(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 788 251 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
23.05.2007 Bulletin 2007/21

(51) Int Cl.:
F04C 29/02 *(2006.01)*

(21) Application number: **06023544.7**

(22) Date of filing: **13.11.2006**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

(30) Priority: **16.11.2005 IT MI20052191**

(71) Applicant: **ING. ENEA MATTEI S.p.A.**
I-20090 Vimodrone
Milano (IT)

(72) Inventor: **Contaldi, Giulio**
20068 Peschiera Borromeo
Milano (IT)

(74) Representative: **Petruzzelli, Antonio**
C.so Italia, No. 43
20122 Milano (IT)

(54) Cooling system for compressor

(57) An integrated cooling system for an oil-lubricated compressor (1) of gaseous fluids comprising a motor unit (2), a compression unit (3) and an external cage (12) of the compression unit (3), wherein said cooling system provides for direct heat exchange with the internal surface of said external cage (12) of the compression unit (3); the invention relates to an oil-lubricated gaseous fluids compressor (1), provided with this system.

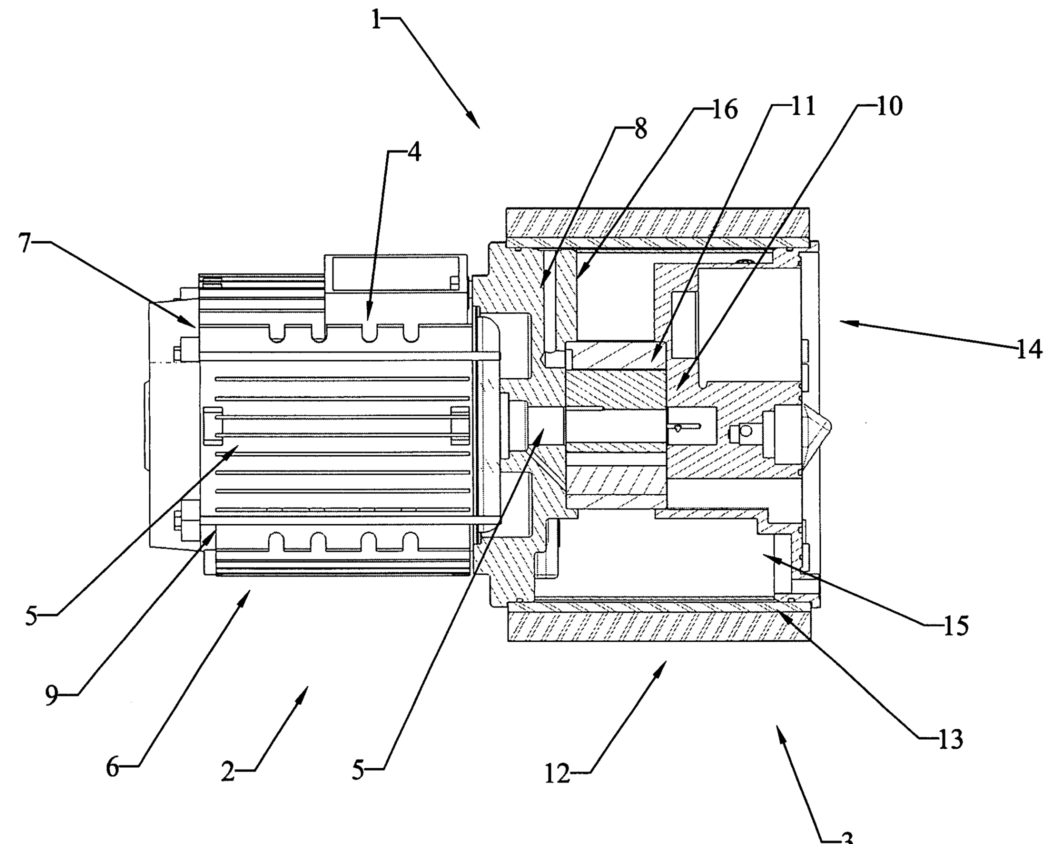

Fig. 1

EP 1 788 251 A1

Description

[0001] The present invention relates particularly but not exclusively to compressors for elastic fluids with low viscosity such as air or gas, of the type lubricated with oil. More specifically a first aspect of the invention relates to a cooling system integrated in the compressor and a second aspect of the invention relates to a compressor of gaseous fluids provided with this system.

[0002] Air compressors have numerous applications, for example in industry or in building, and the various requirements related to these areas of use have entailed the development of a range of extremely diversified products. More particularly, in the area of low-power air compressors, for example up to a few kW, there is a strong drive towards industrialisation of appliances which are as compact and economical as possible, a need met above all via progressive integration of functional and structural elements.

[0003] Air compressors of the oil-lubricated type are known to the state of the art. These compressors have a motor unit, provided for example with an electric motor of variable power, and a compression unit, which may comprise a stator and a vane or screw rotor, or at least one cylinder-piston pair. The moving parts do not encounter contact friction thanks to an oil injection circuit which allows the formation and the maintaining of a thin film of oil between the moving parts, which avoids wear of the same and the phenomenon of seizure at the same time ensuring perfect airtightness. The compression unit also comprises an external cage equipped internally with means for the circulation of air, a space for housing the compression chamber and an oil collection chamber which, during operation of the compressor, transfers the oil upstream of the circuit and recovers the oil downstream of the same. At least one radiator for the cooling of the oil and a fan which removes the heat through convection are also connected to the compression unit.

[0004] The oil injection circuit not only allows the formation of said layer of oil between the moving parts but also contributes to cooling the air during compression, which otherwise would take place in a substantially isoentropic manner. For this reason the oil, which undergoes a temperature rise during the phase of compression of the air, is generally made to circulate in a special finned radiator outside of the compressor, which is appropriately cooled by a fan. The provision of a radiator outside of the compressor undoubtedly represents a limit to the reduction in the volume of the machine, while practicality, simplicity and compactness are instead very important requirements for low-power air compressors.

[0005] The primary object of the present invention is that of providing a system for cooling of the compressed fluid for a compressor of gaseous fluids integrated in the compression unit, without the provision of internal volumes and outside elements additional thereto.

[0006] Another object of the present invention is that of providing a system for cooling of the compressed fluid integrated in a compressor of gaseous fluids with high heat exchange efficiency, yet at the same time with reduced overall dimensions thanks to the smaller number of its component parts.

[0007] The object of the present invention is likewise that of providing a system for cooling compressed fluid integrated in a compressor of gaseous fluids that can be made with a lower production cost in terms of times and raw materials, and at the same time provided with important requirements of quality, reliability and durability.

[0008] All these objects are achieved by the cooling system according to the present invention, for an oil-lubricated compressor of gaseous fluids comprising a motor unit, a compression unit and an external cage of the compression unit provided with a chamber for the collection of the lubricating oil, wherein said cooling system provides for direct heat exchange of the compressed fluid with the internal surface of said external cage of the compression unit.

[0009] Advantageously this system of cooling of the compressed fluid is fully integrated in the compressor.

[0010] The system for cooling of the compressed fluid will preferably comprise means for directing the compressed fluid against the internal walls of said external cage of the compressor.

[0011] According to another aspect of the invention, an oil-lubricated compressor of gaseous fluids is provided, equipped with a motor unit and a compression unit which substantially comprises a rotor and a hollow stator whose internal walls define with said rotor at least one compression chamber, and an external cage provided with a chamber for collection of the lubricating oil, provided with an integrated system for the cooling of the compressed fluid as disclosed above.

[0012] Further features and advantages of the present invention will be made clearer on reading the following detailed description of a preferred embodiment, given by way of a non-limiting example, whereto the drawings refer, in which:

Figure 1 is a sectioned side view of an air compressor according to the present invention, and

Figure 2 is a sectioned front view of the compression unit of the compressor of Figure 1, with the detail of the motor side cover.

[0013] Figure 1 is a sectioned side view of an air compressor provided with the system for cooling the compressed fluid integrated according to the present invention. The air compressor 1 is of the rotary vane type and lubricated with oil, and is composed of the motor unit 2 and the compression unit 3.

[0014] The motor unit 2 comprises an electric motor 4 whose shaft, not shown in the drawing, rotates around the bearings or bushings 5. Said electric motor 4 is closed externally by a cylindrical body 6, which is closed at the rear by the cap 7, and at the front by the motor side cover

8 of the compression unit 3. Said cap 7 is screwed directly to the motor side cover 8 of the compression unit 3 by means of the tie-rods 9, so that the cylindrical body 6 remains closed on both the flat sides. A fan, not shown, is mounted in a known manner on an extension of the drive shaft, also not shown, so as to provide adequate convective cooling for both the motor and compression units.

[0015] The compression unit 3, illustrated schematically, comprises a rotor 10 and a stator 11, which define an air compression chamber, and an external cage 12. This external cage 12 is formed by a motor side cover 8, by a side cylindrical body 13 and by an intake side cover 14.

[0016] The compression unit 3 is of the oil-lubricated type and therefore has known means for the injection and the re-circulation of the same. In this respect the external cage 13 of the compression unit 3 is provided with a chamber 15 for the collection of the oil, formed from an internal volume of said compression unit. The oil is mixed during compression with the air forming a mixture, which exits from the compression chamber through the outlet manifold. The outflow of the pressurised fluid or mixture rises up the vertical channel 16, formed in the motor side cover 8, for example through a radial hole, and impacts against the upper portion of the internal surface of the side cylindrical body 13, following which the oil phase of the mixture is partly separated from the air and subsequently flows along the internal wall of said cylindrical body 13 as far as the oil collection chamber 15, exchanging in this way heat with said internal wall. Following the impact, moreover, the flow of compressed air mixed with the residual oil is divided into two opposite and substantially symmetrical flows, not visible in Figure 1, which flow from above downwards along a forced route as specified in greater detail herein below.

[0017] Figure 2 represents a sectioned front view of the compression unit 3 of Figure 1, wherein the features of the cooling system according to the present invention are highlighted. The mixture or fluid, in the direction of the arrow A, exits under pressure from the outlet manifold 17 and enters the vertical channel 16 as indicated by the arrow B. The flow of the mixture, once it has risen up the channel 16, impacts on the internal wall of the upper portion of the side cylindrical body 13, and divides into two symmetrical flows as mentioned previously. The forced route of the compressed fluid then continues through the gap 18, where cooling takes place through direct heat exchange with the internal walls of the side cylindrical body 13. This gap 18 is defined for this purpose by the internal walls of the side cylindrical body 13 and by the shell 19, a curved body positioned inside the external cage 12 and made in thin sheet metal or another suitable material. The shell 19 is supported concentrically in relation to the side cylindrical body 13 by means of a circular groove formed on the motor side cover 8, and a ring seal in contact with the intake side cover of the external cage 12, both not shown in the drawing. The system for cooling the compressed fluid according to the present invention allows the same external cage 12 of the compression unit to be used by way of an integrated radiator, in that in flowing through the cylindrical gap 19 said two opposite and symmetrical flows of pressurised fluid exchange heat directly with the side cylindrical body 13, whose internal surface is washed from above downwards throughout its development. In order to facilitate this heat exchange and consequent cooling of the fluid, various rows of fins 20 are provided outside of the side cylindrical body 13, as described in a separate patent application in the name of the same Applicant. The compressed fluid, which is a mixture formed by air and oil, is cooled simply and directly, without the provision of any radiator outside of the compressor. Advantageously both the air phase and the oil phase of the compressed fluid exchange heat at the same time, although cooling of the oil phase is preponderant, in such a way that by reaching at a lower temperature the oil collection chamber 15 the subsequent process of separation can take place more efficiently.

[0018] In a different embodiment of the cooling system according to the present invention, not shown in any image, the outlet manifold of the compression chamber is connected in a known manner to a channel or to a plurality of channels, arranged radially, for example in a sunburst, in such a way that the outflow from the compression chamber is divided into a number of flows equal to the number of channels provided, and that each flow is directed against the internal wall of the cylindrical body 13. In this way each flow of mixture is subjected to impact with said internal wall and direct cooling of the fluid and partial demixing of the air phase from the oil phase of the same described previously take place simultaneously. More generically the system of cooling of the pressurised fluid according to the present invention provides means for directing the outflow from the compression chamber against the internal wall of the cylindrical body of the external cage, in such a way that the oil phase flows along the walls as far as the oil collection chamber, and during this route the pressurised fluid efficiently yields thermal energy.

[0019] It is clear how the cooling system is fully integrated in the compression unit of the air compressor, and considerably simplifies the process of assembly of the compressor and its routine and non-scheduled maintenance. To an even more evident extent the cooling system described allows a considerable reduction in the final volume of the machine, having avoided the need for the external radiator. It is understood that the compressor according to the present invention, described here in detail as of the rotary vane type, could also be of the rotary screw type, or with cylinders and pistons, and also have two or more compression chambers, without the principles of operation described losing the special connotations claimed herein below.

Claims

1. A system for cooling the compressed fluid for an oil-lubricated compressor (1) of gaseous fluids comprising a motor unit (2), at least one compression unit (3) and an external cage (12) of the compression unit equipped with a chamber for the collection of the lubricating oil (15), wherein said cooling system provides for the direct heat exchange of the compressed fluid with the internal surface of said external cage (12) of the compression unit (3).

2. A system of cooling of compressed fluid according to claim 1, **characterised in that** this system is integrated in the compressor (1).

3. A system of cooling of compressed fluid according to claim 1, comprising means for directing said compressed fluid against the internal surface of said external cage (12) of the compression unit (3).

4. A system of cooling of compressed fluid according to claim 1, **characterised in that** at least one row of fins (20) is provided outside of the side cylindrical body (13) of the external cage (12) of the compressor (1).

5. A system of cooling of compressed fluid according to the previous claims, **characterised in that** said means for directing said compressed fluid against the internal surface of the external cage (12) of the compression unit (1) consist of at least one radial channel (16).

6. A system of cooling of compressed fluid according to the previous claims, **characterised in that** it comprises a stage of gas - oil separation through mechanical impact following at least one change in direction of the flow of compressed fluid, which impacts for this purpose against the internal surface of the external cage (12) of the compression unit (3).

7. A system of cooling of compressed fluid according to the previous claims, **characterised in that** at the outlet of said at least one radial channel (16) the compressed fluid exchanges heat directly with the side cylindrical body (13), whose internal surface is washed from above downwards throughout its development.

8. A system of cooling of compressed fluid according to the previous claims, **characterised in that** a fan is mounted on said motor unit (2) to cool the motor unit (2) or the compression unit (3).

9. An oil-lubricated compressor (1) of gaseous fluids, provided with a motor unit (2) and a compression unit (3) which substantially comprises a rotor (10) and a hollow stator (11) whose internal walls define with said rotor (10) at least one compression chamber, and an external cage (12) provided with a chamber for collection of the lubricating oil (15), provided with a system of cooling of the compressed fluid according to claims 1 to 8.

10. An oil-lubricated compressor (1) of gaseous fluids according to claim 9, wherein the pressurised fluid, in output from the compression chamber, flows into at least one radial channel (16).

11. An oil-lubricated compressor (1) of gaseous fluids according to claim 10, wherein said at least one radial channel (16) is formed in the motor side cover (18) through at least one radial hole.

12. An oil-lubricated compressor (1) of gaseous fluids according to the previous claims, wherein the pressurised fluid at the outlet of at least one radial channel (16) impacts against the internal wall of the side cylindrical body (13), performing a first gas - oil separation.

13. An oil-lubricated compressor (1) of gaseous fluids according to the previous claims, wherein the flow of pressurised fluid at the outlet of at least one radial channel (16) is divided into at least two opposite and substantially symmetrical flows which flow from above downwards along the internal walls of the external cage (12) of the compression unit (3).

14. An oil-lubricated compressor (1) of gaseous fluids according to claim 9, **characterised in that** it comprises at least one curved shell (19) positioned inside the external cage (12) and supported concentrically in relation to the side cylindrical body (13) of the external cage (12) of the compressor, said curved shell (19) defining with the internal walls of said side cylindrical body (13) a cylindrical gap (18).

15. An oil-lubricated compressor (1) of gaseous fluids according to claim 14, wherein the flow of pressurised fluid at the outlet of at least one radial channel (16) is divided into at least two opposite and substantially symmetrical flows which flow from above downwards through the cylindrical gap (18).

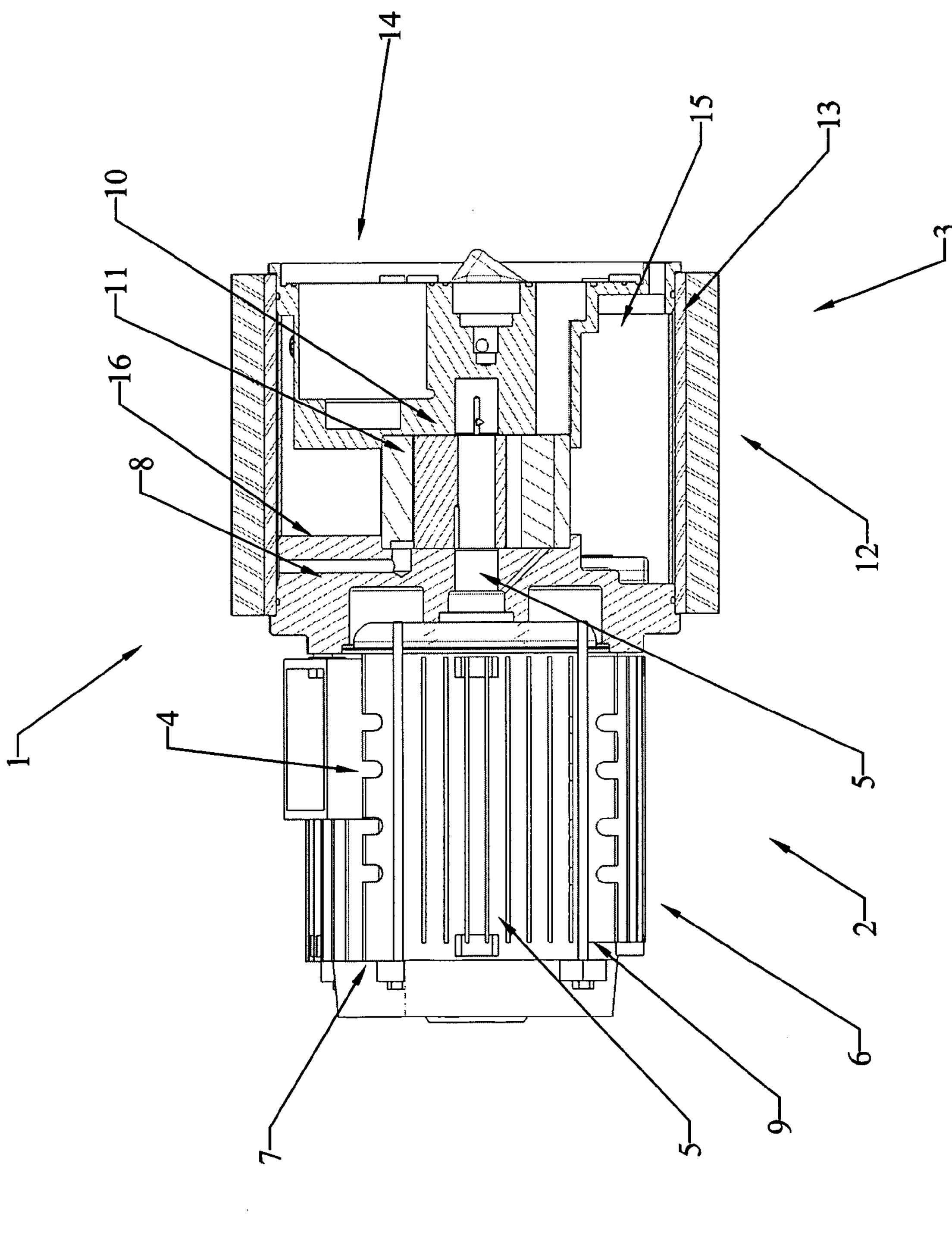

Fig. 1

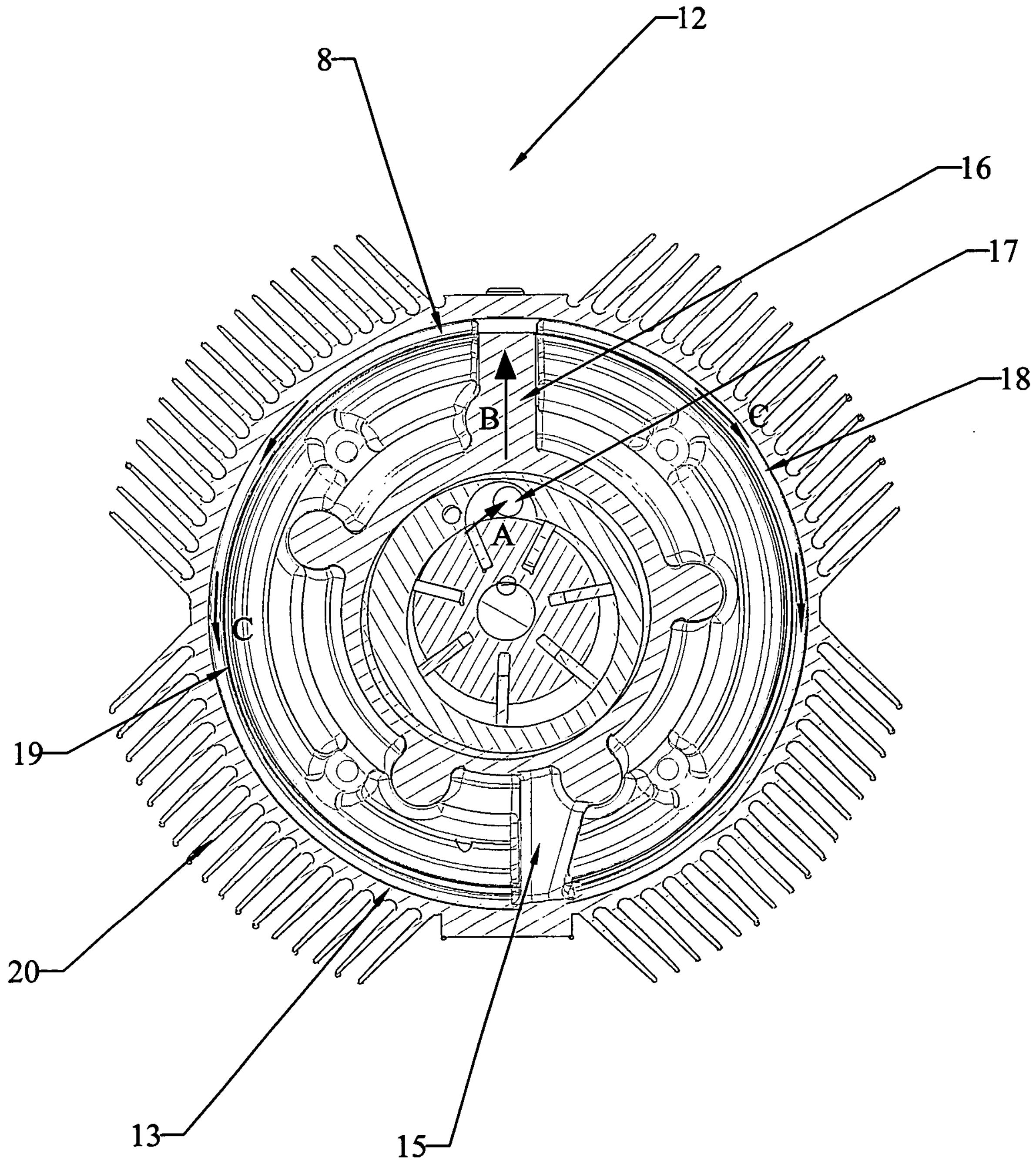

Fig. 2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 02 3544

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	US 4 631 006 A (MURRAY GARY P [US]) 23 December 1986 (1986-12-23) * figures 1,4-6 * * column 1, lines 44-48 * * column 1, lines 61-66 * * column 3, lines 45-50 * * column 4, line 62 - column 5, line 2 * * column 5, lines 18-20 * -----	1-14 14,15	INV. F04C29/02
X	US 4 091 638 A (MITCH GEORGE CHARLES) 30 May 1978 (1978-05-30) * figures 1,2 * * column 1, lines 39-44 * * column 1, lines 54-59 * * column 1, line 66 - column 2, line 25 * * column 2, lines 42-55 * * column 3, line 46 - column 4, line 10 * * column 4, lines 49-53 * -----	1-7,9-13	
X	US 5 178 522 A (ABELEN THOMAS [DE] ET AL) 12 January 1993 (1993-01-12) * figures 1,2 * * column 1, lines 21-23 * * column 2, lines 27-31 * * column 3, lines 12-18 * -----	1,2,4, 8-10	TECHNICAL FIELDS SEARCHED (IPC) F04C
X	US 2 476 041 A (REYNOLD HAPPE ET AL) 12 July 1949 (1949-07-12) * figures 1,2 * * column 1, lines 9-13 * * column 1, lines 46-53 * * column 2, lines 8-10 * * column 2, lines 44-48 * * column 3, lines 19-30 * * column 3, lines 46-58 * * column 4, lines 1-8 * ----- -/--	1-4,6,8, 9	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	1 March 2007	Biloen, David

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 02 3544

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2 057 381 A (KENNEY MAHLON W ET AL) 13 October 1936 (1936-10-13) * figures 2-4 * * page 6, column 1, lines 26-35 * -----	1,5,6	
X	FR 59 634 E (C E M I C) 29 June 1954 (1954-06-29) * figures 1,2 * -----	1-3,5-7, 9-12	
Y	GB 448 167 A (BOSCH ROBERT) 3 June 1936 (1936-06-03) * page 1, lines 62-72 * * figure 1 * -----	14,15	
			TECHNICAL FIELDS SEARCHED (IPC)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	1 March 2007	Biloen, David

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

4

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 02 3544

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

01-03-2007

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4631006 A	23-12-1986	NONE	
US 4091638 A	30-05-1978	AU 509655 B2	22-05-1980
		AU 3099977 A	28-06-1979
		CA 1062483 A1	18-09-1979
		DE 2754476 A1	15-06-1978
		FR 2373695 A1	07-07-1978
		GB 1560438 A	06-02-1980
		JP 53075513 A	05-07-1978
		MX 145354 A	27-01-1982
US 5178522 A	12-01-1993	DE 4017191 A1	05-12-1991
		EP 0459107 A1	04-12-1991
		JP 4231696 A	20-08-1992
US 2476041 A	12-07-1949	NONE	
US 2057381 A	13-10-1936	NONE	
FR 59634 E	29-06-1954	NONE	
GB 448167 A	03-06-1936	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82