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(71) Applicant (for all designated States except US): SCANDIA CV AB [SE/SE]; S-151 87 Sodertalje (SE).

(73) Inventors; and
(75) Inventors/Applicants (for US only): KARDOS, Zoltan [SE/SE]; Karlshusgatan 19, S-151 35 Sodertalje (SE).
DYBDAL, Rolf [SE/SE]; Kungsberget, S-610 50 Jonaker (SE). BJÖRKBACKA, Tommi [SE/SE]; Rafaelsgatan 7, S-152 50 Sodertalje (SE).

(74) Agent: FORSELL, Hans; Scania CV AB, Patents, S-151 87 Sodertalje (SE).

(54) Title: ARRANGEMENT FOR COOLING AN ELECTRICAL CONTROL UNIT IN AN ENGINE SPACE OF A VEHICLE

(57) Abstract: The present invention relates to an arrangement for cooling an electrical control unit (16) in an engine space (la) of a vehicle (1) powered by a combustion engine (2) situated in the engine space (la). The arrangement comprises an inlet line (10) adapted to leading air through the engine space (1) to the engine (2). The electrical control unit (16) is fastened on the inlet line (10) in such a way that it is in heat-transferring contact with the air which is led through the inlet line (10) to the engine (2). The electrical control unit (16) can thus undergo continuously good cooling in the engine space (la) during operation of the combustion engine (2).
Arrangement for cooling an electrical control unit in an engine space of a vehicle

BACKGROUND TO THE INVENTION AND PRIOR ART

The present invention relates to an arrangement for cooling an electrical control unit in an engine space of a vehicle according to the preamble of claim 1.

During operation, electrical control units give off a heat output of the order of 50-150 watts. At this relatively small heat output it is usually sufficient for them to be cooled by surrounding air. However, the electrical control units in a vehicle are often situated in its engine space, in which they are used to control various components. The air in a vehicle's engine space will be warm. The air is drawn into the engine space by a cooling fan. This entails the air passing through one or more radiators in which it cools coolant, charge air, recirculating exhaust gases etc. before it reaches the engine space. As these media may be at very high temperatures, the air in the engine space often reaches a temperature of the order of 80°C. In certain operating states, however, the air temperature in the engine space may temporarily rise to over 100°C. Air at such a high temperature is quite inappropriate for cooling of electrical control units.

A known way of solving this problem is to provide electrical control units in engine spaces with extra heat tolerant components. Such components are costly, leading to expensive electrical control units. Another known practice is to provide electrical control units in engine spaces of vehicles with a heat exchanger on the rear side whereby the electrical control units are cooled by fuel from the vehicle's fuel system. Such a solution entails adaptation of the vehicle's fuel system and having to provide extra fuel lines in the engine space. It also leads to greater risk of fuel leakage in the engine space.
SUMMARY OF THE INVENTION

The object of the present invention is to propose an arrangement which makes it possible for electrical control units in an engine space of a vehicle to be cooled in a reliable and functional way and at low cost.

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. During operation of a combustion engine, air is substantially continuously led through an inlet line to the engine in the engine space. During normal operation, the air in the inlet line will be at a definitely lower temperature than the air in the engine space in which the control unit is situated. It is therefore very appropriate to use the inlet air as a medium for cooling the electrical control unit. The air led to the engine will certainly undergo some warming when it cools the electrical control unit, but this warming is substantially negligible since an electrical control unit has a relatively small heat output. Arranging the electrical control unit on the inlet line in such a way that it is cooled by the air in the inlet line can be done quite easily and in several different ways. Such an adaptation can also be done at low cost.

According to another embodiment of the invention, the inlet line comprises at least one radiator for cooling the air before it reaches the engine, and the electrical control unit is situated at a location downstream of said radiator with respect to the intended direction of air flow in the inlet line. In cases where the air led to the engine is supercharged, it needs to be cooled in at least one charge air cooler before it is led to the engine. In substantially all operating conditions, the compressed air will thus assume a relatively low temperature before it is led into the engine. For it to be provided with good cooling by the air in the inlet line, the electrical control unit needs to be situated in the inlet line at a location downstream of the charge air cooler where the air is coldest.

According to another embodiment of the invention, the electrical control unit is provided with a contact surface fitted against a correspondingly shaped contact surface of the inlet line. An electrical control unit normally has a surrounding casing which
encloses and protects its electrical components. This casing is usually made of material with good thermally conductive characteristics. The inlet line which leads air to the engine is also normally made of material with good thermally conductive characteristics. Fastening the electrical control unit on a correspondingly shaped surface of the inlet line may result in a relatively large heat transfer region between the electrical control unit and the inlet line whereby thermal energy can be transferred from the electrical control unit to the air in the inlet line. The electrical control unit is thus provided with good cooling. The inlet line comprises with advantage a surface irregularity on the inside of said contact surface. Such a surface irregularity may comprise heat-transferring elements which extend into the inlet line. The heat transfer between the electrical control unit and the air in the inlet line is thereby further enhanced.

According to another embodiment of the invention, the electrical control unit is fitted in an aperture in the inlet line and is provided with a contact surface which is in contact with the air in the inlet line. In this case the contact surface of the control unit can be cooled directly by the air flowing within the inlet line. The contact surface of the control unit with the air in the inlet line comprises with advantage surface irregularity elements which result in a much larger heat transfer surface between the control unit and the air in the inlet line and consequently more effective cooling of the electrical control unit. Said surface irregularity elements may take the form of platelike flange elements which have a main extent in the intended direction of air flow within the inlet line. This makes good transfer possible without substantially affecting the flow of air within the inlet line.

According to an embodiment of the invention, the whole of the electrical control unit is situated within the inlet line. This results in very good cooling of the electrical control unit through its being substantially surrounded by the air in the inlet line. Here again the electrical control unit may be provided with heat-transferring flanges to enhance its cooling. The electrical control unit may be fastened to an inside wall surface of the inlet line. Alternatively it may be fastened within the inlet line by suitable fastening elements.
According to an embodiment of the invention, the electrical control unit is provided with an external surface which is in contact with surrounding air. In cases where it is fitted on the outside of the inlet line or in an aperture in the inlet line, the electrical control unit will inevitably have a contact surface with surrounding air. During normal operation, the surrounding air in an engine space will be at such a high temperature as not to be viable for cooling the electrical control unit. With advantage, the control unit's contact surface with surrounding air is therefore made significantly smaller than its heat-transferring contact surface with the inlet line and air in the inlet line.

Alternatively, or in combination, the electrical control unit's contact surface with surrounding air is made of material which has thermally insulating characteristics. The casing of the control unit may in this case comprise thermally insulating material in the region which is in contact with surrounding air. Alternatively, a covering means made of thermally insulating material may be provided on top of the casing in the region which is in contact with surrounding air in the engine space. Such thermally insulating material will substantially prevent the control unit from being warmed by surrounding air in the engine space.

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 electrical control unit cooled by inlet air led to a combustion engine,
Fig 2 depicts in more detail an electrical control unit fastened to an inlet line which leads air to a combustion engine,
Fig 3 is a cross-sectional view of the electrical control unit and the inlet line in Fig 2,
Fig 4 is a cross-sectional view of an alternative electrical control unit and inlet line and
Fig 5 is a cross-sectional view of a further alternative electrical control unit and inlet line.
Fig. 1 depicts a vehicle 1 powered by a supercharged combustion engine 2 situated in an engine space 1a of the vehicle. The vehicle 1 may be a heavy vehicle powered by a supercharged diesel engine. The engine 2 is cooled in a conventional way by a cooling system which contains a circulating coolant. The coolant is circulated in the cooling system by means of a coolant pump 3. The cooling system comprises a thermostat 4 adapted to directing the coolant to a radiator 5 when the coolant needs cooling and to the engine 2 when it does not need cooling in the radiator 5. The radiator 5 is fitted at a forward portion of the vehicle 1. The exhaust gases from the cylinders of the engine 2 are led to an exhaust line 7 via an exhaust manifold 6. The exhaust gases in the exhaust line 7, which will be at above atmospheric pressure, are led to a turbine 8 of a turbo unit. The turbine 8 is thus provided with driving power which is transferred, via a connection, to a compressor 9. A compressor 9 compresses air which is led into an inlet line 10. During the compression the air acquires a raised temperature.

A first charge air cooler 11 is situated in the inlet line 10 to provide the compressed air with a first step of cooling. The coolant in the cooling system is led in a line 12 to the first charge air cooler and in a line 13 from the first charge air cooler 11. The coolant in the cooling system is used to subject the compressed air to the first step of cooling in the first charge air cooler 11. The compressed air may here be cooled to a temperature close to that of the coolant, which is usually within the range 70-90°C. The compressed air is then led to a second charge air cooler 14 situated at a front portion of the vehicle 1. The second charge air cooler 14 is situated in front of the radiator 5 with respect to the intended direction of air flow through the radiators 5, 14. A radiator fan 15 draws surrounding air through the radiators 5, 14 and into the vehicle's engine space 1a. The air in the engine space 1a will be relatively warm from having been used to cool the charge air in the second charge air cooler 14 and the coolant in the radiator 5. When the compressed air is cooled in a second charge air cooler 14 situated at a front portion of the vehicle 1, it is cooled by air at the temperature of the surroundings. It is thus possible to cool the compressed air to a
temperature close to the temperature of the surroundings. Cooling the compressed air
to a temperature close to the temperature of the surroundings makes it possible for a
substantially optimum amount of air to be led to the cylinders of the engine 2. An
electrical control unit 16 is situated in the inlet line 10 at a location close to a manifold
17 which leads the compressed air to the respective cylinders of the engine 2.

Fig. 2 depicts in more detail the electrical control unit 16 fastened on the inlet line 10
close to a manifold 17. Fig. 3 is a cross-sectional view through the electrical control
unit 16 and the inlet line 10. The electrical control unit 16 comprises an internal space
with schematically depicted electrical components 16a. The electrical components 16a
are enclosed by a surrounding casing 16b. The casing 16b is made of material with
good thermally conductive characteristics. The casing 16b may be made of suitable
metal material. The casing 16b has an external surface which comprises a planar
contact surface 16bi with the inlet line 10. The inlet line 10 is made of material with
good thermally conductive characteristics, e.g. metal material. The inlet line 10 has
close to the control unit 16 a wall section 10a which has a substantially planar contact
surface 10ai in fitted contact with the control unit's planar contact surface 16bi. The
control unit's contact surface 16bi and the inlet line's contact surface 10ai may be
fitted together by a fastening means which may be a suitable adhesive or by a
releasable connecting mechanism. What is important, however, is that in a fitted state
the control unit's contact surface 16bi and the inlet line's contact surface 10ai are in
good heat-transferring contact with one another.

The planar wall section 10a of the inlet line 10 comprises an internal contact surface
10a2 which is in contact with the air within the inlet line 10. The internal surface
contact 10a2 comprises platelike flange elements 10b. The platelike flange elements
10b have a main extent in the intended direction of air flow within the inlet line 10 and
will therefore substantially not hinder the air flow within the inlet line 10. The flange
elements 10b have with advantage an extent which corresponds to that of the electrical
control unit 16 on the outside of the inlet line 10. This means that the flange elements
10b have a large contact surface with the air within the inlet line 10, resulting in good
heat transfer between them and the air in the inlet line 10. An extra casing made of
thermally insulating material 18 is placed over an external surface of the casing 16b which is not in contact with the inlet line 10. The electrical control unit 16 is thus provided with an external surface 18a made of thermally insulating material 18 in contact with surrounding air.

During operation of the combustion engine 2, the compressed air undergoes a first step of cooling in the first charge air cooler 11 by coolant and a second step of cooling by air at the temperature of the surroundings in the second charge air cooler 14. By such cooling the compressed air may often be cooled to a temperature close to that of the surrounding air. Before it reaches the manifold 17, the cooled compressed air passes the electrical control unit 16 in the inlet line 10. The air comes here into contact with the flange elements 10b, causing them to assume a temperature substantially corresponding to that of the air within the inlet line 10. This means that the wall section 10a of the inlet line 10 which is in contact with the control unit 16 assumes a relatively low temperature. During operation, the electrical control unit 16 develops a heat output of 50-150 watts. It thus undergoes warming. In this situation the control unit 16 is cooled by air in the inlet line 10 via the relatively large contact surfaces 10ai, 16bi between it and the inlet line 10. During operation, the surrounding temperature in an engine space 1a may be of the order of 80°C. This temperature is definitely higher than that of the air in the inlet line 10 and usually higher than that of the electrical control unit 16 after it has been cooled by the air in the inlet line 10. Here the extra thermally insulating casing 18 prevents the electrical control unit 16 from being warmed by the warm air in the engine space 1a. The air in the inlet line 10 undergoes a certain warming when it is led past the flange elements 10b, but this warming is relatively small because the electrical control unit 16 develops only a relatively small heat output during operation. In this situation the electrical control unit 16 is provided, during operation, with continuously good cooling by air at a relatively low temperature. The electrical control unit 16 therefore need not include expensive electrical components capable of tolerating high temperatures.

Fig. 4 is a cross-sectional view of an alternative embodiment of the electrical control unit 16 and the inlet line 10. In this case the inlet line 10 is provided with an aperture
10c. The size of the aperture 10c is such that it is closed when the electrical control unit 16 is applied on the inlet line 10. To achieve a safe and tight closure, an external surface 16b2 of the electrical control unit's casing 16b is fitted against an internal surface 10d of the inlet line close to the aperture 10c by a fastening means such as a suitable adhesive. The casing 16b in the fitted state has a contact surface 16b3 which is in contact with the air which is led through the inlet line 10. The contact surface 16b3 comprises platelike flange elements 16c which have a main extent in the intended direction of air flow within the inlet line 10 and will therefore substantially not hinder the air flow within the inlet line 10. They may have an extent along substantially the whole of the control unit's contact surface 16b3 with the air in the inlet line 10. The flange elements 16c are thus provided with a large contact surface with the air within the inlet line 10, resulting in good heat transfer between them and the air in the inlet line 10. The casing has here a contact surface 16b4 with surrounding air in the engine space.

During operation of the combustion engine 2 the air in the inlet line 10 cools the electrical control unit 16 via the contact surface 16b3. With such cooling, the electrical control unit 16 may assume a relatively low temperature. In this case the electrical control unit 16 is also in heat-transferring contact with the surrounding air via the contact surface 16b4. The control unit's contact surface 16b4 with surrounding air is significantly smaller than its contact surface 16b3 with the air in the inlet line 10, since the contact surface 16b4 with the air in the engine space has no flange elements. The electrical control unit 16 undergoes cooling via the contact surface 16b4 at times when the air in the engine space is colder than the electrical control unit 16, but warming at times when the air in the engine space is warmer than the electrical control unit 16. In all circumstances the air in the inlet line 10 provides the electrical control unit 16 with continuously good cooling whatever the temperature of the air in the engine space 1a. This ensures that the control unit 16 will be at an acceptable low temperature in all operating conditions.

Fig. 5 is a cross-sectional view of a further alternative embodiment of the electrical control unit 16 and the inlet line 10. In this case the whole of the control unit 16 is
fitted within the inlet line 10. The control unit's casing 16b here again comprises a contact surface 16b which is in contact with the air led through the inlet line 10. The contact surface 16b comprises platelike flange elements 16c which have a main extent in the intended direction of air flow within the inlet line 10. The casing comprises also a contact surface 16bs fastened against an inside surface 10e of the inlet line 10. A fastening means such as a suitable adhesive may be applied between said surfaces to keep the electrical control unit 16 in position at the intended location within the inlet line 10. The electrical control unit 16 may in this case be moved down and fastened within the inlet line 10 before it is connected to the manifold 17. Since in this case the whole of it is within the inlet line, the electrical control unit 16 is provided with very good cooling by the air in the inlet line 10.

The invention is in no way restricted to the embodiments described but may be varied freely within the scopes of the claims.
Claims

1. An arrangement for cooling an electrical control unit (16) in an engine space (la) of a vehicle (1) powered by a combustion engine (2) situated in the engine space (la), which arrangement comprises an inlet line (10) adapted to leading air through the engine space (1) to the engine (2), characterised in that the electrical control unit (16) is fastened on the inlet line (10) in such a way that it is in heat-transferring contact with the air which is led through the inlet line (10) to the engine (2).

2. An arrangement according to claim 1, characterised in that the inlet line comprises at least one radiator (14) for cooling the air before it reaches the engine (2) and that the electrical control unit (16) is situated at a location downstream of said radiator (14) with respect to the intended direction of air flow in the inlet line (10).

3. An arrangement according to claim 1 or 2, characterised in that the electrical control unit (16) is provided with a contact surface (16bi) fitted in contact with a correspondingly shaped contact surface (10ai) of the inlet line (10).

4. An arrangement according to claim 3, characterised in that the inlet line (10) comprises a surface irregularity (10b) on the inside of said contact surface (10ai).

5. An arrangement according to claim 1 or 2, characterised in that the electrical control unit (16) is fitted in an aperture (10c) in the inlet line (10) and is provided with a contact surface (16b1) which is in contact with the air within the inlet line (10).

6. An arrangement according to claim 5, characterised in that the electrical control unit's contact surface (16b2) with the air in the inlet line comprises a surface irregularity element (16c).

7. An arrangement according to claim 6, characterised in that said surface irregularity element takes the form of platelike flanges (16c) which have a main extent in the intended direction of air flow within the inlet line (10).
8. An arrangement according to any one of the foregoing claims, characterised in that the electrical control unit (16) is provided with a contact surface (16b, 18a) which in a fitted state is in contact with surrounding air.

9. An arrangement according to claim 8, characterised in that the electrical control unit's contact surface (18a) with surrounding air comprises material which has thermally insulating characteristics.

10. An arrangement according to claim 1 or 2, characterised in that the whole of the electrical control unit (16) is situated within the inlet line (10).
## 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: F02B, F02M, G06F, H05K**

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 database consulted during the international search (name of database and, where practicable, search terms used)

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## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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