

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
24 August 2006 (24.08.2006)

PCT

(10) International Publication Number
WO 2006/088406 A1

(51) International Patent Classification:

F28F 19/00 (2006.01) *F28F 1/02* (2006.01)
F02B 29/04 (2006.01) *F28F 1/40* (2006.01)
F28D 1/053 (2006.01)

(21) International Application Number:

PCT/SE2006/000126

(22) International Filing Date: 30 January 2006 (30.01.2006)

(25) Filing Language:

Swedish

(26) Publication Language:

English

(30) Priority Data:

0500372-8 17 February 2005 (17.02.2005) SE

(71) Applicant (for all designated States except US): **SCANIA CV AB (PUBL)** [SE/SE]; S-151 87 Södertälje (SE).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **PETTERSSON, Rickard** [SE/SE]; Söderby 633, S-144 51 Rönninge (SE).

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

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

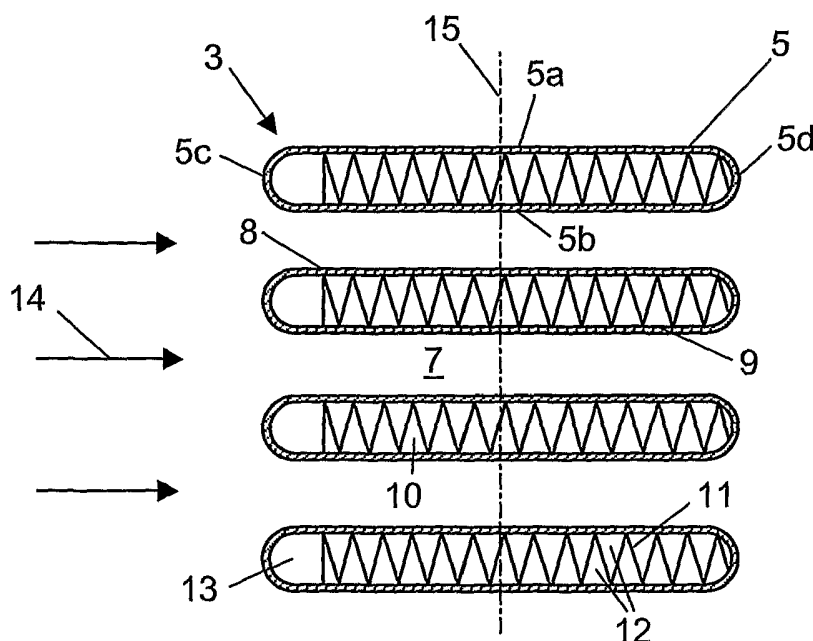
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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.

(54) Title: AIR COOLER



(57) Abstract: The present invention relates to an air cooler. The air cooler comprises at least one tubular element (5) with an inside surface (9) which defines a passage (10) for air which is to be cooled in the air cooler, and at least one heat-conducting element (11, 11') which is fastened inside said passage (10) and shaped in such a way as to divide the passage (10) into a plurality of flow paths (12, 12'). A medium at a lower temperature than the air which is to be cooled in the air cooler is caused to flow in contact with an outside surface (8) of the tubular element (5) so that the air in the air cooler undergoes cooling as it is led through said passage (10). The size of the heat-conducting element (11, 11') is such that it occupies only part of the cross-section of the passage (10), thereby forming in

a remaining portion of the passage (10) an elongate duct (13, 13') which has a larger cross-sectional area than the cross-sectional areas of the respective flow paths (12, 12') which are formed by the heat-conducting element 11, 11').

Air cooler

BACKGROUND TO THE INVENTION, AND STATE OF THE ART

5 The present invention relates to an air cooler according to the preamble of claim 1.

The amount of air which can be supplied to a supercharged combustion engine of a vehicle depends on the pressure of the air but also on the temperature of the air. Supplying the largest possible amount of air to a supercharged combustion engine
10 entails cooling compressed air in a charge air cooler before it is led to the combustion engine. The charge air cooler is usually situated in front of the conventional radiator of a vehicle. A charge air cooler usually comprises two gathering tanks and a plurality of tubular elements arranged in parallel which connect the gathering tanks. The parallel tubular elements are arranged at a distance from one another so that
15 surrounding cold air can flow between the tubular elements and cool the compressed air in the tubular elements. The compressed air can be cooled to a temperature substantially corresponding to the temperature of the surrounding air.

The cooling effect of the charge air cooler can be increased by fitting inside the tubular
20 elements one or more folded metal sheets, so-called turbulators. The metal sheets divide the tubular elements into a plurality of relatively narrow flow paths. The metal sheets provide extra contact surface with respect to the compressed air in the tubular elements so that the compressed air can be cooled more effectively. The shape of the metal sheets may also be such as to promote turbulent flow of the compressed air.
25 Such flow further increases the cooling effect on the compressed air as it passes through the tubular elements.

In certain weather conditions, the compressed air in a charge air cooler is cooled to a temperature below the dewpoint temperature of the air. Water vapour in the
30 compressed air condenses, with the result that water in liquid form is precipitated inside the charge air cooler. When the temperature of the surrounding air is very low, there is also risk that water in liquid form may freeze to become ice inside the charge

air cooler. Such ice formation takes place largely on the surfaces of the metal sheets. As the metal sheets provide relatively narrow flow paths for the compressed air, such situations entail risk that ice may block the flow paths. In such cases the air flow to the combustion engine may be reduced to a level at which operational malfunctions
5 occur.

US 4 246 963 refers to a heat exchanger which is preferably used in aircraft. The heat exchanger comprises a cooler package with separate ducts for cold air and for warm air. The various ducts are arranged alternately above one another and have a
10 substantially perpendicular extent through the cooler package relative to one another. The cold air very often contains crystals of ice. Such air being led into the heat exchanger may result in ice formations at the inlet to the cold air ducts. Such formations of ice may to a greater or lesser extent stop the flow of cold air through the heat exchanger. To solve this problem, a tubular beam element is arranged at the inlet
15 to the cold air ducts. Warm air is led in parallel through the tubular beam element and the ordinary ducts for warm air. The warm air led through the beam element heats the beam element's outside surface which defines the inlet to the cold air ducts. The beam element's outside surface will thus be at a high enough temperature to prevent ice formation at the inlets to the cold air ducts.

20

SUMMARY OF THE INVENTION

The object of the present invention is to provide an air cooler so constructed as to ensure that air can be led through the cooler even in circumstances where the air is
25 cooled by a medium which is at a very low temperature.

This object is achieved with the air cooler of the kind mentioned in the introduction which is characterised by the features indicated in the characterising part of claim 1. When the medium, which may be surrounding air, is at a very low temperature, there is
30 risk that water vapour in the air which is to be cooled in the air cooler may condense and freeze to become ice. This ice formation takes place on the inside surface of the tubular elements and on the surfaces of the heat transfer element. As the heat transfer

element divides the passage into relatively narrow flow paths, there is obvious risk that the flow paths may to a greater or lesser extent be blocked if ice forms on surfaces of the heat transfer element. Arranging the heat transfer element in only part of the cross-section of the passage results in an elongate duct in the remainder of the passage. If
5 such a duct is of sufficient size, there is substantial assurance that it will not freeze. Air flow can therefore substantially always be maintained through the air cooler. The relatively warm air flowing through the elongate duct also supplies heat to the heat-conducting element. Ice formations on the heat-conducting element can thus gradually be caused to melt, thereby clearing adjacent flow paths.

10

According to an embodiment of the present invention, said elongate duct is arranged at a front side of the tubular portion with respect to the direction of flow of the medium. At the front side, the medium will initially flow in contact with a surface of the tubular portion. This is where the medium is at its lowest temperature. The most effective
15 cooling of the tubular element thus takes place at said front side. Such a location of the elongate duct is often sufficient to provide the air in the duct with fully acceptable cooling without the assistance of a heat transfer element. According to another embodiment, the elongate duct may alternatively be arranged at a rear side of the tubular portion with respect to the direction of flow of the medium. Since the
20 temperature of the medium rises as it flows past the heat transfer element, there is less cooling action at the rear side of the heat transfer element. There is thus less risk of ice formation in the elongate duct. The elongate duct may therefore be of a smaller size. It is also possible to arrange the duct in an intermediate portion of the passage with heat transfer elements fitted on mutually opposite sides.

25

According to another preferred embodiment of the present invention, said passage has a cross-sectional profile with a greater extent in the direction of flow of the medium than in a direction perpendicular to said direction of flow. Such a configuration of the tubular element results in a relatively elongate contact surface with respect to the
30 flowing medium, thereby promoting cooling of the air in the tubular element. With advantage, said elongate duct has a cross-sectional profile with substantially the same width as height. If for example the duct has a cross-sectional profile of

underdimensioned extent in height or width, there is obvious risk that ice may build up in the direction of underdimensioned extent of the duct in such a way as to block the duct. If on the contrary the duct is of overdimensioned extent in one direction, the result is an unnecessarily tall or wide duct. Such an overdimensioned duct reduces the number of flow paths, leading to less cooling of the air passing through the tubular element. An optimum duct is therefore likely to be of substantially same extent in height and width.

According to a preferred embodiment of the present invention, the cooler comprises a plurality of tubular elements arranged parallel in a row at a distance from one another so that between adjacent tubular elements there are gaps through which the medium is caused to flow. The tubular elements may be arranged at a substantially uniform distance from one another. The result is a substantially uniform flow of air in the gaps between adjacent tubular elements. The air is thus cooled to substantially the same temperature in all the tubular elements.

According to a preferred embodiment of the present invention, the tubular element is made of a material which has good heat-conducting characteristics. The result is effective heat transfer between the medium outside and the air inside the tubular element. The tubular element may be made of aluminium, which has excellent heat-conducting characteristics. The heat-conducting element is preferably likewise made of a material which has good heat-conducting characteristics. Here again, aluminium is a suitable material. The heat-conducting element may be made of folded sheet material. Sheet material provides a contact surface which can easily be shaped so that suitable flow paths can be formed in the passage. The contact surfaces may be shaped in such a way as to promote turbulent flow through the flow paths. The surfaces may for example have a gill-like structure, resulting in still more effective cooling of the air in the tubular element.

According to a preferred embodiment of the present invention, the air cooler is a charge air cooler adapted to cooling air which is at above atmospheric pressure. A charge air cooler may be used inter alia in a vehicle to cool compressed air before it is

led to a supercharged combustion engine. It is not uncommon for the compressed air to be cooled in the charge air cooler to a temperature below the dewpoint temperature, with the result that water vapour in the air condenses inside the charge air cooler.

Conventional charge air coolers are usually cooled by surrounding air. If the surrounding air is at a very low temperature, there is also risk that condensate inside the charge air cooler may freeze to become ice. The elongate duct according to the invention in the charge air cooler's tubular element makes it possible in substantially all circumstances to maintain sufficient air flow through the charge air cooler for running the supercharged combustion engine.

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 a charge air cooler according to the present invention,
- Fig. 2 depicts a cross-section through the charge air cooler along the plane A-A in Fig. 1 and
- Fig. 3 depicts a charge air cooler according to an alternative embodiment.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

Fig. 1 depicts a charge air cooler which may for example be fitted at a front portion of a vehicle which is powered by a supercharged combustion engine. A supercharged combustion engine needs a supply of compressed air. The function of the charge air cooler is to cool the compressed air before it is led to the combustion engine. The charge air cooler comprises an inlet 1 to a first gathering tank 2 for receiving warm compressed air from a compressor. The first gathering tank 2 comprises a plurality of internal apertures via which the compressed air can be led to a cooler package 3 which extends between the first gathering tank 2 and a second gathering tank 4. The cooler package 3 comprises a plurality of tubular elements 5 which extend in a substantially

rectilinear manner between the first gathering tank 2 and the second gathering tank 4. The tubular elements 5 are arranged parallel vertically above one another. The tubular elements 5 are arranged at a substantially uniform distance from one another so that there are regular gaps 7 between adjacent tubular elements 5. Surrounding air can therefore flow through said gaps 7 between adjacent tubular elements 5. The flow of surrounding air through the cooler package 3 can be caused by the vehicle's movement and/or by a radiator fan drawing air through the cooler package 3. The second gathering tank 4 comprises internal apertures for receiving cooled compressed air from the respective tubular elements 5. The cooled compressed air is led out from the second gathering tank 4 via an outlet 6 before being led through suitable pipelines to the supercharged combustion engine.

Fig. 2 depicts a cross-sectional view of four tubular elements 5 of the cooler package 3. The tubular elements 5 are of identical configuration. The tubular elements 5 are made of a material with high thermal conductivity, e.g. aluminium. The tubular elements 5 have in cross-section a substantially elongate profile with two mutually opposite long sides 5a, b which are substantially planar. The mutually opposite long sides 5a, b are connected by two mutually opposite short sides 5c, d which are of a convex rounded shape outwards. The tubular elements 5 have an outside surface 8 which defines a contact surface with surrounding air. The tubular elements 5 have an inside surface 9 which defines a passage 10 for the compressed air when it is led between the gathering tanks 2, 4.

Each of the tubular elements 5 comprises a heat-conducting element 11 which is fastened inside the passage 10 and is in contact with the inside surface 9 at a number of points. The heat-conducting element 11 is arranged in the passage 10 in order to increase the cooling contact surface with respect to the compressed air which is led through the passage 10. The heat-conducting element 11 is made of a material with good thermal conductivity, e.g. aluminium. The heat-conducting element 11 may be made of sheet aluminium folded in such a way as to divide the passage into a plurality of substantially parallel flow paths 12. Each of the flow paths 12 will thus be of relatively limited cross-sectional area. The compressed air flowing through the

passage 10 in the respective tubular elements 5 is adapted to being cooled by surrounding air. The surrounding air has a main direction of flow 14 towards the cooler package 3 which is substantially perpendicular to a plane 15 extending centrally through the tubular elements 5 which are arranged vertically above one another. Part
5 of the surrounding air, however, encounters the forward short side 5c of a tubular element 5 before it flows through a gap 7 between two adjacent tubular elements 5. The surrounding air is usually at a considerably lower temperature than the compressed air in the tubular element 5. When the surrounding air comes into contact with the outside surface 8 of the tubular element 5, it causes cooling of the outside
10 surfaces 8. As the tubular elements 5 and the heat transfer element 11 are composed of material with good heat-conducting characteristics, they also provide the inside surface 9 and the heat transfer element 11 of the respective tubular elements 5 with effective cooling. The inside surface 9 and the heat transfer element 11 thus provide very effective cooling of the compressed air in the passages 10 of the respective tubular
15 elements 5.

When the surrounding air temperature is low, the compressed air in the charge air cooler may be cooled to a temperature below the dewpoint temperature of the compressed air. In such cases, water vapour in the compressed air condenses, with the
20 result that water in liquid form is precipitated inside the passages 10 of the respective tubular elements 5. If the temperature of the surrounding air is very low, there is risk that condensate may freeze to become ice inside the passages 10. Such ice will form on the inside surface 9 of the tubular elements 5 and on the surfaces of the heat transfer element 11. As the heat transfer element 11 comprises flow paths 12 with relatively
25 small cross-sectional areas, there is obvious risk that flow paths 12 may to a greater or lesser extent be blocked if ice forms on the surfaces of the heat transfer element 11. Such situations cause operational malfunctions of the combustion engine through insufficient air supply.

30 According to the present invention, however, the size of the heat-conducting element 11 is such that it occupies only part of the cross-section of the passage 10 so that a remaining portion of the passage cross-section forms a duct 13 which has a larger

cross-sectional area than the cross-sectional areas of the respective individual flow paths 12 formed by the heat-conducting element 11. In Fig. 2, the heat-conducting element 11 is arranged in the passage 10 in such a way that said duct 13 is formed at the forward short side 5c of the tubular element 5 relative to the direction of flow 14 of the surrounding air. In this case the elongate duct 13 has substantially the same height and width. The duct 13 should at least not be so narrow in either direction as to increase the risk of the duct 13 becoming frozen up. When there is a very low ambient temperature and the flow paths 12 freeze up, such a channel 13 of a suitable size makes it possible substantially always to maintain an air flow through the charge air cooler. The compressed air in the duct 13 also provides heat to the heat-conducting element 11. Ice formations on the heat-conducting element 11 can thus gradually be caused to melt so that blocked flow paths 12 can resume their air guiding function.

Fig. 3 depicts a cross-sectional view of four tubular elements 5 according to an alternative embodiment.

In this case, the heat-conducting element 11' is arranged in the passage in such a way that a duct 13' is formed at the rear short side 5d of the tubular element relative to the direction of flow 14 of the surrounding air. Here again the elongate duct 13' has a cross-sectional shape with substantially the same height as width. The heat-conducting element 11' is folded in such a way as to divide the passage into a plurality of substantially parallel flow paths 12' which are of relatively small cross-sectional area. The heat-conducting element 11' is also provided with surfaces of protruding portions and apertures, thereby promoting turbulent flow of air through the flow paths 12'. The heat-conducting element 11' thus provides very effective cooling of the compressed air as it passes through the flow paths 12'. The cooling air flow results in a gradually rising temperature along the elongate gap 7. The cooling effect at the rear short side 5d of the tubular element is therefore not the same as at the forward short side 5c, thereby further reducing the risk of the duct 13' freezing up. When there is a very low ambient temperature, such a duct 13' of a suitable size makes it possible always to maintain an air flow through the charge air cooler. The compressed air in the duct 13'

also provides heat to the heat-conducting element 11' so that existing ice formations on the heat-conducting element 11' can be gradually melted.

5 The invention is in no way limited to the embodiments described with respect to the drawings but may be varied freely within the scopes of the claims. A plurality of separate heat-conducting elements may be arranged in the passage. The elongate duct may be arranged in any desired portion of the passage.

Claims

1. An air cooler, whereby the air cooler comprises at least one tubular element (5) with an inside surface (9) which defines a passage (10) for air which is to be cooled in the air cooler, and at least one heat-conducting element (11, 11') which is fastened inside said passage (10) and shaped in such a way as to divide the passage (10) into a plurality of flow paths (12, 12'), and whereby a medium at a lower temperature than the air which is to be cooled in the air cooler is caused to flow in contact with an outside surface (8) of the tubular element (5) so that the air in the air cooler undergoes cooling as it is led through said passage (10), characterised in that the size of the heat-conducting element (11, 11') is such that it occupies only part of the cross-section of the passage (10), thereby forming in a remaining portion of the passage (10) an elongate duct (13, 13') which has a larger cross-sectional area than the cross-sectional areas of the respective flow paths (12, 12') which are formed by the heat-conducting element (11, 11').
2. An air cooler according to claim 1, characterised in that said elongate duct (13) is arranged at a front side (5c) of the tubular portion with respect to the direction of flow (14) of the medium.
3. An air cooler according to claim 1, characterised in that said elongate duct (13) is arranged at a rear side (5d) of the tubular portion with respect to the direction of flow (14) of the medium.
4. An air cooler according to any one of the foregoing claims, characterised in that said passage (10) has a cross-sectional profile with a larger extent in the direction of flow (14) of the medium than in a direction perpendicular to said direction of flow (14).
5. An air cooler according to any one of the foregoing claims, characterised in that said elongate duct (13, 13') has a cross-sectional profile with substantially the same width as height.

6. An air cooler according to any one of the foregoing claims, characterised in that the cooler comprises a plurality of tubular elements (5) arranged parallel in a row at a distance from one another so that there are between adjacent tubular elements (5) gaps
5 (7) through which the medium is caused to flow.

7. An air cooler according to any one of the foregoing claims, characterised in that the tubular element (5) is made of a material which has good heat-conducting characteristics.

10

8. An air cooler according to any one of the foregoing claims, characterised in that the heat-conducting element (11, 11') is made of a material which has good heat-conducting characteristics.

15 9. An air cooler according to claim 8, characterised in that the heat-conducting element (11, 11') is made of a folded sheet material.

10. An air cooler according to any one of the foregoing claims, characterised in that the cooler is a charge air cooler adapted to cooling compressed air.

1/2

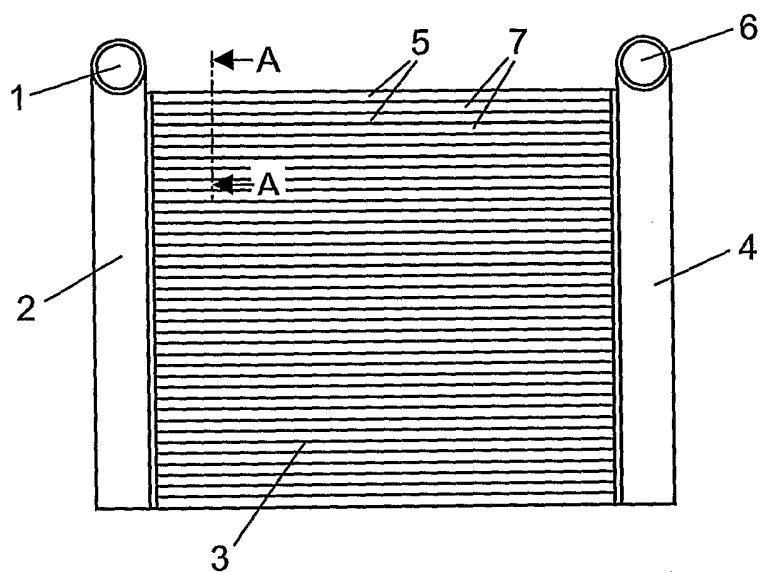


Fig 1

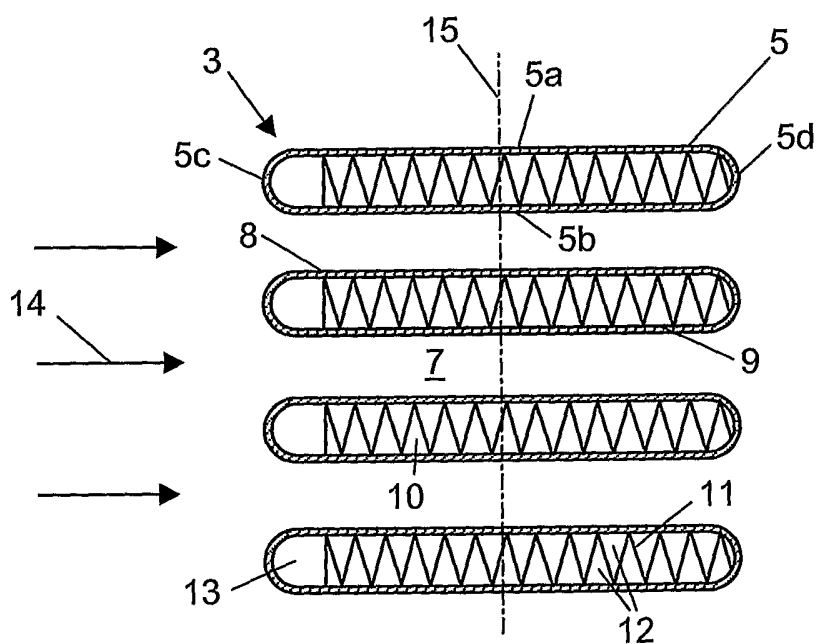


Fig 2

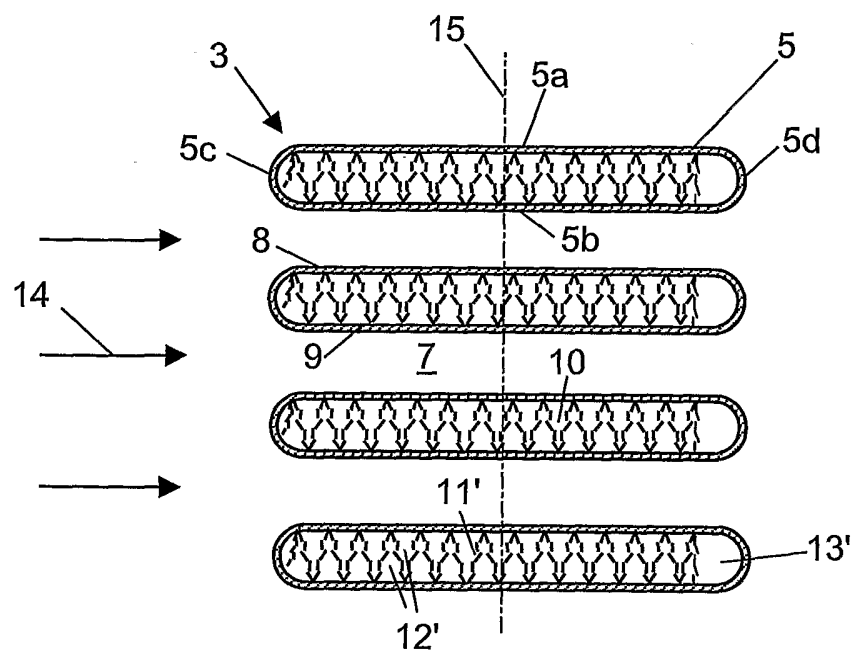


Fig 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2006/000126

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: F28F, 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, 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	US 4246963 A (ANDERSON), 27 January 1981 (27.01.1981), see the whole document --	1-10
Y	DE 29614186 U1 (AKG-THERMOTECHNIK GMBH & CO. KG), 5 February 1998 (05.02.1998), figures 1-7 --	1-10
A	US 5174373 A (SHINMURA), 29 December 1992 (29.12.1992), figure 7 --	
A	US 20040050531 A1 (HORIUCHI ET AL), 18 March 2004 (18.03.2004), figures 3,5,7,19,23,, claim 24 --	

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

26 April 2006

Date of mailing of the international search report

05-05-2006

Name and mailing address of the ISA/

Swedish Patent Office

Box 5055, S-102 42 STOCKHOLM

Facsimile No. +46 8 666 02 86

Authorized officer

Annette Riedel / JA A

Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2006/000126

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5163507 A (JOSHI), 17 November 1992 (17.11.1992), figure 4 --	
A	US 3601185 A (EDWARD A. ROTHMAN), 24 August 1971 (24.08.1971), figure 2 --	
A	WO 2004113817 A1 (HALLA CLIMATER CONTROL CORPORATION), 29 December 2004 (29.12.2004), figure 2 --	
A	PATENT ABSTRACTS OF JAPAN vol. 016, no. 284 (M-1270), 24 June 1992 (1992-06-24) & JP 2073592 A (MATSUSHITA ELECTRIC IND CO LTD), 9 mARCH 1992 (1992-03-09) abstract -- -----	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2006/000126

International patent classification (IPC)

F28F 19/00 (2006.01)

F02B 29/04 (2006.01)

F28D 1/053 (2006.01)

F28F 1/02 (2006.01)

F28F 1/40 (2006.01)

Download your patent documents at www.prv.se

Cited patent documents can be downloaded at www.prv.se by following the links e-tjänster/anförda dokument. Use the application number as username. The password is **90ch0whay5**.

Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

INTERNATIONAL SEARCH REPORT

Information on patent family members

04/03/2006

International application No.

PCT/SE2006/000126

US	4246963	A	27/01/1981	CA	1119583	A	09/03/1982
				DE	2939858	A,C	30/04/1980
				FR	2439971	A,B	23/05/1980
				GB	2036286	A,B	25/06/1980
				JP	1141132	C	24/03/1983
				JP	55060177	A	07/05/1980
				JP	57031078	B	02/07/1982
				SE	454211	B,C	11/04/1988
				SE	7908837	A	27/04/1980

DE	29614186	U1	05/02/1998	NONE
----	----------	----	------------	------

US	5174373	A	29/12/1992	JP	2984326	B	29/11/1999
				JP	4073599	A	09/03/1992
				JP	3454518	B	06/10/2003
				JP	4363593	A	16/12/1992

US	20040050531	A1	18/03/2004	CN	1500198	A	26/05/2004
				EP	1370818	A	17/12/2003
				JP	2004530092	T	30/09/2004
				US	20050269066	A	08/12/2005
				WO	02066918	A	29/08/2002

US	5163507	A	17/11/1992	NONE
----	---------	---	------------	------

US	3601185	A	24/08/1971	DE	2048010	A,B,C	19/05/1971
				FR	2066982	A,B	13/08/1971
				GB	1267027	A	15/03/1972

WO	2004113817	A1	29/12/2004	NONE
----	------------	----	------------	------