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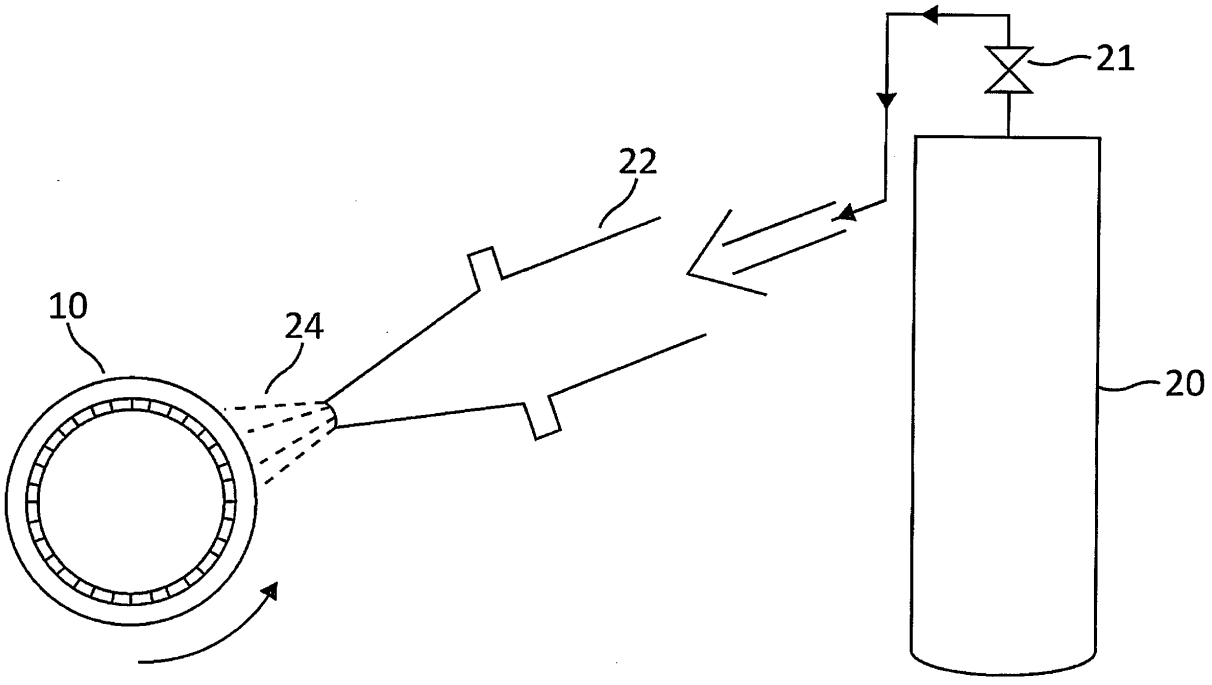
(71) Applicant: **Linde Aktiengesellschaft**
80331 München (DE)

(72) Inventor: **Foret, Pierre**
80796 München (DE)

(74) Representative: **Gellner, Bernd**
Linde AG
Legal Services Intellectual Property
Dr.-Carl-von-Linde-Strasse 6-14
82049 Pullach (DE)

(54) Method and device for lubricating a tribological system

(57) Method for lubricating a tribological system comprising the following steps:
- Providing gaseous carbon dioxide, and
- bringing the gaseous carbon dioxide into contact with regions of the tribological system to be lubricated.



EP 2 770 042 A1

Description

Background of the invention

[0001] The invention relates to a method and a device for lubricating a tribological system.

Prior art

[0002] Tribological systems comprise at least two parts, which perform a relative movement to one another while in contact, thereby creating friction and wear. Such friction and wear created by the movement and the contact of such parts can result in a deterioration of the system and a shorter lifetime.

[0003] For example, heavy load bearings for machine tools, gear boxes, turbines (gas turbines) or space equipment are subject to wear and friction, which must be minimized in order to ensure longevity.

[0004] To this effect, special bulk materials, surfaces and/or lubricants are constantly being developed, in order to decrease friction and wear, thereby increasing the lifetime of such systems.

[0005] As lubricants, it is well known to use oil-based substances. The atmosphere surrounding such tribological systems is usually air. However, air is not inert and reacts with the surfaces or bulk material of the components of a tribological system (for example metals) and also with lubricants. Especially, air can lead to deterioration due to oxidation of metals and/or lubricants. These disadvantages are especially prominent in case of high temperatures.

[0006] Such interactions between the tribological system and the surrounding atmosphere have an important overall effect on the lifetime of the system as well as its efficiency.

[0007] From WO 2006/119047 A2 it is known to use supercritical carbon dioxide as a lubrication means for metal work pieces during metal working processes. The provision of supercritical carbon dioxide is, however, relatively expensive. Also, the provision and handling of supercritical carbon dioxide is time-consuming.

[0008] The present invention thus seeks to provide a lubricant for tribological systems which is efficient, as well as easy and cheap to provide and handle.

[0009] The invention thus provides a method and a device according to the independent claims.

[0010] Advantageous embodiments of the invention are the subject matter of the independent claims.

[0011] According to the invention, a highly effective lubricant for numerous tribological systems is provided, which is both inexpensive and easy to handle.

[0012] According to a preferred embodiment, gaseous carbon dioxide is provided by expanding liquid carbon dioxide provided in a gas cylinder or vessel. It can be transformed into the gaseous state for example using membrane techniques. After being directed to the tribological system to be lubricated (i. e. regions of the tribological system, which are to be lubricated), this gaseous carbon dioxide can be released into the atmosphere. As is well known, health hazards in connection with carbon dioxide are minimal, so that no specific measures for protecting users in the vicinity of the lubricated tribological system are necessary. Gasous carbon dioxide can be supplied from cylinders with gaseous content. It is also possible to collect carbon dioxide after lubrication in order to recycle it, for example to provide synthetic fuels.

[0013] Gaseous carbon dioxide can easily be handled. For example, it can be provided in cylinders or containers containing liquid carbon dioxide. Such a cylinder can be provided with means for gaseous extraction, as is commonly known. Carbon dioxide is cheap and readily available.

[0014] The invention will now be described in more detail on the basis of a preferred embodiment as shown in the figures.

[0015] Figure 1 shows a preferred embodiment of a device according to the invention with which a tribological system can be lubricated.

[0016] As an example of a tribological system to be lubricated, a bearing 10 is shown. A cylinder 20 containing liquid carbon dioxide is provided with a nozzle device 22 (not shown true to scale relative to the cylinder 20), through which liquid carbon dioxide can be expanded to provide a stream 24 of gaseous carbon dioxid. A closing valve is expediently provided between cylinder 20 and nozzle device 22.

[0017] By expedient placement of nozzle 22 in relation to the bearing 10, lubrication of the latter by means of gaseous carbon dioxide can be effectively provided.

[0018] As carbon dioxide is non-hazardous for users, no means for retrieving gaseous carbon dioxide subsequently to its contact with bearing 10 are necessary.

[0019] Injection of gaseous carbon dioxide enables an effective lubrication of regions of tribological systems to be lubricated. Especially, specific shapes of nozzles 22 can be used in order to transport gaseous carbon dioxide to desired regions or places.

[0020] Wear and friction of tribological systems, especially metal parts of such systems, is thus effectively reduced.

[0021] This observation especially holds for tribological systems operating at elevated temperatures, especially for temperatures above 200°C.

[0022] It is presumed that by usage of gaseous carbon dioxide as lubricant metal or iron carbonates are formed on the surface of components of tribological systems, resulting in efficient proctective layers.

[0023] A continuous supply of gaseous carbon dioxide is usually necessary, since such protective layers of metal or ion carbonates will be removed by rubbing, i. e. components of a tribological system moving relative to one another.

[0024] It has been shown that usage of gaseous carbon dioxide as lubricant requires no further addition of other lubricants, such as oil based lubricants.

[0025] The invention constitutes a dry lubrication, which can especially be utilized for applications in which any kind of dampness is to be avoided.

[0026] In most tribological applications, liquid or grease lubricants are used against friction and wear. However, under extreme conditions e. g. (very high or low temperature, vacuum, radiation, extreme pressure) solid lubricants (i.e. molybdenum disulfide, graphite, hexagonal boron nitride) have conventionally been the only choice. At least for some of these applications, gaseous carbon dioxide may now be used as lubricant.

[0027] Examples of applications are: air compressors, food industry applications, railway track joints, open gear, ball bearings, machine-shop works, space vehicles (bearings, rings).

[0028] The invention is also useful to reduce wear and friction in tribological systems containing materials such as ceramics and polymers.

[0029] Further preferred examples of tribological systems, with which the invention can advantageously be used, are, for example, bearings, magnetic storage devices, transmission devices, driveline devices, brakes, cylinders, valves, wheels, dampers, equipment used in mining and mineral processing, cutting devices, gearboxes, turbines and space equipment. Spacecraft contain a variety of instruments and mechanisms that require lubrication. Such devices include solar array drives, momentum, reaction and filter wheels, tracking antennas, scanning devices and sensors.

Claims

1. Method for lubricating a tribological system (10) comprising the following steps:

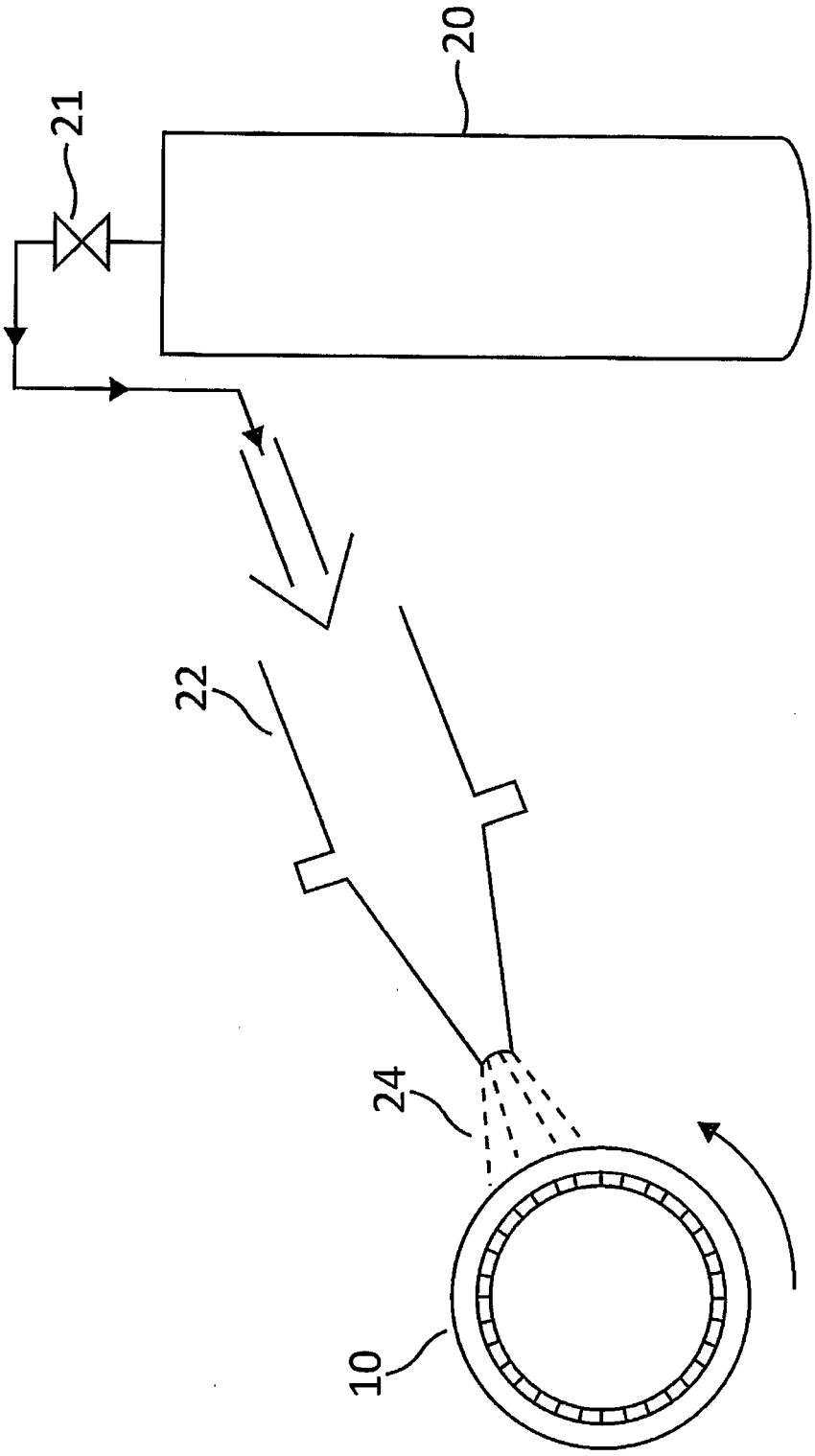
   - Providing gaseous carbon dioxide, and
   - bringing the gaseous carbon dioxide into contact with regions of the tribological system (10) to be lubricated.

2. Method according to claim 1, wherein the gaseous carbon dioxide is provided by expanding liquid carbon dioxide.

3. Device for lubricating a tribological system, comprising a means (20, 21) for providing gaseous carbon dioxide, and means (22) for bringing the gaseous carbon dioxide into contact with regions of the tribological system (10) to be lubricated.

4. Device according to claim 3, comprising a cylinder (20) containing liquid carbon dioxide, which is provided with a nozzle (22) for expanding the liquid carbon dioxide to provide gaseous carbon dioxide.

5. Use of gaseous carbon dioxide as a lubrication means for tribological systems.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EUROPEAN SEARCH REPORT

Application Number
EP 13 00 0876

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	WU X ET AL: "Tribological Behaviors of 52100 Steel in Carbon Dioxide Atmosphere", TRIBOLOGY LETTERS, KLUWER ACADEMIC PUBLISHERS-PLENUM PUBLISHERS, NE, vol. 17, no. 4, 1 November 2004 (2004-11-01), pages 925-930, XP019292414, ISSN: 1573-2711 * page 925, column 2, paragraph 1 * * chapter 4: conclusion * * figures 1-5 *	1,2,5	INV. C10M171/00
X	NUNEZ E E ET AL: "Lubricity effect of carbon dioxide used as an environmentally friendly refrigerant in air-conditioning and refrigeration compressors", WEAR, ELSEVIER SEQUOIA, LAUSANNE, CH, vol. 270, no. 1-2, 2 December 2010 (2010-12-02), pages 46-56, XP027503133, ISSN: 0043-1648, DOI: 10.1016/J.WEAR.2010.09.005 [retrieved on 2010-09-25] * abstract * * figure 2 *	1,2,5	TECHNICAL FIELDS SEARCHED (IPC) C10M
A,D	WO 2006/119047 A2 (UNIV MICHIGAN [US]; SKERLOS STEVEN J [US]; HAYES KIM F [US]; CLARENS A) 9 November 2006 (2006-11-09) * the whole document *	1,2,5	

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
Munich	6 June 2013	Klaes, Daphne

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)

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Application Number
EP 13 00 0876

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1, 2, 5

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

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LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 13 00 0876

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1, 2, 5

   Method for lubricating a tribological system with gaseous carbon dioxide

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2. claims: 3, 4

   Device for lubricating a tribological system

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 13 00 0876

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.

06-06-2013

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		EP 1885827 A2	13-02-2008
		JP 5113040 B2	09-01-2013
		JP 2008539096 A	13-11-2008
		US 2006247139 A1	02-11-2006
		US 2008293599 A1	27-11-2008
		WO 2006119047 A2	09-11-2006

EPO FORM P0459

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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Patent documents cited in the description

- WO 2006119047 A2 **[0007]**