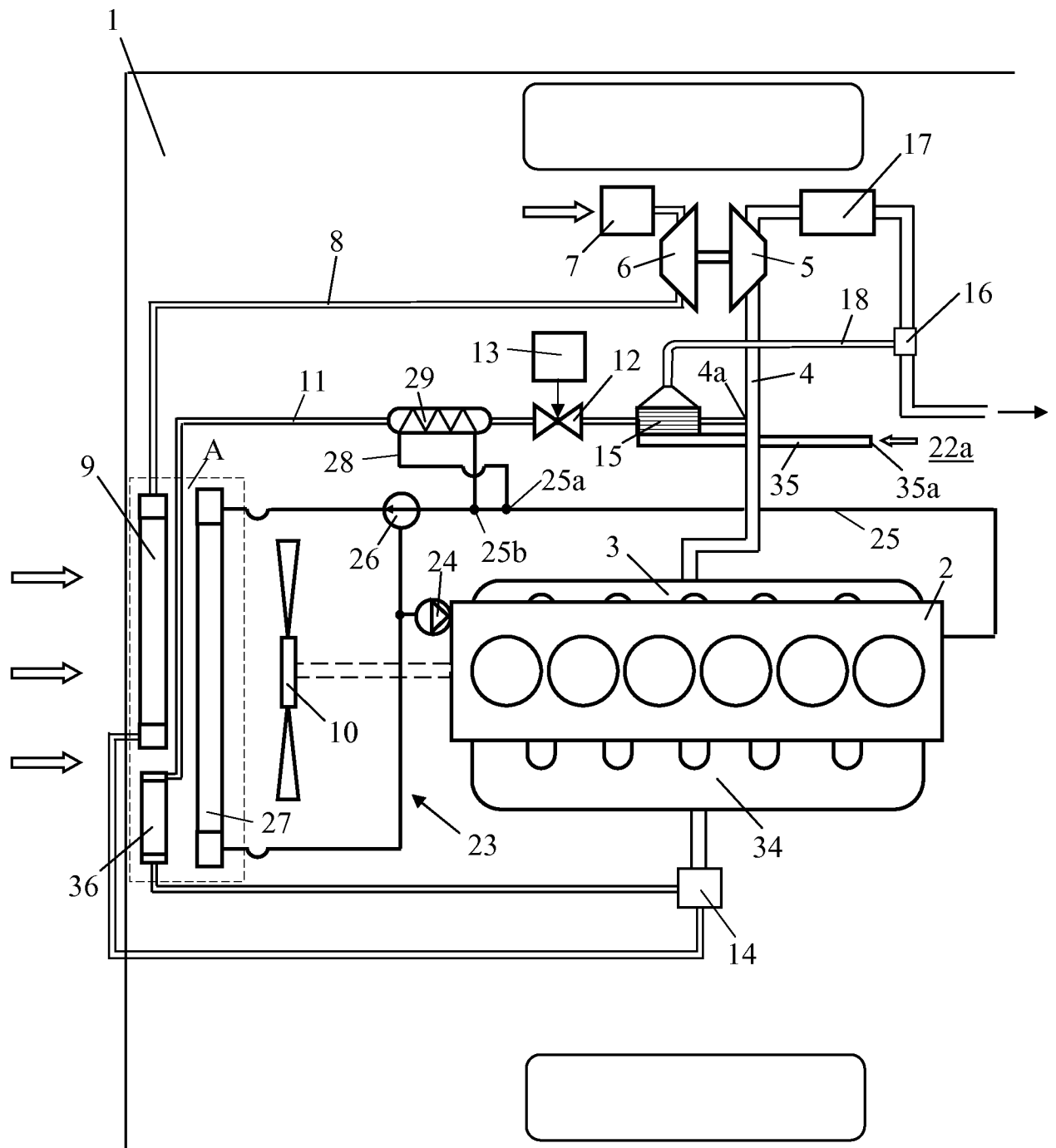


Fig 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2009/051358

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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)

IPC: F02M, F01P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2007055644 A1 (SCANIA CV AB), 18 May 2007 (18.05.2007), page 8, line 1 - line 30, figure 2, abstract --	1-8,10
A	US 20080264609 A1 (R. LUTZ ET AL), 30 October 2008 (30.10.2008), figure 15 --	8-9
Y	US 20070039321 A1 (A.D. SHEIDLER ET AL), 22 February 2007 (22.02.2007), figure 1, abstract, paragraph (0002) --	1-8,10

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

15 February 2010

Date of mailing of the international search report

17 -03- 2010

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2009/051358

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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Y	US 20070039322 A1 (C.A. BERING ET AL), 22 February 2007 (22.02.2007), figures 1-2, abstract, paragraph (0007) --	1-8,10
A	DE 818590 C (KLÖCKNER-HUMBOLDT-DEUTZ A.G.), 25 October 1951 (25.10.1951), page 2, line 4 - line 20 --	1-3
A	US 20070204614 A1 (J.A. KOLB), 6 Sept 2007 (06.09.2007), figure 5 --	4-5
A	US 4557226 A (A. MAYER ET AL), 10 December 1985 (10.12.1985), figures 4-5, abstract --	1-3
A	GB 1065206 A (ROLLS-ROYCE LIMITED), 12 April 1967 (12.04.1967), figures 1-2, claim 1 --	1-3
A	US 6244256 B1 (J.C. WALL ET AL), 12 June 2001 (12.06.2001), column 4, line 26 - line 54, figure 2 -- -----	1-10

International patent classification (IPC)**F02M 25/07** (2006.01)**F01P 5/08** (2006.01)**Download your patent documents at www.prv.se**

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