(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
25 August 2011 (25.08.2011)

PCT

(10) International Publication Number
WO 2011/102959 A2

(51) International Patent Classification:
F02B 37/00 (2006.01) *F02B 39/00* (2006.01)
F02M 25/07 (2006.01)

(21) International Application Number:
PCT/US2011/023295

(22) International Filing Date:
1 February 2011 (01.02.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10 2010 008 299.6
17 February 2010 (17.02.2010) DE

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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, TH, 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, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, 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, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

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— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

— *of inventorship (Rule 4.17(iv))*

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

(54) Title: TURBOCHARGER

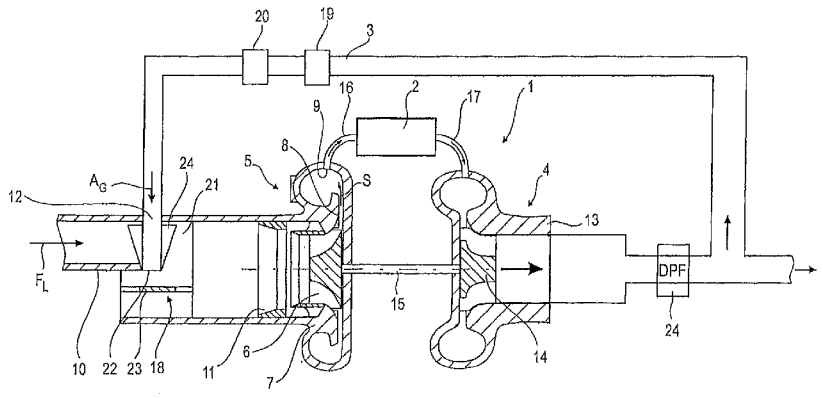

FIG. 1

(57) Abstract: The present invention relates to a turbocharger (1) for an internal combustion engine (2), having at least one low-pressure exhaust-gas recirculation line (3) which opens out via an exhaust-gas mixing-in opening (12) into an intake line (10) of the internal combustion engine (2); having a turbine (4) and having a compressor (5) which is drive-connected to the turbine (4) and which has a compressor wheel (6) which is arranged in a compressor housing (7) into which the intake line (10) opens out via a compressor inlet (11), and having a mixing device (18) for mixing recirculated exhaust gas (A_G) and fresh air (FL), characterized in that the mixing device (18) has an inflow distributor (21) in which the exhaust-gas recirculation line (3), which extends at least substantially along the longitudinal axis (L) thereof, and the intake line (10), which extends at least substantially at right angles to the longitudinal axis (L), open out, and in that, as viewed in the flow direction (R) of the exhaust gases (A_G), an impact plate (23) is provided downstream of an outflow opening (22) of the exhaust-gas recirculation line (3).

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TURBOCHARGER

DESCRIPTION

The invention relates to a turbocharger according to the preamble of claim 1.

A generic turbocharger is known from WO 2008/095658 A1.

Turbochargers of said type are used in internal combustion engines which, in order to meet the legally prescribed exhaust-gas limit values, recirculate large exhaust-gas quantities into the intake path of the engine over a wide operating range. In low-pressure exhaust-gas recirculation (LP-EGR), exhaust gas is supplied to the fresh-air flow upstream of the compressor of the turbocharger. If this mixing is not effective, exhaust-gas-laden strands at elevated temperature are drawn through the compressor.

This non-uniform mixing of the exhaust gas with the fresh air can lead to rotationally asymmetrical depositions of the unburned hydrocarbons and of the soot at one side in the compressor housing. As a result of the single-sided blockage of the diffuser region, consequential damage can then be expected, as a result of the increasing radial thrust, to the compressor wheel as a result of rubbing and to the bearing arrangement as a result of additional radial forces. To make the unavoidable depositions more uniform, therefore, a rotationally symmetrical mixing profile of the compressor supply flow is preferable. This is also the case in particular with regard to a uniform speed profile at the compressor wheel inlet.

It is therefore an object of the present invention to provide a turbocharger for an internal combustion engine according to the preamble of claim 1, which turbocharger overcomes the abovementioned disadvantages and in particular seeks to improve the mixing of the recirculated exhaust gas with the fresh intake air over the shortest possible distance, and to obtain as rotationally symmetrical a mixing profile as possible.

Said object is achieved by means of the features of claim 1.

As a result of the design of the mixing device according to the invention and of the turbocharger according to the invention, it is achieved firstly that the fresh intake air is supplied to the compressor radially via the inflow distributor. Here, the low-pressure exhaust-gas recirculation supply flow runs axially, that is to say in the direction of the longitudinal axis of the inlet distributor. To obtain as rotationally symmetrical and fast a mixture as possible, the jet of the recirculated exhaust gases is directed toward an impact plate. Said impact plate advantageously generates the radial distribution of the low-pressure exhaust-gas recirculation supply flow. Furthermore, it is advantageously obtained that any water droplets present in the recirculated exhaust-

gas flow are reduced in size by the impact plate, which leads to a minimization of droplet impact against the compressor wheel.

Here, tests and analysis carried out within the context of the invention have shown that the arrangement according to the invention generates a uniform and rotationally symmetrical speed and temperature profile already a very short mixing distance downstream of the outlet of the recirculated exhaust gases. Here, the temperature distribution is identical to the mixing field of the exhaust-gas components.

The subclaims relate to advantageous refinements of the invention.

Further details, advantages and features of the invention will emerge from the following description of an exemplary embodiment and from the drawing, in which:

figure 1 shows a schematically highly simplified sectional illustration of a turbocharger according to the invention; and

figure 2 shows a schematically highly simplified diagram showing the principle of a particularly preferred embodiment of the mixing device according to the invention.

The turbocharger 1 illustrated in figure 1 has a turbine 4 with a turbine wheel 14 arranged in a turbine housing 13. Said turbine wheel 14 is connected via a rotor shaft 15 to a compressor wheel 6, which is arranged in a compressor housing 7, of a compressor 5.

An exhaust-gas recirculation line 3 from an engine 2 leads preferably via a regulating valve 19 and a cooler 20 into an intake line 10 of the engine 2 through an exhaust-gas mixing-in opening 12. In the intake line 10, a mixing device 18 is arranged upstream of the compressor inlet 11.

Also illustrated are a supply line 16 from the compressor inlet 9 to the engine 2, and an exhaust-gas line 17 from the engine 2 to the turbine housing 13.

As a result of this arrangement according to the invention of the exhaust-gas recirculation line 3, the exhaust gas A_G is conducted through the exhaust-gas mixing-in opening 12 into the intake line 10. Here, the exhaust gas A_G impinges on the fresh air F_L, which is then mixed together in the flow direction of the fresh air F_L through the mixing device 18. After the virtually complete mixing of the two mass flows, the mixture flows through the compressor inlet 11 into the diffuser 8.

As can be seen from a juxtaposition of figures 1 and 2, the mixing device 18 according to the invention has an inflow distributor 21 in which firstly the intake line 10 for the supply of fresh air F_L opens out and into which secondly the exhaust-gas recirculation line 3 is conducted. As can be seen in particular from the illustration of figure 2, the two lines 3 and 10 are at least substantially at right angles to one another, preferably at an angle of exactly 90°. Said arrangement results in a radial introduction

of fresh air F_L, and an introduction of exhaust gas at least substantially along the longitudinal axis L of the inflow distributor 21.

In the particularly preferred embodiment illustrated in figure 2, a guide cone 24 is arranged in the inflow distributor 21, which guide cone 24 tapers, proceeding from its inlet 25, in the flow direction R of the exhaust gases A_G. The exhaust-gas recirculation line 3 opens out into said guide cone 24, which exhaust-gas recirculation line 3 has an outflow opening 22 at its end. An impact plate 23 is provided downstream of said outflow opening 22 as viewed in the flow direction R of the exhaust gases A_G, toward which impact plate the supplied exhaust-gas flow A_G is conducted. Here, the impact plate 23 can be fixed in a suitable way for example in a pipe connector 26 which adjoins the inflow distributor 21, or in the inflow distributor 21 itself.

As explained in the introduction, said arrangement yields the advantage that the impact plate 23 effects the radial distribution of the supplied exhaust gases A_G and, furthermore, reduces the size of any water droplets present in the recirculated exhaust-gas flow.

To supplement the disclosure, reference is made explicitly to the diagrammatic illustration of the invention in figures 1 and 2.

LIST OF REFERENCE SYMBOLS

1	Turbocharger/exhaust-gas turbocharger
2	Engine
3	Exhaust-gas recirculation line
4	Turbine
5	Compressor
6	Compressor wheel
7	Compressor housing
8	Diffuser
9	Compressor outlet
10	Intake line
11	Compressor inlet
12	Exhaust-gas mixing-in opening
13	Turbine housing
14	Turbine wheel
15	Rotor shaft
16	Supply line
17	Exhaust-gas line
18	Mixing device
19	Regulating valve
20	Cooler
21	Inflow distributor
22	Outflow opening
23	Impact plate
24	Guide cone
25	Inlet
26	Pipe connector
A_G	Exhaust gas
F_L	Fresh air
L	Longitudinal axis
R	Flow direction of the exhaust gases A_G

CLAIMS

1. A turbocharger (1) for an internal combustion engine (2),

- having at least one low-pressure exhaust-gas recirculation line (3) which opens out via an exhaust-gas mixing-in opening (12) into an intake line (10) of the internal combustion engine (2);
- having a turbine (4) and
- having a compressor (5)
  - which is drive-connected to the turbine (4) and
  - which has a compressor wheel (6) which is arranged in a compressor housing (7) into which the intake line (10) opens out via a compressor inlet (11), and
- having a mixing device (18) for mixing recirculated exhaust gas (A_G) and fresh air (FL), characterized
- in that the mixing device (18) has an inflow distributor (21) in which the exhaust-gas recirculation line (3), which extends at least substantially along the longitudinal axis (L) thereof, and the intake line (10), which extends at least substantially at right angles to the longitudinal axis (L), open out, and
- in that, as viewed in the flow direction (R) of the exhaust gases (A_G), an impact plate (23) is provided downstream of an outflow opening (22) of the exhaust-gas recirculation line (3).

2. The turbocharger as claimed in claim 1, characterized in that the mixing device (18) has a guide cone (24) which is arranged in the inflow distributor (21).

3. The turbocharger as claimed in claim 1 or 2, characterized in that the exhaust-gas recirculation line (3) opens out in the guide cone (24).

4. The turbocharger as claimed in one of claims 1 to 3, characterized in that the impact plate (23) is arranged substantially parallel to the flow direction of the fresh air (FL).

5. The turbocharger as claimed in one of claims 1 to 3, characterized in that the impact plate (23) is arranged substantially perpendicular to the flow direction of the fresh air (FL).

6. A mixing device (18) for mixing recirculated exhaust gas (AG) and fresh air (FL) of a turbocharger (1) according to the preamble of claim 1, characterized by

- an inflow distributor (21) in which the supply line (3), which extends at least substantially along the longitudinal axis (L) thereof, and the intake line (10), which extends substantially at right angles to the longitudinal axis (L), open out, and
- by an impact plate (23) which is arranged downstream of an outlet opening (22) of the supply line (3) as viewed in the flow direction (L) of the exhaust gases (AG).

7. The mixing device as claimed in claim 6, characterized by a guide cone (24) which is arranged in the inflow distributor (21).

8. The mixing device as claimed in claim 6 or 7, characterized in that the exhaust-gas recirculation (3) opens out in the guide cone (24).

9. The mixing device as claimed in one of claims 6 to 8, characterized in that the impact plate (23) is arranged substantially parallel to the flow direction of the fresh air (FL).

10. The mixing device as claimed in one of claims 6 to 8, characterized in that the impact plate (23) is arranged substantially perpendicular to the flow direction of the fresh air (FL).

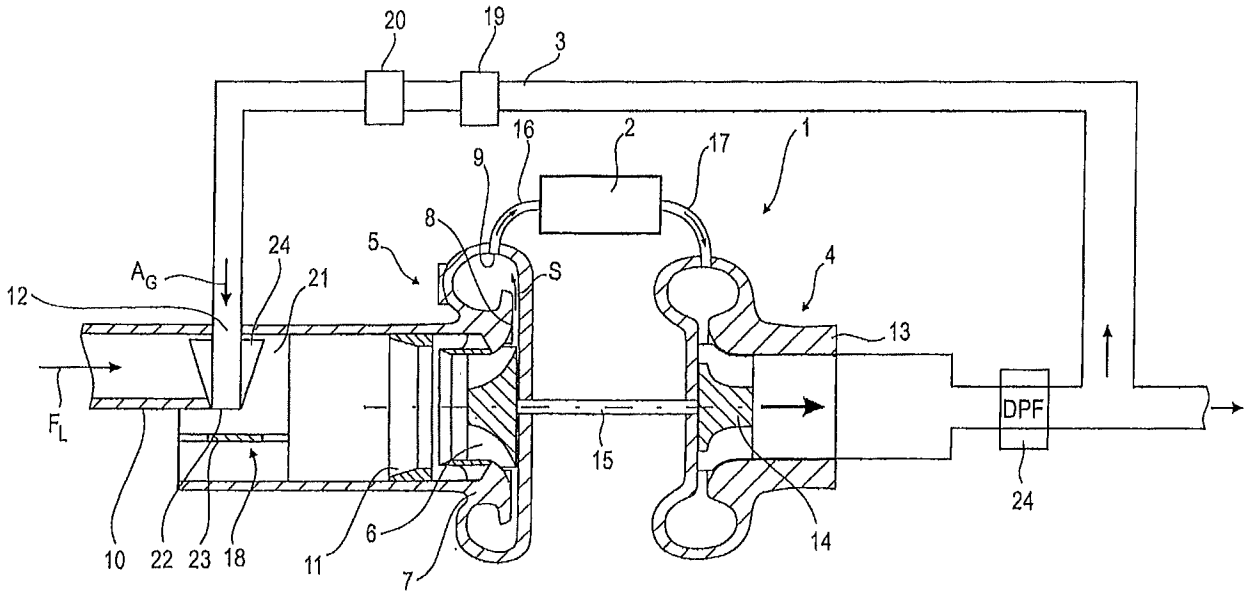

FIG. 1

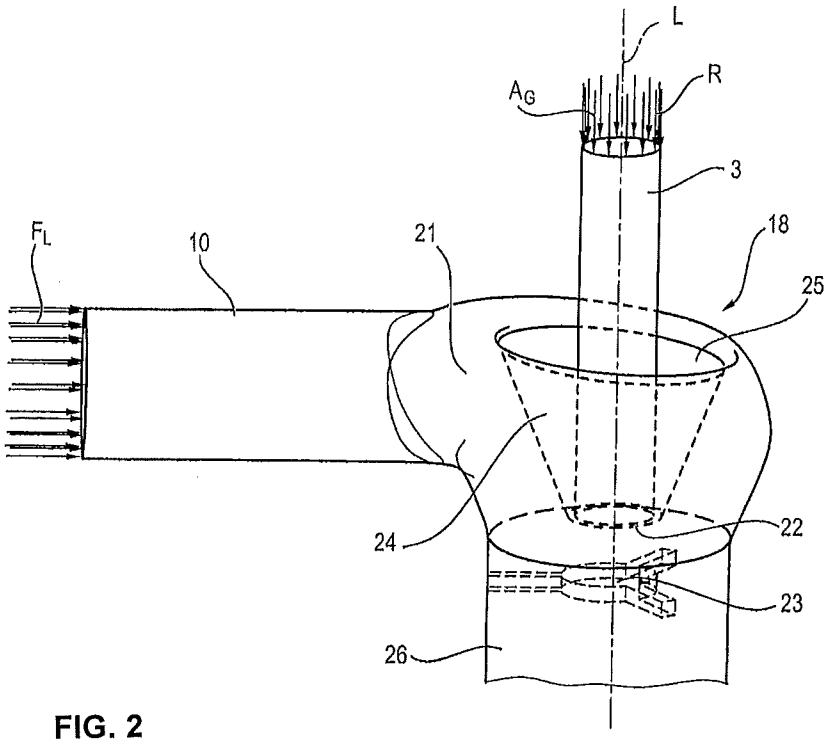

FIG. 2