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(54) Cooling arrangement for an agricultural vehicle

(57) A cooling arrangement (1) for an agricultural vehicle comprises at least two heat exchangers (11, 12, 21, 22) and a fan (2) directing an air flow to the at least two heat exchangers (11, 12, 21, 22), wherein the fan (2) is a radial fan, upstream of which, in relation to the air flow, at least one heat exchanger (11, 12) is arranged, and downstream of which, in relation to the air flow, at least one heat exchanger (21, 22) is arranged.

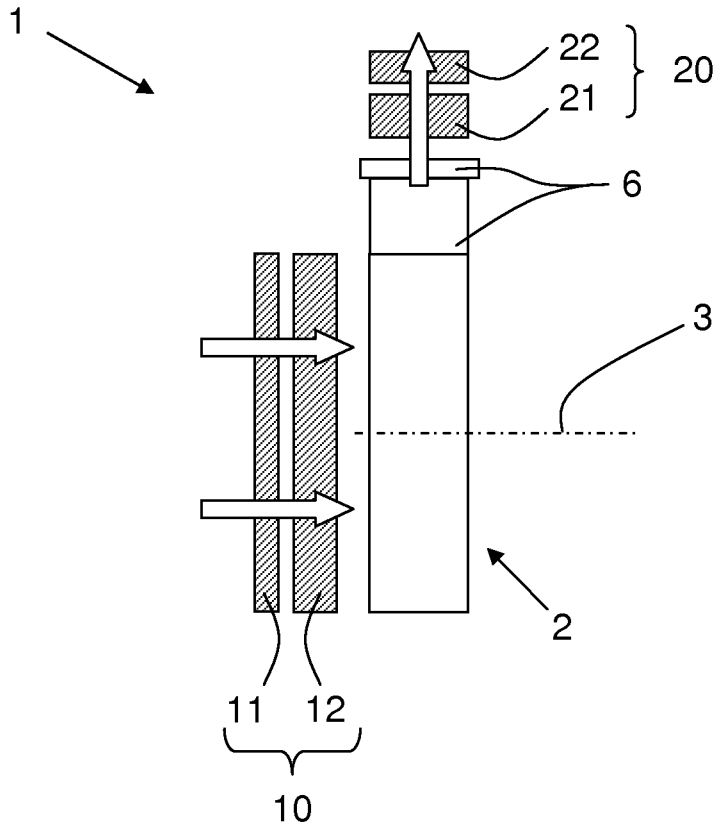

Fig. 2

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Description

[0001] The invention relates to a cooling arrangement for an agricultural vehicle according to the preamble of claim 1.

[0002] Agricultural vehicles are mostly equipped with a system for the cooling of one or more working assemblies. If an internal combustion engine serves as the main drive of the vehicle, the cooling system is used for example in order to cool a cooling medium flowing through the engine block and to thereby dissipate heat from the engine block. High power requirements of engines existing today make such a cooling system practically indispensable.

[0003] In addition, in agricultural vehicles, depending on the type of vehicle, a requirement for cooling exists for a plurality of further working assemblies such as gear box, hydraulic arrangements, air conditioning or for other purposes (cooling of charge air, fuel, lubricating oil), which can advantageously be covered by a commonly used cooling system.

[0004] A cooling system comprises as an important component a cooling arrangement which mostly consists of a heat exchanger and a fan as essential components. These are arranged with respect to each other such that the fan directs an air flow past an exchange surface of the heat exchanger or through an exchange surface (permeable in this case) of the heat exchanger, in order to cause an heat exchange between the air flow and the heat exchanger.

[0005] As the exchange surface of the heat exchanger is heated by a cooling medium flowing through the heat exchanger, which has previously been heated by any working assembly of the vehicle, the exchange surface largely emits this heat to the air flow produced by the fan - and hence to the environment. In this way, a cooling of a working assembly of the vehicle is achieved.

[0006] Because of growing power requirements in agricultural vehicles, the outputs of the internal combustion engines which are used, and hence also the cooling capacities of necessary cooling arrangements are increasing. The cooling capacities increase furthermore because, related to increased engine outputs and/or to higher comfort of the vehicles, further working assemblies (e.g. air-conditioning units, auxiliary devices etc.) of the vehicles and operating resources and/or auxiliary resources (fuel, charge air, lubricant, hydraulic oil etc.) of the vehicles are cooled.

[0007] In the construction of higher output cooling arrangements for agricultural vehicles, restrictions exist in particular with regard to the structural space and to the noise produced operationally by the cooling arrangement.

[0008] From prior art according to DE 40 09 726 A1 for example a cooling arrangement is known in which a fan directs a cooling air flow to at least two heat exchangers. The heat exchangers serve for the separate cooling of their own medium each, wherein for example one of the heat exchangers cools the internal combustion engine and another heat exchanger cools a working medium of an additional assembly. To reduce the space requirement and for the shared use of an air flow, the heat exchangers are arranged in one plane adjacent to each other upstream of an axial fan. Furthermore, it is proposed to arrange a further heat exchanger upstream of the heat exchangers which are lying adjacent to each other.

[0009] A reduced space requirement is achieved by this arrangement. In practice, however, it is found that the arrangement causes intense flow noises in particular in the case of high cooling capacities with high air volume flows. Turbulences occurring due to the construction are regarded as a cause for this.

[0010] It is therefore an object of the present invention to provide a cooling arrangement with high cooling capacity, which is able to operate with reduced noise.

[0011] This object is achieved by a cooling arrangement according to claim 1. Accordingly, in a cooling arrangement as defined in the preamble of claim 1, the fan is embodied as a radial fan, upstream of which, in relation to the air flow, at least one heat exchanger is arranged, and downstream of which, in relation to the air flow, at least one heat exchanger is arranged.

[0012] It has been recognized that with an axial fan used as in DE 40 09 726 A1, high cooling capacities can only be achieved if the impellor is operated at high speed which, in turn, leads to an intense noise development due to high volume flows of air. The hub of the fan wheel lying in the flow path, which causes turbulences of the air flow, contributes to the noise production.

[0013] According to the invention, a radial fan is used to eliminate these disadvantages. This radial fan operates with a higher compressing of the drawn-in air (than an axial fan), so that a higher cooling capacity can be achieved on a relatively small structural space. Owing to the reduced volume flow due to the higher compression, and owing to a freer flow path, the radial fan causes less flow noises.

[0014] Another reason for lower noises at a high overall output of the cooling arrangement lies in the arrangement of exchangers in relation to the fan. According to the invention, at least on of the heat exchangers is arranged upstream of the fan, in relation to the air flow, and at least on of the heat exchangers is arranged downstream of the fan, in relation to the air flow. This arrangement further contributes to the reduction of turbulences and hence of flow noises.

[0015] Advantageously, the heat exchangers can be exposed to air flows of different speed and/or compression. In the drawing-in region of the radial fan, the air stream can be distinctly slower than in the downstream outlet region. Accordingly, one heat exchanger could advantageously be used arranged upstream of the radial fan, which heat exchanger is able to be operated with a slow air stream. The reverse could apply for another heat exchanger arranged downstream of the radial fan.

[0016] In the simplest case, one heat exchanger is arranged upstream and downstream of the radial fan respectively. According to an advantageous development of the invention, the heat exchanger arranged upstream of the fan is associated with a first group comprising at least one further heat exchanger arranged upstream of the fan. Accordingly, several heat exchangers are situated upstream of the fan, in relation to the air flow.

[0017] Accordingly, as an alternative or in addition, the heat exchanger arranged downstream of the fan is associated with a second group comprising at least one further heat exchanger arranged downstream of the fan. Accordingly, several heat exchangers are situated downstream of the fan, in relation to the air flow.

[0018] In general, by arrangement of several heat exchangers before or after the fan, advantageous installation places can be used to cover different requirements, for example with regard to the required cooling capacity or to structural space aspects. Different arrangements of heat exchangers are conceivable in detail here. For instance, several heat exchangers associated with one group can be arranged adjacent to each other in relation the direction of the air flow. In this case, the air flow is divided to the heat exchangers. One advantage of such arrangement is that impinging air is not already heated by the heat exchanger lying adjacent thereto.

[0019] In addition, several heat exchangers associated with one group can be arranged one after the other in air flow direction. Hereby, a particularly space-saving arrangement is produced, with this being able to be embodied such that the air flow acts upon all the heat exchangers, lying one behind the other, fully or — for example with a smaller output requirement - only partially. Any desired combinations of arrangements are conceivable.

[0020] Advantageously, a heat exchanger associated with the first group has a different medium flowing through than a heat exchanger associated with the second group. Accordingly, the heat exchangers of the two groups serve different cooling purposes.

[0021] The heat exchangers can serve in principle for the cooling of any medium. For instance, a medium flows through at least one of the heat exchangers, the medium being an operating and/or auxiliary resource for the vehicle. The medium can be for instance fuel, charge air for an internal combustion engine of the vehicle, cooling water for an engine, air-conditioning unit coolant, hydraulic oil, gear oil etc.. Advantageously, different heat exchangers of the cooling arrangement have different ones of the previously mentioned media flowing through.

[0022] The heat exchangers can be arranged and aligned in different ways in relation to the vehicle. Advantageously, provision is made that a surface of a heat exchanger with air flowing through, arranged upstream of the fan, extends approximately transversely to the longitudinal axis of the vehicle. With such an arrangement, head wind impinging on the vehicle from the front can arrive with less deflection into the upstream heat exchanger.

[0023] In addition, provision can be made that the surface of a heat exchanger with air flowing through, arranged downstream of the fan, extends approximately parallel to the longitudinal axis of the vehicle. A particularly favourable arrangement makes provision that the air flow leaves an heat exchanger arranged downstream of the fan in upwards direction.

[0024] According to an advantageous further development of the invention, the fan comprises an impeller, the rotation axis of which is aligned approximately parallel to the longitudinal axis of the vehicle. The drive assembly of the fan can be arranged in this case advantageously in front of or behind the fan (in relation to the longitudinal direction of the vehicle), whereby the cooling arrangement can be integrated in a space-saving manner for example into the elongated bonnet of a tractor.

[0025] To reliably achieve the necessary output, the fan expediently has a housing accommodating an impeller which is able to be brought into rotation. The upstream or downstream heat exchangers are advantageously able to be mounted onto the housing respectively, so that a closed flow path is produced.

[0026] The housing advantageously surrounds the impeller circumferentially, with a radial air outlet being provided on a circumferential region of the housing. In addition, the housing advantageously has an axial air inlet.

[0027] The cooling arrangement according to the invention can be used for different agricultural vehicles. A particular use exists for agricultural vehicles in which, in addition to the cooling of a main drive assembly such as an internal combustion engine, there is a further cooling requirement. This is the case, for example, in tractors. The cooling arrangement can also be used in other agricultural vehicles, such as self-propelled harvesting machines (forage harvesters, combine harvesters etc.).

[0028] The invention is described in further detail below with reference to the enclosed figures. Further details and advantages of the invention will also emerge therefrom.

Fig. 1 shows a diagrammatic sectional view of a fan of a cooling arrangement according to the invention,

Fig. 2 shows a diagrammatic sectional view of a cooling arrangement according to the invention.

[0029] Fig. 1 shows a fan 2 of a cooling arrangement according to the invention. The fan 2 is embodied as a radial fan. It has a helical housing 4, in which an impeller 5 is rotatably mounted about a rotational axis 3. The impeller 5 is driven by a drive assembly (not illustrated) and rotates in operation about rotational axis 3.

[0030] The impeller 5 is a radial ventilator which in operation draws in air in axial direction (parallel to rotational axis 3), which is indicated by the three arrows. By rotation, the impeller 5 deflects the drawn-in air through 90° and

blows it out in radial direction. In Fig. 1 eight blades are indicated on the impeller 5 for this purpose. The number of blades can differ as desired. The blades can be configured in a manner previously known per se with regard to shape and arrangement.

[0031] In general, the impeller 5 can be a radial ventilator drawing in air (axially) either on one side or on both sides. Preferably, a radial ventilator drawing in on one side is used, because with this, the flow path of the air is not impaired by a drive assembly.

[0032] The housing 4 of the fan 2 has an air outlet 6 on a circumferential region lying on the left in Fig. 1. The air emerging radially from the impeller 5 flows, as indicated by the two wide arrows, out from the housing 4 through the air outlet 6.

[0033] Fig. 2 shows a cooling arrangement 1 according to the invention, which has a fan 2, which may correspond in construction to the fan 2 described in Fig. 1. The cooling arrangement 1 comprises, alongside the fan 2, four heat exchangers 11, 12, 21, 22. These serve for the cooling of different cooling media of an agricultural vehicle (not shown), for example a tractor, into which the cooling arrangement 1 can be incorporated. For this purpose, the heat exchangers 11, 12, 21, 22 are preferably integrated into different cooling circuits, in order for example to cool fuel, charge air for an internal combustion engine of the vehicle, cooling water for an engine, air-conditioning unit coolant, hydraulic oil, gear oil or suchlike. It is conceivable to add further heat exchangers to the arrangement.

[0034] According to the invention, at least one of the heat exchangers 11, 12 is arranged upstream of the fan 2 in relation to the air flow direction indicated by the arrows, and at least one of the heat exchangers 21, 22 is arranged downstream of the fan 2 in relation to the air flow direction indicated by the arrows. The upstream heat exchangers 11, 12 are associated for this with a first group 10, whereas the downstream heat exchangers 21, 22 are associated with a second group 20.

[0035] The heat exchangers of the first group 10 preferably serve for the cooling of cooling water, air-conditioning coolant, fuel. The heat exchangers of the second group 20 preferably serve for the cooling of engine charge air, gear oil.

[0036] As can be seen in Fig. 2 with the aid of the air flow arrows, all heat exchangers 11, 12, 21, 22 are flowed through by the air flow produced by the fan 2. The fan 2, which corresponds in construction to the fan 2 according to Fig. 1, is shown in Fig. 2 in a view in which the rotational axis 3 of the impeller 5 (the latter not shown in Fig. 2) lies in the plane of the drawing. Accordingly, it can be seen that the air flowing through the upstream heat exchangers 11, 12 of the first group 10 enters into the fan 2 in axial direction (in relation to rotational axis 3).

[0037] Preferably, rotational axis 3 is aligned approximately parallel to a longitudinal axis of the vehicle, on which the cooling arrangement comes into use. Preferably, the drawing-in direction of the air entering into the fan 2 corresponds to the direction of the head wind of the vehicle, for which the first group 10 is arranged in front of the fan 2 in the direction of travel of the vehicle.

[0038] As can be seen from Fig. 2, the air outlet 6 of the fan 2 is arranged above rotational axis 3 of the fan 2 and opens upwards. Air emerging from the fan 2 therefore streams out, as indicated by the upwardly directed arrow, upwards through the heat exchangers of the second group 20.

[0039] Heat exchangers 11, 12, 21, 22 can be basically configured or arranged differently. In particular - deviating from the diagrammatic illustration in Fig. 2 — these can be provided such that the air flow does not flow through these, but rather flows past them. For this, they can also be aligned parallel to the air flow.

[0040] However, the heat exchangers 11, 12, 21, 22 are preferably embodied according to Fig. 2, according to which these comprise a surface through which the air flows. Accordingly the heat exchange takes place within the heat exchangers, where a faster heat transmission is possible.

[0041] As seen in Fig. 2, the surfaces of the heat exchangers 11, 12 preferably extend approximately transversely to the longitudinal axis of the vehicle, which is approximately parallel to the rotation axis 3. In difference, the surfaces of the heat exchangers 21, 22 preferably extend approximately parallel to the longitudinal axis of the vehicle.

[0042] According to the invention, high cooling capacities with a relative low noise production can be achieved with the cooling arrangement 1. In particular, it is found advantageous that through the arrangement of heat exchangers both upstream of the radial fan and downstream of the radial fan, turbulences of the air flow can be reduced. Whereas in the drawing-in region of the radial fan, relatively low air flow speeds prevail, these can be relatively high in the outlet region. This can be utilized advantageously by usage of heat exchangers which are adapted with regard to area and/or with regard to output. In this way, it is also possible to optimize the air flow path with respect to fluid mechanics.

List of reference numbers

[0043]

1	cooling arrangement
2	fan
3	rotational axis
4	housing
5	impeller
6	air outlet
10	first group of heat exchangers

11 heat exchanger

12 heat exchanger

20 second group of heat exchangers

21 heat exchanger

22 heat exchanger

Claims

1. Cooling arrangement (1) for an agricultural vehicle, comprising at least two heat exchangers (11, 12, 21, 22) and a fan (2) directing an air flow to the at least two heat exchangers (11, 12, 21, 22), **characterized in that** the fan (2) is a radial fan, upstream of which, in relation to the air flow, at least one heat exchanger (11, 12) is arranged, and downstream of which, in relation to the air flow, at least one heat exchanger (21, 22) is arranged.

2. Cooling arrangement according to claim 1, **characterized in that** the heat exchanger (11, 12) arranged upstream of the fan (2) is associated with a first group (10) comprising at least one further heat exchanger (11, 12) arranged upstream of the fan (2).

3. Cooling arrangement according to claim 1 or 2, **characterized in that** the heat exchanger (21, 22) arranged downstream of the fan (2) is associated with a second group (20) comprising at least one further heat exchanger (21, 22) arranged downstream of the fan (2).

4. Cooling arrangement according to claim 2 or 3, **characterized in that** several heat exchangers (11, 12, 21, 22) associated with one group (10, 20) are arranged one after the other in direction of the air flow.

5. Cooling arrangement according to one of the preceding claims, **characterized in that** a heat exchanger (11, 12) associated with the first group (10) is flowed through by a different medium than a heat exchanger (21, 22) associated with the second group (20).

6. Cooling arrangement according to one of the preceding claims, **characterized in that** a medium flows through at least one of the heat exchangers (11, 12, 21, 22), the medium being an operating and/or auxiliary resource for the vehicle.

7. Cooling arrangement according to one of the preceding claims, **characterized in that** a surface, with air flowing through, of a heat exchanger (11, 12) arranged upstream of the fan (2) extends approximately transversely to the longitudinal axis of the vehicle.

8. Cooling arrangement according to one of the preceding claims, **characterized in that** the surface, with air flowing through, of a heat exchanger (21, 22) arranged downstream of the fan (2) extends approximately parallel to the longitudinal axis of the vehicle.

9. Cooling arrangement according to one of the preceding claims, **characterized in that** the air flow leaves an heat exchanger (21, 22) arranged downstream of the fan (2) in upwards direction.

10. Cooling arrangement according to one of the preceding claims, **characterized in that** the fan (2) comprises an impeller (5), the rotational axis (3) of which is aligned approximately parallel to the longitudinal axis of the vehicle.

11. Cooling arrangement according to one of the preceding claims, **characterized in that** the fan (2) has a housing (4) accommodating an impeller (5) which is able to be brought into rotation.

12. Cooling arrangement according to claim 11, **characterized in that** the housing (4) surrounds the impeller (5) circumferentially, with a radial air outlet (6) being provided on a circumferential region of the housing (4).

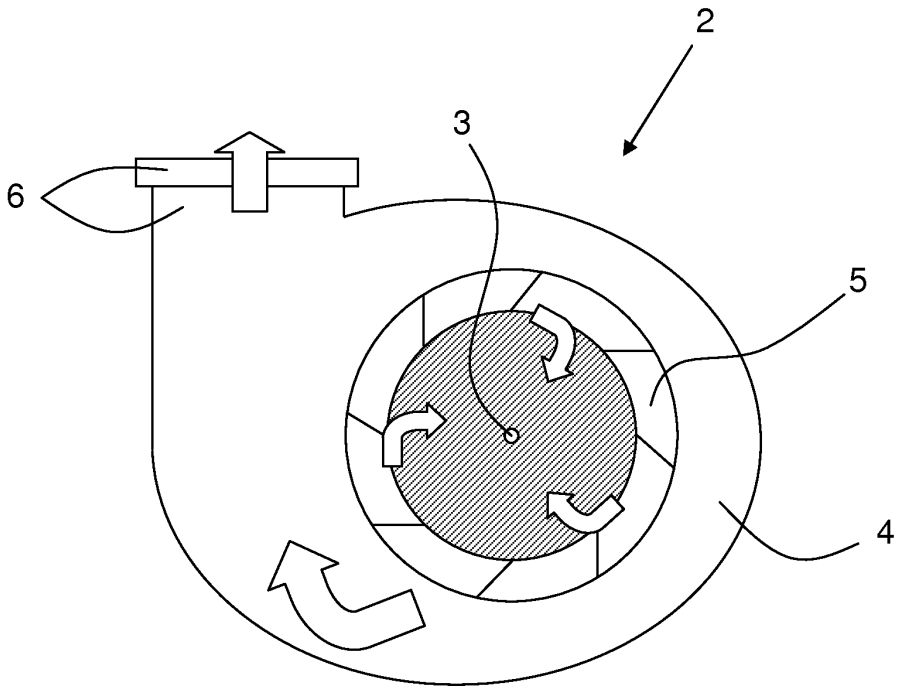

Fig. 1

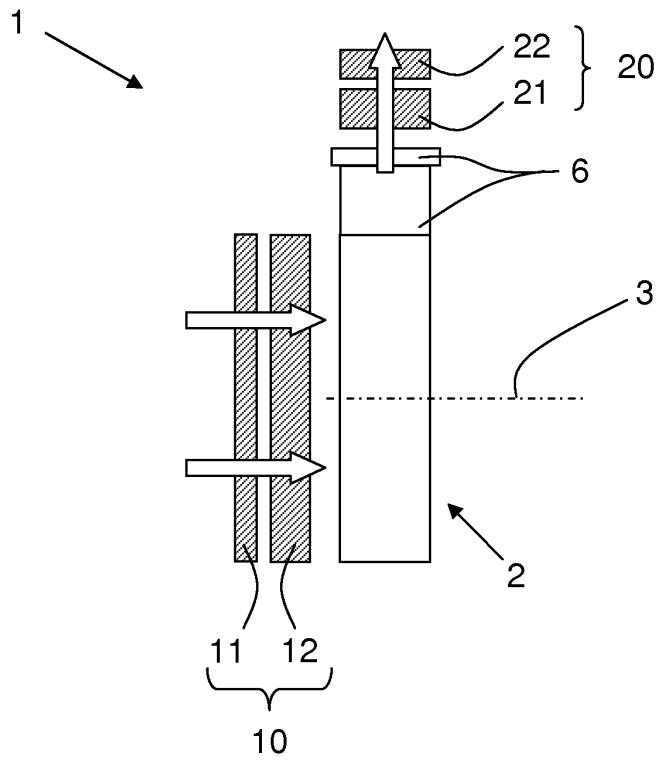

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 10 17 4863

DOCUMENTS CONSIDERED TO BE RELEVANT

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X Y	US 6 401 801 B1 (DICKE PAUL A [US]) 11 June 2002 (2002-06-11) * column 2, line 56 - column 4, line 10 * * column 1, lines 6-12; figures 1,2 * -----	1,3,5-8, 10-12 4,9	INV. F01P3/18
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			TECHNICAL FIELDS SEARCHED (IPC) F01P

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	10 March 2011	Luta, Dragos

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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