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(71) Applicant: **HIDROS S.P.A.**
35028 Piove Di Sacco (IT)

(72) Inventor: **GRAZIOTTO, Raffaello**
35010 Vigonza, PD (IT)

(74) Representative: **Modiano, Micaela Nadia et al**
Modiano & Partners
Via Meravigli, 16
20123 Milano (IT)

(54) DE-ICING SYSTEM FOR HEAT PUMP REFRIGERATION MACHINES

(57) A de-icing system (10) for heat pump refrigeration machines, comprising, in a circuit (11) through which a refrigerating fluid flows, a first heat exchanger (12) and a second heat exchanger (13), a compressor (14) on a branch of said circuit (11) between the two heat exchangers (12, 13), at least one expansion valve (15, 16) on the other branch between the two heat exchangers (12, 13) and a four-way valve (18), for reversing the direction of the flow of the refrigerating fluid; the de-icing system (10) also comprises means (19) for migrating the refrigerating fluid from a point downstream of the second heat exchanger (13), when it acts as a condenser, to a point upstream of the first heat exchanger (12), when it acts as an evaporator, bypassing a first expansion valve (15) suitable for the heating cycle.

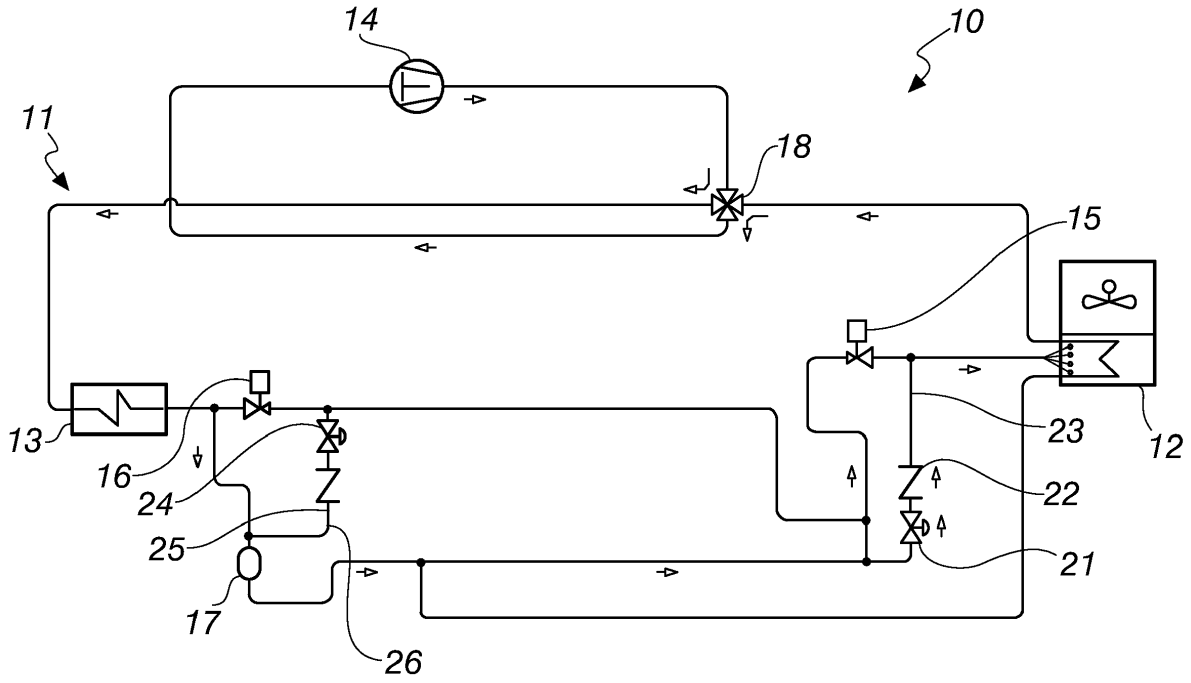

Fig. 1

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Description

[0001] The present invention relates to a de-icing system for heat pump refrigeration machines.

[0002] As is known, heat pump refrigeration machines mainly comprise an evaporation unit and a condensing unit, at which they absorb and release heat, a compressor on a branch between the evaporator and the condenser and an expansion valve on the other branch between the evaporator and the condenser.

[0003] Depending on the requirements, they are able to operate both in heating mode and in cooling mode by reversing the operating cycle.

[0004] As is known, when they work in heating mode, ice forms on the evaporator due to the presence of moisture in the external air and a reduction in heat exchange efficiency consequently occurs due to the insulation of the ice.

[0005] Since the frost that forms cannot be drained, it in fact accumulates progressively in the evaporator until it blocks it completely.

[0006] This phenomenon causes a decrease in the performance of the machine to the point of compromising its reliability.

[0007] In order to solve this drawback, these machines are capable of reversing the thermodynamic cycle within a time interval, causing de-icing.

[0008] Currently, the de-icing cycle is performed typically by virtue of a four-way valve, which allows to reverse the operating mode of the machine from heat pump to climate control unit or refrigerator and vice versa. The four-way valve is installed between the evaporator and the compressor in the heating mode or between the compressor and the condenser in the cooling mode and, by means of the reversal of the direction of flow at two of its four ends, it reverses the functionality of the exchangers, both at the beginning and at the end of the de-icing cycle, converting the evaporator into a condenser in order to allow de-icing. Since the dissipation heat accumulates inside it, any frost that has accumulated is in fact melted. To perform reversal, the four-way valve swaps the delivery branch with the intake branch.

[0009] This solution is not free from drawbacks.

[0010] When reversal occurs, the refrigerating fluid of the machine that is in the high-pressure branch downstream of the compressor is connected to the low-pressure branch upstream of the compressor, where it migrates due to the pressure differential, flushing the compressor completely. In this manner, the refrigerating fluid dilutes the oil that is contained in the compressor, causing its migration.

[0011] The compressor is therefore forced to work, for a certain period of time, without lubrication.

[0012] Another drawback resides in that the four-way valve, by instantly connecting the high-pressure branch of the refrigeration circuit to the intake of the compressor, provides an equalization of the pressures starting from a pressure differential of even 30 bar. This equalization is particularly noisy and subjects the piping of the refrigeration system to particularly intense stresses, generating vibrations that can lead to rupture of the pipes or in any case require constructive solutions.

[0013] Since the de-icing cycle, in the winter period, is performed up to twice every hour, it is evident that these drawbacks are not negligible.

[0014] The aim of the present invention is to provide a de-icing system for heat pump refrigeration machines by virtue of which the drawbacks described above are obviated.

[0015] Within this aim, an object of the invention is to provide a de-icing system for heat pump refrigeration machines that renders the machine reliable for longer times than machines of the known type that are subject to the described drawbacks.

[0016] This aim, as well as these and other objects that will become better apparent hereinafter, are achieved by a de-icing system for heat pump refrigeration machines, comprising, in a circuit through which a refrigerating fluid flows, a first heat exchanger and a second heat exchanger, a compressor on a branch of said circuit between said two heat exchangers, at least one expansion valve on the other branch between said two heat exchangers and a four-way valve, for reversing the direction of the flow of the refrigerating fluid, characterized in that it also comprises means for migrating the refrigerating fluid from a point downstream of said second heat exchanger, when it acts as a condenser, to a point upstream of said first heat exchanger, when it acts as an evaporator, bypassing a first expansion valve suitable for the heating cycle.

[0017] Further characteristics and advantages of the invention will become better apparent from the description of a preferred but not exclusive embodiment of the de-icing system according to the invention, illustrated by way of non-limiting example in the accompanying drawings, wherein:

Figure 1 is a view of a de-icing system according to the invention in the heating mode;
Figure 2 is a view of a de-icing system according to the invention in the cooling mode.

[0018] With reference to the figures, the de-icing system, according to the invention is designated generally by the reference numeral 10.

[0019] The de-icing system 10 is installed in a machine of a known type and comprises, in a circuit 11 through which a refrigerating fluid flows, a first heat exchanger 12 (with which a fan is associated) and a second heat exchanger 13, a compressor 14 on one branch of the circuit 11 between the two heat exchangers 12 and 13 and at least one expansion valve on the other branch between the two exchangers 12 and 13. In this case there are two valves, which will be referenced hereinafter in the description as first expansion valve 15, for the winter heating cycle, and as second expansion valve 16, for the summer cooling cycle.

[0020] The system comprises conveniently also a liquid receiver 17, which is adapted to accumulate the excess refrigerating fluid in the operation that requires the lowest amount of charge, i.e., winter operation, and a four-way valve 18 for reversal of the flow of the refrigerating fluid.

[0021] The de-icing system 10 comprises advantageously, within the circuit 11, means 19 for the migration of the refrigerating fluid from a point downstream of the second heat exchanger 13, when it acts as a condenser, to a point upstream of the first heat exchanger 12, when it acts as an evaporator, bypassing the first expansion valve 15 suitable for the heating cycle. These means will be referenced hereinafter as first refrigerating fluid migration means 19 and are activated in the heating mode of the machine.

[0022] The de-icing system 10 also comprises advantageously other means 20 for the migration of the refrigerating fluid from a point downstream of the first heat exchanger 12, when it acts as a condenser, to a point upstream of the second heat exchanger 13, when it acts as an evaporator, bypassing the second expansion valve 16 suitable for the cooling cycle. These means will be referenced hereinafter as second refrigerating fluid migration means 20 and are activated in the cooling mode of the machine.

[0023] In particular, as shown, the first refrigerating fluid migration means 19 comprise a first solenoid valve 21 and a first one-way valve 22, which are installed on a first circuit branch 23 comprised substantially between the second heat exchanger 13 and the first heat exchanger 12.

[0024] The second refrigerating fluid migration means 20 comprise a second solenoid valve 24 and a second one-way valve 25, which are installed on a second circuit branch 26 comprised substantially between the first heat exchanger 12 and the second heat exchanger 13.

[0025] The circuit 11 is also conveniently provided with a manifold 27 for the liquid refrigerating fluid in output from the second heat exchanger 13, i.e., the condenser, in the summer mode, in order to bypass the first expansion valve 15. A one-way valve (not shown) is conveniently present along the branch 28 that extends from the manifold 27.

[0026] The operation of the de-icing system according to the invention is as follows.

[0027] When an adapted control system, during the operation of the machine in the heating mode, determines the need to perform the de-icing cycle, the compressor 14 is stopped, the four-way valve 18 is left in the current position and the first solenoid valve 21 is energized.

[0028] Figure 1 shows the operation of the circuit during the heating mode, and the path of the fluid during this mode, in the normal heating cycle and before the de-icing cycle (with the compressor 14 motionless), is visible by virtue of the indication of the arrows.

[0029] By virtue of the difference in pressure that occurs across the first solenoid valve 21, therefore across the first circuit branch 23, by bypassing the first expansion valve 15 that is normally crossed in the winter cycle when the compressor 14 is in operation, the valve 21 allows the refrigerating fluid to migrate from the high-pressure side, downstream of the second heat exchanger 13, the condenser, and the liquid receiver 17, to the low-pressure side, upstream of the first heat exchanger 12, the evaporator. The first one-way valve 22 prevents the bleeding of refrigerating fluid through the first solenoid valve 21 when the pressure differential across it is negative, i.e., when the downstream pressure is higher than the upstream pressure.

[0030] The migration of refrigerating fluid progressively causes the equalization of the pressures in the refrigeration circuit.

[0031] At this point the four-way valve 18 is reversed without any stress and emission of sound.

[0032] Then the compressor 14 is restarted and the actual de-icing cycle begins.

[0033] Figure 2 shows the operation of the circuit during the cooling mode, and shows, by virtue of the indication of the arrows, the path of the fluid during this mode, in the de-icing cycle and at the end thereof (with the compressor 14 motionless).

[0034] With reference to such figure, the functionality of the heat exchangers 12 and 13 is reversed with respect to the preceding situation, causing the first heat exchanger 12 to act as a summer condenser. In this matter, since the dissipation heat accumulates therein, the accumulated frost is melted.

[0035] At the end of the de-icing cycle the compressor 14 is stopped again, the four-way valve 18 is left in its current position and the second solenoid valve 24 is energized.

[0036] By virtue of the difference in pressure that is present across the second solenoid valve 24, therefore across the second circuit branch 26, bypassing the second expansion valve 16 normally crossed in the summer cycle and in the de-icing cycle when the compressor 14 is in operation, the valve 24 allows the refrigerating fluid to migrate from the high-pressure side, downstream of the first heat exchanger 12, the condenser in this step, to the low-pressure side, upstream of the second heat exchanger 13, the evaporator in this step. The second one-way valve 25 prevents the bleeding of refrigerating fluid through the second solenoid valve 24 when the pressure differential across it is negative, i.e., when the downstream pressure is higher than the upstream pressure.

[0037] This migration of refrigerating fluid progressively causes the equalization of the pressures in the refrigeration circuit.

[0038] At this point the four-way valve 18 is reversed without any stress and noise emission.

[0039] The compressor 14 is then restarted and the machine can resume its regular operation.

[0040] In the described operations, substantially the refrigerating fluid is transferred, before the actual reversal

of the valve, in the region of the refrigeration circuit to which it will be assigned after the two reversals of the four-way valve, equalizing the pressures progressively without any type of mechanical stress and freeing the operation for reversal of the four-way valve from any stress on the compressor.

[0041] Furthermore, the de-icing cycle can be faster, since the refrigerating fluid is migrated directly into the part to which it will be assigned during the de-icing cycle, without being transferred by means of the compressor. Since it is already warm, it contributes already in this step to the de-icing of the frost that has accumulated in the exchanger, utilizing fully the heat capacity of the refrigerating fluid.

[0042] The equalization of the pressures allows to reduce drastically the returns of liquid refrigerant into the housing of the compressor, avoiding subjecting the latter to operations with reduced or no lubrication, safeguarding its operation and reliability.

[0043] Furthermore, again by virtue of the equalization of the pressures, during the reversal no noise is emitted, since the pipes are not stressed and therefore are not subjected to vibrations, extending significantly the life of the system and simplifying its production.

[0044] In practice it has been found that the invention achieves the intended aim and objects, providing a de-icing system that is capable of making the machine reliable for longer times than machines of the known type, substantially improving the operating conditions of the compressor and avoiding stresses on the pipes.

[0045] The invention thus conceived is susceptible of numerous modifications and variations, all of which are within the appended claims; all the details may furthermore be replaced with other technically equivalent elements.

[0046] In practice, the materials used, so long as they are compatible with the specific use, as well as the contingent shapes and dimensions, may be any according to the requirements and the state of the art.

[0047] The disclosures in Italian Patent Application No. 102015000045966 (UB2015A003199) from which this application claims priority are incorporated herein by reference.

[0048] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. A de-icing system for heat pump refrigeration machines, comprising, in a circuit (11) through which a refrigerating fluid flows, a first heat exchanger (12) and a second heat exchanger (13), a compressor (14) on a branch of said circuit (11) between said two heat exchangers (12, 13), at least one expansion valve (15, 16) on the other branch between said two heat exchangers (12, 13) and a four-way valve (18), for reversing the direction of the flow of the refrigerating fluid, said de-icing system (10) being **characterized in that** it also comprises means (19) for migrating the refrigerating fluid from a point downstream of said second heat exchanger (13), when it acts as a condenser, to a point upstream of said first heat exchanger (12), when it acts as an evaporator, bypassing a first expansion valve (15) suitable for the heating cycle.

2. The de-icing system according to claim 1, **characterized in that** it comprises other means for migrating the refrigerating fluid (20) from a point downstream of said first heat exchanger (12), when it acts as a condenser, to a point upstream of said second heat exchanger (13), when it acts as an evaporator, bypassing a second expansion valve (16) suitable for the cooling cycle.

3. The de-icing system according to claim 1, **characterized in that** said refrigerating fluid migration means (19) comprise a first solenoid valve (21) and a first one-way valve (22), which are installed on a first circuit branch (23) comprised substantially between said second heat exchanger (13) and said first heat exchanger (12).

4. The de-icing system according to claim 1, **characterized in that** said other refrigerating fluid migration means (20) comprise a second solenoid valve (24) and a second one-way valve (25), which are installed on a second circuit branch (26) comprised substantially between said first heat exchanger (12) and said second heat exchanger (13).

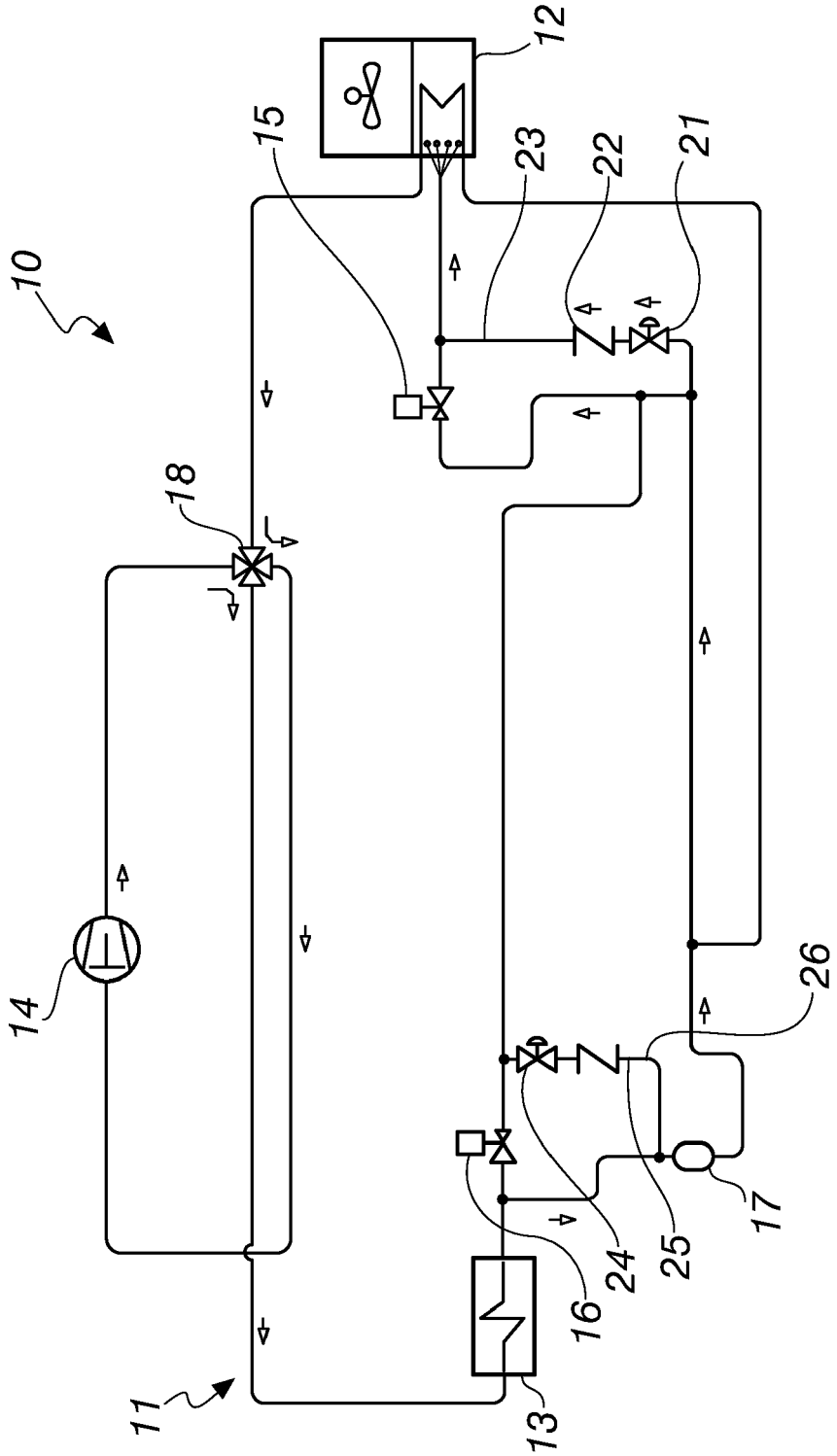

Fig. 1

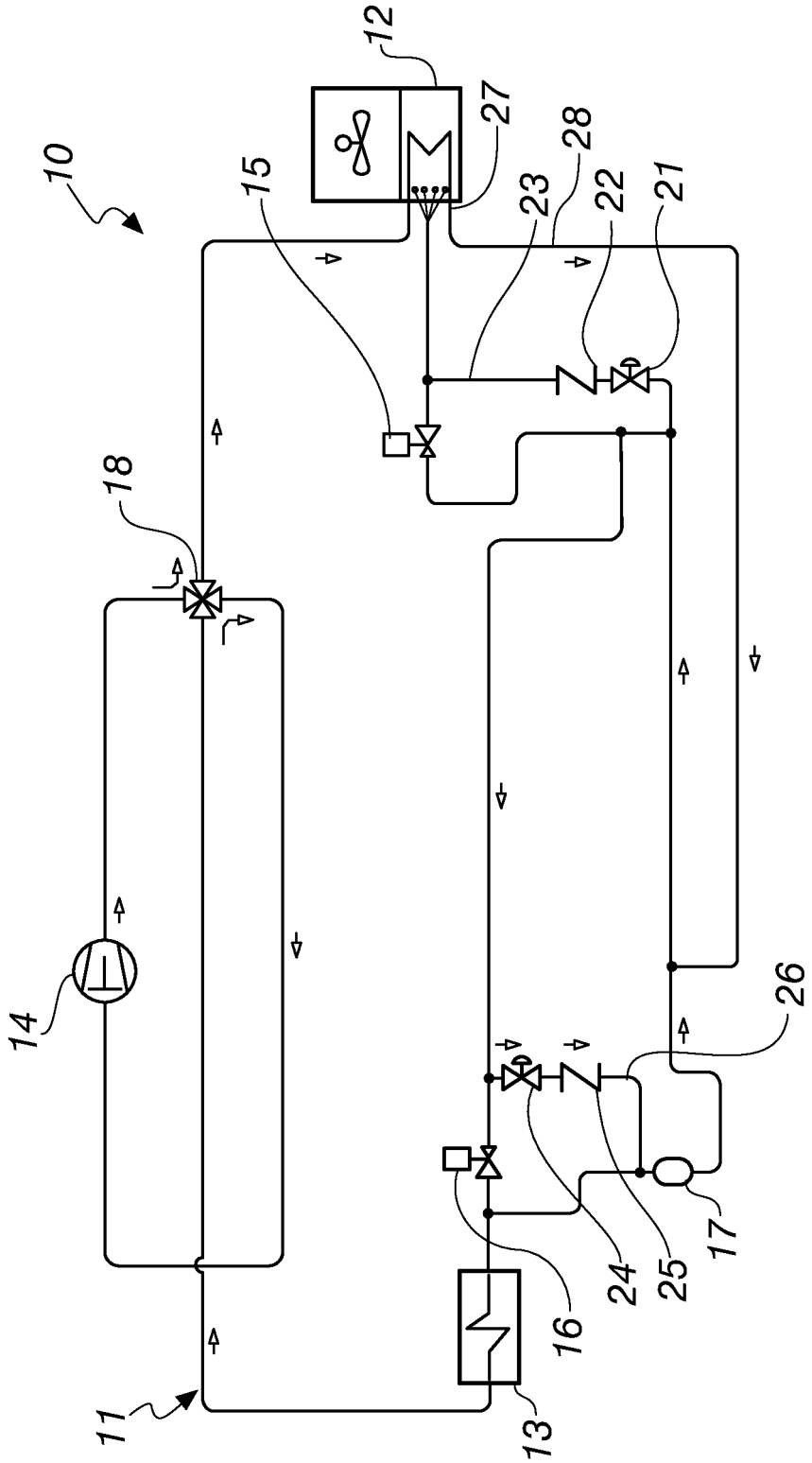

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 16 18 3976

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 2004/000399 A1 (GAVULA PATRICK [US]) 1 January 2004 (2004-01-01) * paragraphs [0023] - [0026]; figure 2 *	1-4	INV. F25B13/00 F25B47/02
X	EP 1 118 823 A1 (DAIKIN IND LTD [JP]) 25 July 2001 (2001-07-25) * paragraph [0051]; figure 2 *	1-4	
X	EP 0 449 641 A2 (MITSUBISHI ELECTRIC CORP [JP]) 2 October 1991 (1991-10-02) * column 8, line 3 - column 9, line 19; figures 1,2 *	1-4	

TECHNICAL FIELDS SEARCHED (IPC)

F25B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	27 January 2017	Ritter, Christoph

CATEGORY OF CITED DOCUMENTS

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27-01-2017

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004000399 A1	01-01-2004	US 2004000399 A1	01-01-2004
		US 2006086496 A1	27-04-2006
EP 1118823 A1	25-07-2001	AU 745198 B2	14-03-2002
		AU 5997599 A	17-04-2000
		CN 1320205 A	31-10-2001
		DE 69913184 D1	08-01-2004
		DE 69913184 T2	27-05-2004
		EP 1118823 A1	25-07-2001
		ES 2212674 T3	16-07-2004
		JP 3094996 B2	03-10-2000
		JP 2000105030 A	11-04-2000
		US 6609390 B1	26-08-2003
		WO 0019157 A1	06-04-2000
EP 0449641 A2	02-10-1991	DE 69109532 D1	14-06-1995
		DE 69109532 T2	18-01-1996
		EP 0449641 A2	02-10-1991
		HK 1006328 A1	19-02-1999
		US 5165250 A	24-11-1992

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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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Patent documents cited in the description

- IT 102015000045966 **[0047]**
- IT UB2015003199 A **[0047]**