

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
6 March 2003 (06.03.2003)

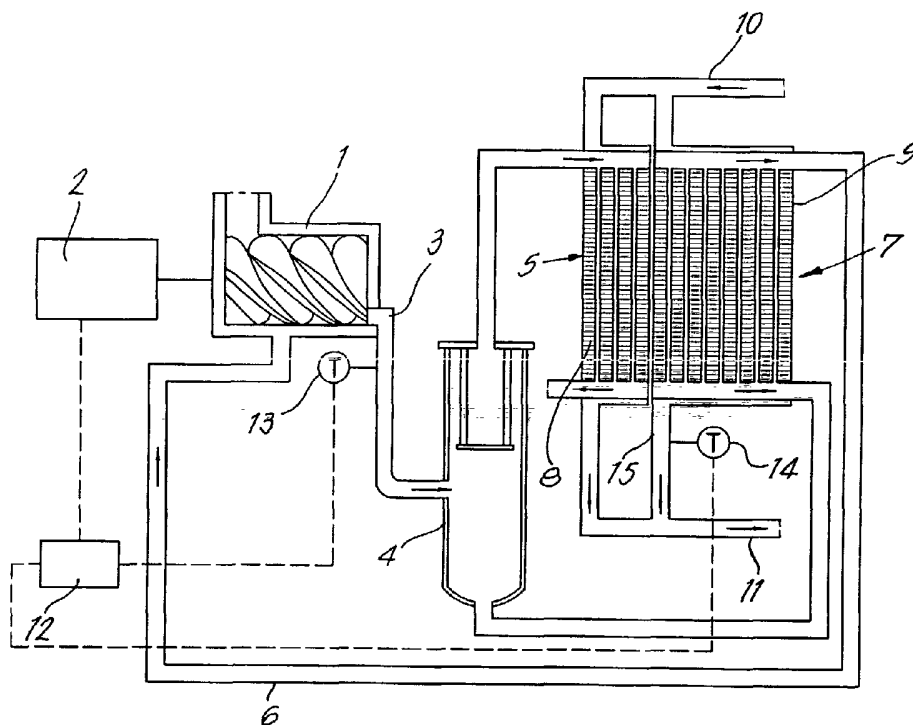
PCT

(10) International Publication Number  
**WO 03/019010 A1**

- (51) International Patent Classification<sup>7</sup>: **F04C 29/00**, 29/10, 29/04, 18/16
- (72) Inventor; and  
(75) Inventor/Applicant (for US only): **TALBOOM, Bart, Anton, Lode** [BE/BE]; Duivenstraat 26, B-2550 Kontich (BE).
- (21) International Application Number: PCT/BE02/00141
- (74) Agent: **DONNE, E.**; Bureau M. F. J. Bockstael nv., Arenbergstraat 13, B-2000 Antwerpen (BE).
- (22) International Filing Date: 29 August 2002 (29.08.2002)
- (25) Filing Language: English
- (81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.
- (26) Publication Language: English
- (30) Priority Data: 2001/0566 30 August 2001 (30.08.2001) BE
- (71) Applicant (for all designated States except US): **ATLAS COPCO AIRPOWER** [BE/BE]; Naamloze Venootschap, Boomsesteenweg 957, B-2610 Wilrijk (BE).
- (84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),

[Continued on next page]

(54) Title: METHOD FOR THE PROTECTION OF A VOLUMETRIC LIQUID-INJECTED COMPRESSOR



(57) Abstract: This invention relates to a method for the protection of a volumetric liquid-injected compressor of the type comprising a compressor element (1) driven by a motor (2), a pressure conduit (3), a separator (4) for injection liquid erected in this pressure conduit (3), an injection conduit (6) for injecting the separated injection liquid into the compressor element (1), and a liquid-cooled cooler (7) in this injection conduit (6). The outlet

[Continued on next page]



Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),  
European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE,  
ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK,  
TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,  
GW, ML, MR, NE, SN, TD, TG).

**Published:**

— with international search report

**Declaration under Rule 4.17:**

— of inventorship (Rule 4.17(iv)) for US only

*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.*

---

temperature of the compressed gas is measured and, depending on at least this temperature and on a limit value, it is determined whether the motor (2) has to be stopped. Also, the environmental temperature in the outlet (5) for the cooling water of the radiator (9) is measured and the limit value is rendered dependent on this environmental temperature.

Method for the protection of a volumetric liquid injected compressor.

---

5 This invention relates to a method for the protection of a volumetric liquid-injected compressor of the type comprising a compressor element driven by a motor, a pressure conduit connected to the compressor element, a separator for injection liquid erected in this pressure  
10 conduit, an injection conduit for injecting the separated injection liquid into the compressor element, and a cooler in this injection conduit, according to which method at least the outlet temperature of the compressed gas is measured and, depending on at least this  
15 temperature and on a limit value, it is determined whether the motor has to be stopped.

In such compressors, injection liquid, for example, water, is injected into the compressor element in order  
20 to lubricate and cool the rotor or rotors thereof. This injection liquid also serves as a sealing agent between the two rotors of the compressor element. This liquid is discharged along with the compressed gas and separated from the gas in a separator or vessel and re-used for  
25 injection.

When the injection fails or is too low, the internal cooling during compression fails, and the temperature of the compressed gas, when exiting the compressor element,  
30 immediately becomes very high. Depending on the internal pressure ratio of the compressor element, this temperature can reach 250 to 300°C.

Therefore, such compressors are protected by measuring  
35 the outlet temperature of the outgoing compressed gas and, if this temperature exceeds a certain fixed limit

value, stopping the motor.

In most of the oil-injected volumetric compressors, a thermostatic valve in the injection conduit provides for that the compressor element reaches its normal temperature as soon as possible, which temperature can be set closely to the aforementioned limit value.

With compressors without such thermostatic valve, for example, water-injected compressors in which such valve in practice is not usual and desirable, the injection temperature and, consequently, also the temperature of the compressed gas at the outlet of the compressor element depend on the environmental temperature. It is, in fact, desirable to keep the temperature of the injection water as low as possible in order to approach an isothermic compression as closely as possible. This has a favourable influence onto the energy output of the compression.

The invention in particular relates to such compressors without thermostatic regulation.

When the outlet temperature of the compressed gas in a compressor, said cooler of which is cooled by cooling liquid, mostly cooling water, suddenly starts to rise, this will be measured, with a certain delay, by a temperature sensor, and, also with a certain delay, a reaction upon this temperature increase will take place.

In particular if the environmental temperature is low, this may form a problem. In this case, the normal outlet temperature of the compressor element also is low, such that, with a sudden increase of this outlet temperature, the temperature measured by the temperature sensor will follow only slowly, which may lead to temperature peaks.

With a high environmental temperature, this problem will occur less. The outlet temperature of the compressed gas then will be in the proximity of the set protection temperature. Sudden temperature increases only result in  
5 a limited delay, such that major temperature peaks will be avoided.

When, in compressors in which the cooler is cooled with cooling liquid, mostly water, the temperature of the  
10 cooling liquid is very low, or if the cooling liquid flow rate is very high, then in that type of compressors the normal temperature level is very remote from the set protection value, which in the case of sudden temperature increases may lead to high temperature peaks.

15 The present invention aims at offering a solution for the above-mentioned problem and at providing a method for protecting a volumetric compressor, in which said temperature peaks are avoided.

20 In a compressor of the type as determined in the first paragraph, and with a liquid-cooled cooler, provided with an in- and outlet for cooling liquid, according to the invention said problem is solved in that the outlet  
25 temperature of the compressed gas, as well as the temperature and the flow rate of the cooling liquid are measured and that the temperature protection is rendered dependent on this temperature and the flow rate.

30 It is also recommended for liquid-injected compressors with a liquid-cooled cooler, to maintain an absolute limit for the outlet temperature of the compressed gas.

It may, in fact, happen that that the cooler does not  
35 work optimum and the flow of cooling water is hampered, as a result of which the temperature of the injection

liquid rises. The protection temperature, which depends thereupon, also will rise, which might lead to inacceptably high temperatures at the outlet of the compressor element.

5

With the intention of better showing the characteristics of the invention, hereafter, as an example without any limitative character, a preferred form of embodiment is described, with reference to the accompanying drawings, wherein the figure schematically represents a volumetric  
10 water-injected screw-type compressor according to the invention.

The volumetric water-injected compressor with, thus,  
15 water as an injection liquid, represented in the figure, substantially consists of a compressor element 1, a motor 2 driving this compressor element 1, a pressure conduit 3 which is connected to the compressor element 1 and in which successively a vessel which is a water separator 4  
20 and a cooler 5 are erected, and an injection conduit 6, for returning the separated water and injecting it into the compressor element 1, in which a cooler 7 is erected.

The coolers 5 and 7 are liquid-cooled coolers with  
25 separate radiators 8 and 9, which are erected in the pressure conduit 3 and the injection conduit 6, respectively.

The radiators 8 and 9 are connected with their inlet to a  
30 common supply conduit 10 for cooling liquid, mostly cooling water, and connected with their outlet to a common discharge conduit 11 for this cooling liquid.

The compressor comprises a protection against excessive  
35 temperatures by means of an electronic control device 12 which controls the motor 2 and to which two temperature

sensors 13 and 14 are connected.

Temperature sensor 13 is arranged at the outlet of the compressor element 1 in the pressure conduit 3, and  
5 temperature sensor 14 is provided in the outlet 15 for the cooling water of the radiator 9 and, thus, of the cooler 7.

Protecting takes place as follows:

10

When the compressor is operating, the outlet temperature of the compressed gas is measured by means of temperature sensor 13, as well as the outlet temperature of the cooling water of the cooler 7 is measured by means of  
15 temperature sensor 14.

By the control device 12, the difference between these two temperatures is determined and compared to a put-in limit value of the temperature difference. If this limit  
20 value is reached or exceeded, then the control device 12 stops the motor 2.

In this manner, a limitation of the temperature increase or, in other words, a relative temperature limit is  
25 obtained.

As the protection is related to the environmental temperature, the protection level at which the motor 2 is stopped, for the entire range of operation or temperature  
30 range, is closer to the normal value of the outlet temperature of the air, at the outlet of the compressor element, as a consequence of which the influence of a sudden temperature increase only results in a minor delay of the protection.

35

The control device 12 also adds said limit value for the

temperature difference to a chosen limit value of the environmental temperature. The sum thereof provides an absolute limit and, when it is reached or exceeded, the control device 12 also commands the stopping of the motor 2.

This last-mentioned outlet temperature of the cooling water is a measure for the cooling water temperature at the inlet and of the cooling water flow rate.

When the outlet temperature of the cooling water exceeds a certain pre-set value, the control device 12 commands to stop the motor 2.

For each type of cooler, there is, for a certain output, a certain ratio between the outlet temperature of the cooling water and that of the compressed gas at the outlet of the compressor element 1.

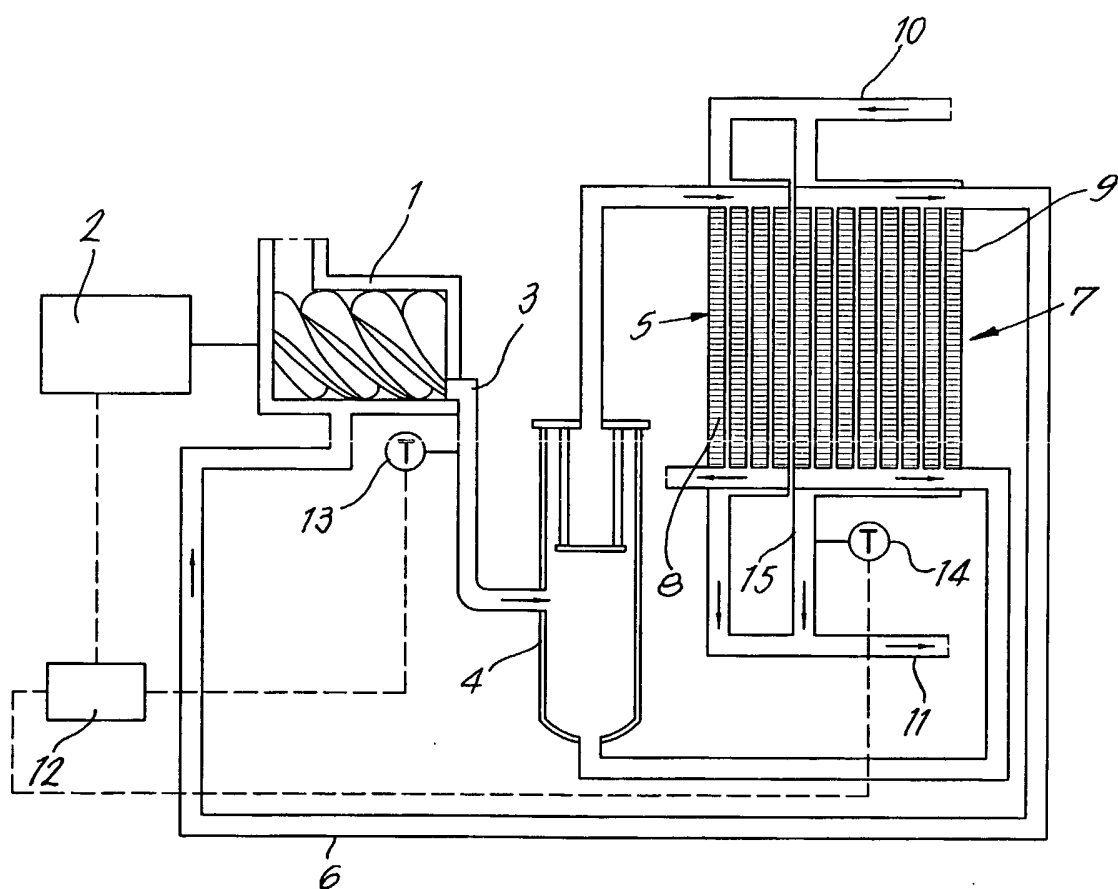
In consideration of the fact that the cooling water might fail or be strongly reduced in an undesired manner, an absolute limit for the outlet temperature is maintained. The control device 12 also stops the motor 2 when this absolute limit is reached or exceeded.

The present invention is in no way limited to the form of embodiment described as an example and represented in the figure; on the contrary, such method may be realized according to different variants, without leaving the scope of the invention.

Claims.  

---

- 1.- Method for the protection against excessive  
5 temperatures of a volumetric liquid-injected compressor  
of the type comprising a compressor element (1) driven by  
a motor (2), a pressure conduit (3) connected to the  
compressor element (1), a separator (4) for injection  
10 liquid erected in this pressure conduit (3), an injection  
conduit (6) for injecting the separated injection liquid  
into the compressor element (1), and a cooler (7) in  
this injection conduit (6), according to which method at  
least the outlet temperature of the compressed gas is  
15 measured and, depending on at least this temperature and  
on a limit value, it is determined whether the motor (2)  
has to be stopped, characterized in that the temperature  
and the flow rate of the cooling liquid are measured and  
the temperature protection is rendered dependent on this  
20 temperature and this flow rate.
- 2.- Method according to claim 1, characterized in that  
the temperature and the flow rate of the cooling liquid  
in the cooler (7) are measured indirectly by measuring  
25 the temperature of the cooling liquid of the cooler (7)  
in the outlet (18), said temperature depending on said  
parameters, and in that the temperature protection is  
rendered dependent on this temperature in the outlet  
(18).
- 30 3.- Method according to claim 1 or 2, characterized in  
that the protection takes place additionally in function  
of a set absolute limit for the outlet temperature of the  
compressed gas.



# INTERNATIONAL SEARCH REPORT

PCT/BE 02/00141

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 F04C29/00 F04C29/10 F04C29/04 F04C18/16

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 7 F04C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 347 821 A (OLTMAN ROBERT L ET AL) 20 September 1994 (1994-09-20) claim 1; figure 2 ---	1
A	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 03, 30 March 2000 (2000-03-30) -& JP 11 336684 A (HITACHI LTD), 7 December 1999 (1999-12-07) abstract ---	1
A	US 5 797 980 A (FILLET FREDERIC) 25 August 1998 (1998-08-25) claim 1; figure 1 --- --/--	1



Further documents are listed in the continuation of box C.



Patent family members are listed in 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 document 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

18 October 2002

Date of mailing of the international search report

29/10/2002

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Dimitroulas, P

# INTERNATIONAL SEARCH REPORT

PCT/BE 02/00141

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 08, 30 June 1998 (1998-06-30) & JP 10 077980 A (ISHIKAWAJIMA HARIMA HEAVY IND CO LTD), 24 March 1998 (1998-03-24) abstract ----	1
A	US 5 884 494 A (ULLAND PAUL D ET AL) 23 March 1999 (1999-03-23) claim 1; figure 1 ----	1
A	US 4 502 833 A (HIBINO YOZO ET AL) 5 March 1985 (1985-03-05) claim 1; figure 1 ----	1
A	US 4 336 001 A (ANDREW EDUARDO V ET AL) 22 June 1982 (1982-06-22) claim 1; figure 1 -----	1

# INTERNATIONAL SEARCH REPORT

Information on patent family members

PCT/BE 02/00141

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5347821	A	20-09-1994	CA 2127340 A1 US 5431025 A	24-01-1995 11-07-1995
JP 11336684	A	07-12-1999	NONE	
US 5797980	A	25-08-1998	FR 2746667 A1 CA 2201045 A1 EP 0798464 A1 JP 10024209 A	03-10-1997 27-09-1997 01-10-1997 27-01-1998
JP 10077980	A	24-03-1998	NONE	
US 5884494	A	23-03-1999	AU 8658398 A CN 1269871 T EP 1009934 A1 WO 9913225 A1	29-03-1999 11-10-2000 21-06-2000 18-03-1999
US 4502833	A	05-03-1985	JP 1690731 C JP 3057316 B JP 58070078 A	27-08-1992 30-08-1991 26-04-1983
US 4336001	A	22-06-1982	US 4227862 A	14-10-1980