

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
17 April 2003 (17.04.2003)

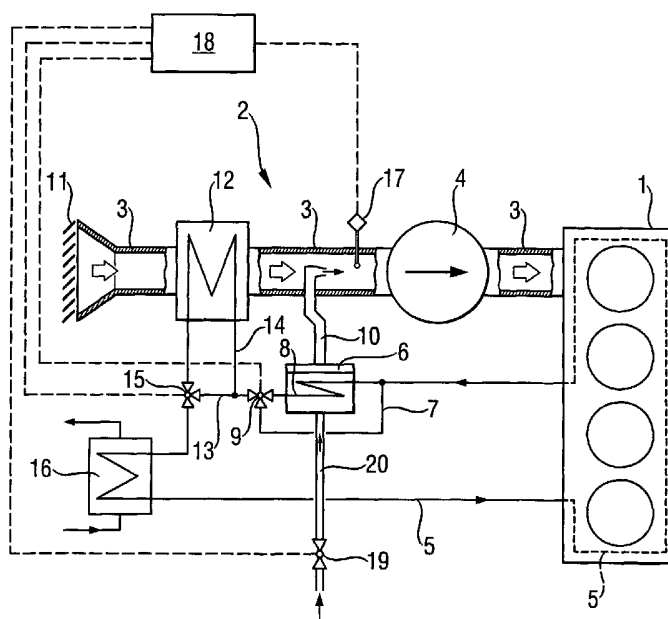
PCT

(10) International Publication Number
WO 03/031795 A1

- (51) International Patent Classification⁷: **F02M 25/035**, 31/10, F02B 47/02
- (21) International Application Number: PCT/FI02/00776
- (22) International Filing Date: 1 October 2002 (01.10.2002)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
20011965 9 October 2001 (09.10.2001) FI
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- (81) Designated States (national): AE, AG, AL, AM, AT (utility model), AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ (utility model), CZ, DE (utility model), DE, DK (utility model), DK, DM, DZ, EC, EE (utility model), EE, ES, FI (utility model), FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK (utility model), SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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(54) Title: ARRANGEMENT AND METHOD IN CONNECTION WITH A DIESEL ENGINE



(57) Abstract: Arrangement in connection with a diesel engine (1) comprising an air supply system (2) for the diesel engine for supplying suction air to the engine from the environment, the air supply system (2) comprising at least a channel arrangement (3), a compressor (4) and a heat exchanger (12) for suction air and a cooling circuit (5) for the diesel engine, to which circuit at least one heat exchanger is connected. The heat exchanger (6) connected to the cooling circuit (5), which recovers waste heat from the diesel engine is arranged to evaporate water by the heat received from the cooling circuit (5). The invention also relates to a corresponding method.

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Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

ARRANGEMENT AND METHOD IN CONNECTION WITH A DIESEL ENGINE

The present invention relates to an arrangement in connection with a diesel engine in accordance with the preamble of claim 1 and a method in connection with a diesel engine in accordance with the preamble of claim 7.

As it is generally known, the use of a diesel engine may produce a considerable amount of nitrogen oxide emissions. Various methods have been developed to reduce the emissions, such as selective catalytic reduction systems, water injection directly into combustion chamber, moistening of suction air with steam or water. All the prior art approaches require high investments and are technically relatively complicated.

The object of the present invention is to provide an arrangement and a method minimizing the prior art problems. Especially an object of the present invention is to provide an arrangement and a method, by which the nitrogen emissions from a pressure charged diesel engine could be reduced simply and effectively.

The aims of the invention are achieved principally as is described in more detail in claims 1 and 7 as well as in the other claims.

The arrangement according to the invention in connection with a diesel engine comprises an air supply system for supplying suction air to the engine from the environment. The air supply system further comprises at least a channel arrangement, a compressor and a heat exchanger for suction air. The arrangement also comprises a cooling circuit recovering waste heat from the diesel engine, to which circuit at least one heat exchanger is connected. The heat exchanger connected to the cooling circuit is arranged to evaporate water by the heat received from the cooling circuit. In addition, the heat exchanger is connected via a steam feed channel to the channel arrangement of the air supply system. The steam feed channel is arranged to connect the

channel arrangement to the heat exchanger, whereby produced steam can be conducted to the suction air of the engine.

5 Preferably, the steam feed channel is arranged so that the pressure prevailing in the channel arrangement can affect the pressure prevailing in the heat exchanger, whereby the evaporation pressure is reduced thus reducing also the boiling point. In a case like this the required temperature level in the cooling circuit is lower than it would be at a higher evaporation pressure. Preferably, the cooling circuit recovering waste heat from the diesel engine is a cooling
10 circuit of a diesel engine block and/or of a cylinder head, which operates at higher temperature level, whereby also the evaporation temperature becomes relatively high.

15 Preferably, the heat exchanger is connected to the cooling circuit of the engine so that the steam feed channel joins the channel arrangement in the flow direction of the suction air before the compressor. The flow channel of the cooling circuit branches off to form two separate channels, of which the first one passes by the heat exchanger and the second one goes via the heat exchanger. The cooling circuit is after the heat exchanger connected in the
20 flow direction of the coolant to a heat exchanger for suction air provided in the air supply system.

In the method in connection with a diesel engine comprising an air supply system for the diesel engine, which air supply system comprises at least a
25 channel arrangement, a compressor and a heat exchanger for suction air, a cooling circuit for the diesel engine, to which circuit at least one heat exchanger is connected, during the running of the engine, suction air pressurised by the compressor is conducted to the engine by means of the air supply system of the diesel engine, the coolant flowing in the cooling circuit is
30 cooled by a heat exchanger connected to the cooling circuit, and water is introduced into the heat exchanger to be evaporated by means of the heat ex-

changer to produce steam, and the steam produced in this manner is introduced into the air supply system of the diesel engine.

5 Preferably, some produced steam is introduced into the air supply system of the diesel engine, to a location specifically before the compressor. Thus the pressure level in this steam feeding location is relatively low, approximately equal to the ambient pressure. The water evaporation in the heat exchanger is arranged to take place preferably at a pressure of about ≤ 1 bar. The water evaporation in the heat exchanger is controlled by conducting some of the
10 coolant flowing in the cooling circuit to pass by the heat exchanger without delivering any heat there.

By the present invention a considerable reduction of nitrogen oxide emissions from a diesel engine is achieved by relatively small investments and operation
15 costs. By moistening the air by steam the formation of water drops can be totally avoided, whereby the compressor is not worn for this reason. Additionally, the need to treat the water to be evaporated can be reduced to a minimum in the approach according to the invention, but this is naturally dependent on the quality of the water available.

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In the following the invention is described by way of example with reference to the attached drawing, in which Fig. 1 shows schematically the arrangement in connection with a diesel engine.

25 In Fig. 1 the reference number 1 refers to a diesel engine. An air supply system 2 is arranged in connection with the diesel engine 1. The air supply system comprises a channel arrangement 3 for supplying suction air to the engine 1 from the environment. In connection with the channel arrangement 3 is provided a compressor assembly, of which only a compressor 4 is shown
30 for the clarity of illustration. In the following the operation of the diesel engine is described as related to the present invention. In other respects the

engine comprises components known per se and it operates and can be used in manners known per se.

It is generally known to cool the engine block and the other components. According to the invention heat is transferred from the cooling circuits 5 of the engine to the evaporation of water in the heat exchanger 6. In the heat exchanger 6 it is preferably possible according to the invention to maintain a pressure corresponding at most the ambient pressure.

Thus the water required for moistening the suction air of the engine may preferably be evaporated by a fluid, which is at a relatively low temperature, and also by very simple devices. According to the invention the pressure level developed in the channel arrangement 3 of the air supply system 2 being lower than the ambient pressure can be utilized for reducing also the pressure on the water side of the heat exchanger, whereby the boiling point of the water will drop. In order to make this possible the heat exchanger is connected to the air supply system 2 so that the pressure in the air supply system 2 can affect the pressure in the heat exchanger 6. Water feed pipe 20 is connected to the heat exchanger 6 for supplying water for evaporation in the heat exchanger 6. Valve 19 is provided to control the amount of water to be supplied. The arrangement and the method according to the invention can also be used when the coolant is available at a temperature of at least 100 °C. Then the heat exchanger can also be used when over-pressurized, i.e. at a pressure of more than about 1 bar.

The coolant flowing from the engine 1 is conducted to the heat exchanger 6, where the water used for moistening is evaporated by means of the heat received from the coolant. The heat exchanger 6 is connected to the cooling circuit 5 of the engine so that the flow channel branches off to form two separate channels 7, 8, of which the first one 7 passes by the heat exchanger and the second one 8 goes via the heat exchanger. These are joined together by means of a valve 9 after the heat exchanger 6 to form again one

flow channel. The amount of the steam to be produced can be controlled by means of the valve 9 so that the more coolant is conducted by the valve 9 to pass via the second channel 8 and the heat exchanger 6, the more intense the evaporation is. Steam feed channel 10 from the heat exchanger is arranged to extend to the channel arrangement 3 of the air supply system 2 so that it opens to a spot after the suction air filter 11 and before the compressor 4. After the valve 9 a heat exchanger 12 for suction air is connected to the cooling circuit 5. The heat exchanger 12 is connected to the cooling circuit 5 of the engine so that the flow channel branches off to form two separate channels 13, 14, of which the first one 13 passes by the heat exchanger and the second one 14 goes via the heat exchanger. These are joined together by means of a three-way valve 15 after the heat exchanger 12 to form again one flow channel. The operation of the heat exchanger 12 and the temperature of the suction air can be controlled by adjusting the valve 15. Preferably, the arrangement also comprises a heat exchanger 16, by means of which the coolant can be cooled to a temperature suitable for the cooling of the engine 1 before the coolant is introduced back to the engine 1.

The arrangement also comprises means 17 for determining the air humidity and temperature, preferably positioned before the compressor 4. These means 17 are connected to an automation system 18, which also controls the operation of the valves 9, 15 and 19. The operation of the valves 9 and 15 is controlled on the basis of the determined humidity and temperature and the valve 19 is controlled by having the surface in the heat exchanger 6 on a desired level (not shown). The state of the suction air of the engine, as regards the humidity and temperature, is maintained on a desired level, but condensation is, however, avoided.

According to the invention the temperature of the suction air is maintained at about 35°C and the relative humidity at about 95 %, whereby the nitrogen oxide (NO_x) emissions can be reduced by ca 40 - 50 %. Additionally, it is

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advantageous to see that the temperature in the air chamber (not shown) of the engine itself is about 62 °C.

The invention is not limited to the above-described applications, but several
5 other modifications are conceivable in the scope of the appended claims.

CLAIMS

1. Arrangement in connection with a diesel engine (1) comprising an air supply system (2) for the diesel engine for supplying suction air to the engine
5 from the environment, the air supply system (2) comprising at least a channel arrangement (3), a compressor (4) and a heat exchanger (12) for suction air, a cooling circuit (5) for recovering waste heat from the diesel engine, to which circuit at least one heat exchanger is connected, said at least one heat
10 exchanger (6) being arranged to evaporate water by the heat received from the cooling circuit (5), **characterised** in that a water feed pipe (20) is connected to the heat exchanger (6) for supplying the water to be evaporated to the heat exchanger (6), and that the heat exchanger (6) is via a steam feed channel (10) connected to the channel arrangement (3) of the air supply system (2) for introducing the steam produced by the water supplied via the water feed pipe, into the channel arrangement.
15
2. Arrangement in connection with a diesel engine (1) according to claim 1, **characterised** in that the cooling circuit recovering waste heat from the diesel
20 engine is a cooling circuit of a diesel engine block and/or of a cylinder head.
3. Arrangement in connection with a diesel engine (1) according to claim 1, **characterised** in that the steam feed channel (10) joins the channel arrangement (3) in the flow direction of the air before the compressor (4).
25
4. Arrangement in connection with a diesel engine (1) according to any of the preceding claims, **characterised** in that the steam feed channel (10) is arranged to transmit the effect of the pressure prevailing in the channel arrangement over to the heat exchanger (6).
30

5. Arrangement according to any of the preceding claims, **characterised** in that the heat exchanger (6) is connected to the cooling circuit (5) of the engine so that the flow channel branches off to form two separate channels (7, 8), of which the first one (7) passes by the heat exchanger (6) and the second one (8) goes via the heat exchanger.

6. Arrangement according to claim 5, **characterised** in that the cooling circuit is after the heat exchanger (6) in the flow direction of the coolant connected to a heat exchanger (12) for suction air arranged in the air supply system (2).

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7. Method in connection with a diesel engine (1) comprising an air supply system (2) for the diesel engine, which air supply system (2) comprises at least a channel arrangement (3), a compressor (4) and a heat exchanger (12) for suction air, a cooling circuit (5) for recovering waste heat from the diesel engine, to which circuit at least one heat exchanger is connected, in which method during the running of the engine

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- suction air pressurised by the compressor is conducted to the engine by means of the air supply system (2) of the engine,

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- the coolant flowing in the cooling circuit is cooled by a heat exchanger (6) connected to the cooling circuit (5),

characterised in that

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water is introduced into the heat exchanger (6) to be evaporated by means of the heat exchanger (6) in order to produce steam, and that the steam produced in this manner is introduced into the air supply system (2) of the diesel engine.

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8. A method according to claim 7, **characterised** in that the water evaporation in the heat exchanger (6) is arranged to take place at a pressure of about ≤ 1 bar.

9. A method according to any of the claims 7 - 8, **characterised** in that the water evaporation in the heat exchanger (6) is controlled by conducting some

of the coolant flowing in the cooling circuit to pass by the heat exchanger (6) without delivering any heat there.

10. A method according to any of the claims 7 - 9, **characterised** in that
5 some produced steam is introduced into the air supply system (2) of the diesel engine, to a location before the compressor.

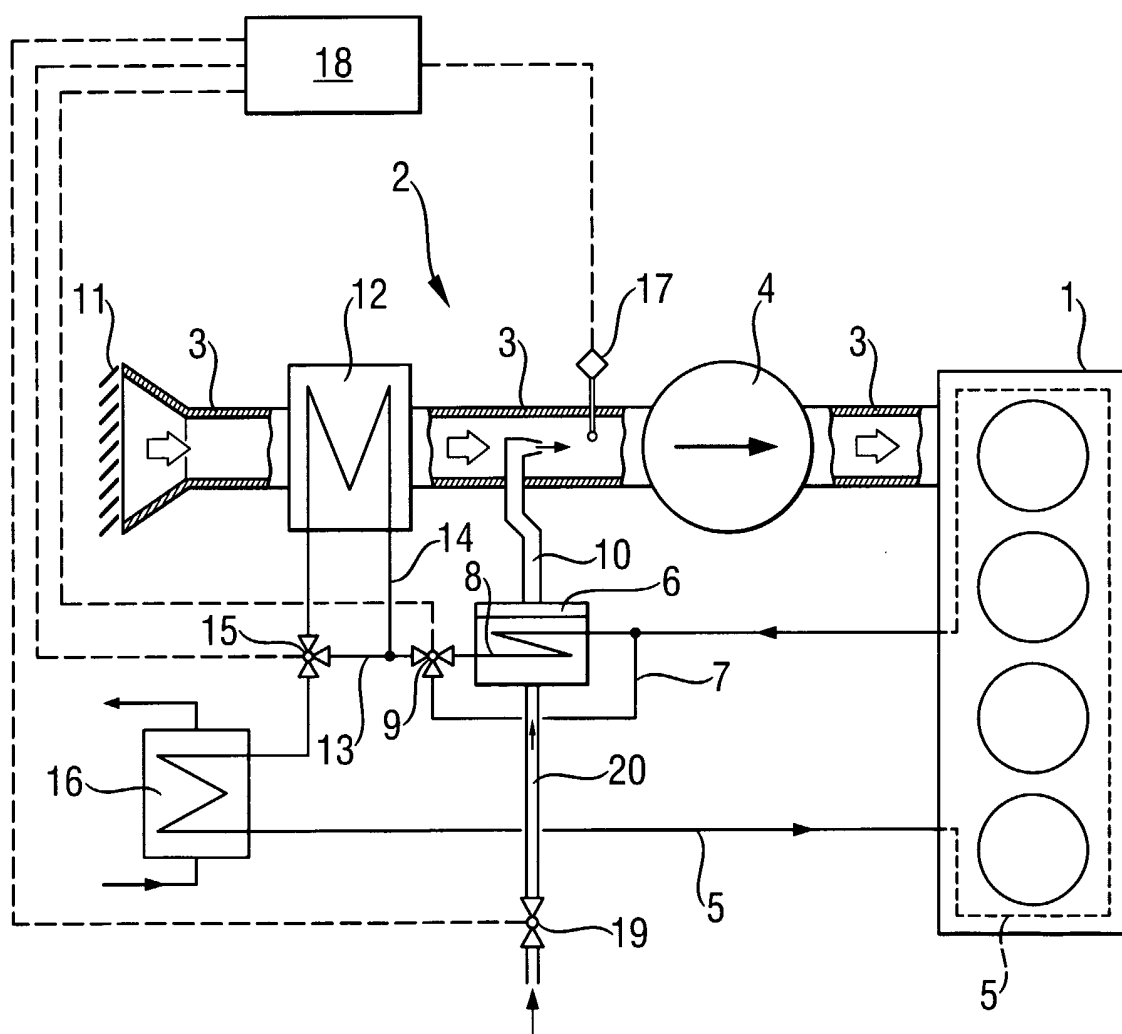


Fig. 1

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 02/00776

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F02M 25/035, F02M 31/10, F02B 47/02

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)

IPC7: F02M, F02B

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,A	WO 02075141 A1 (MUNTERS EUROFORM GMBH), 26 Sept 2002 (26.09.02), figure 1, abstract --	
A	US 5797265 A (HÄGGLUND), 25 August 1998 (25.08.98), figures 1,3, abstract --	
A	US 5609029 A (AHNGER ET AL), 11 March 1997 (11.03.97), figures 1,2, abstract --	
A	EP 1076169 A2 (MUNTERS EUROFORM GMBH), 14 February 2001 (14.02.01), figures 1,2, abstract --	

 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

14 January 2003

Date of mailing of the international search report

16-01-2003

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International application No.

PCT/FI 02/00776

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 3439444 A1 (BBC AKTIENGESELLSCHAFT BROWN, BOVERI & CIE.), 30 April 1986 (30.04.86), page 7, line 4 - line 14, figure 1, abstract -- -----	

INTERNATIONAL SEARCH REPORT

Information on patent family members

30/12/02

Inte.....al application No.

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