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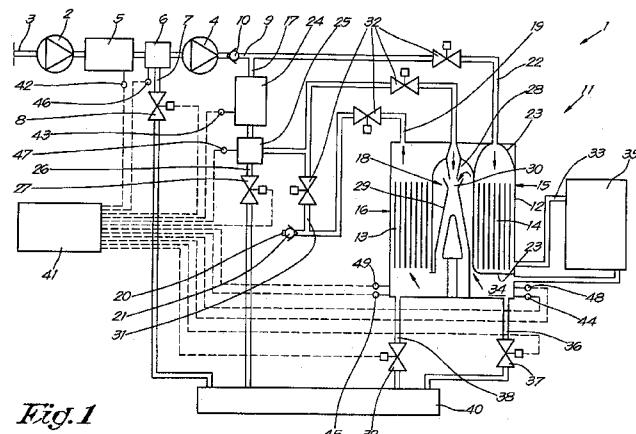
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(54) Title: METHOD FOR CONTROLLING A COMPRESSED AIR UNIT AND COMPRESSED AIR UNIT FOR APPLYING SUCH A METHOD



Method for controlling a compressed air unit and compressed air unit for applying such a method.

5 The present invention concerns a method for controlling a compressed air unit such as a compressor unit, a dryer unit or the like as well as a compressed air unit to apply such a method.

10 From US 6,588,443 B2 is already known a method for controlling a compressed air unit, and in particular for discharging condensate from a multi-stage compressor unit, whereby the condensate which is formed in a cooler of each respective pressure stage is discharged via a drain pipe

15 provided downstream said pressure stage to that end.

A disadvantage of such a method according to US 6,588,443 B2 is that many valves are required and that a device for applying such a method is voluminous, as several valves and

20 connections are present. Another disadvantage of such a method is that it cannot be used to perform other functions than to discharge condensate.

From EP 0,391,250 A2 is known a device which can be used to

25 discharge a condensate until a set level is reached, as soon as another pre-set maximum level of condensate has been reached in a collector.

A disadvantage of this configuration is that no other

30 measuring signals are taken into account and that such a configuration is only suitable for discharging the

condensate coming from only one collector to an open reservoir, and in that it cannot be used to perform other functions.

5 US 6,196,253 B1 describes a drain valve to immediately discharge condensate when it is present at the inlet of said drain valve. The disadvantage of such a valve gear, however, is that it can only be used to discharge condensate from a single reservoir to an open reservoir.

10 Another disadvantage is the lack of a large volume, which implies that many work cycles are required to discharge large volumes of condensate.

15 The present invention aims to provide a method for controlling a compressed air unit, which method has been improved in many different aspects compared to the known methods.

20 To this end, the present invention concerns a method for controlling a compressed air unit which is provided with at least one controllable drain valve, characterised in that this method comprises the step of controlling the above-mentioned drain valve, at least on the basis of a system parameter which is not a system parameter on the feed side

25 of said drain valve.

With the feed side of the drain valve is meant the inlet side of the valve here or, in other words, the side which is upstream in relation to said drain valve.

In this case, by a drain valve is meant a valve which can be used to drain condensate, but it is not excluded to use such a valve for other functions as well.

5 An advantage of a method according to the invention is that it allows to realize a simple and compact configuration, since only a limited number of valves are required.

10 The above-mentioned system parameter hereby consists of a measurable, physical parameter appearing in the compressed air unit, such as a temperature value, a pressure value, a liquid level or the like, or an internal status signal which is generated on the basis of a measurable physical parameter.

15 By such an internal status signal is meant a signal which is calculated in a controller or determined by means of the measurement of a physical parameter. An example of such an application consists in realising a control by means of a 20 timer which starts on the basis of the registration of a certain measurable, physical parameter.

An advantage of the method according to the invention is that it allows to perform certain functions which have been 25 realised up to now by means of separate components, such as blow-off valves or the like, by means of drain valves, such that certain components are no longer required.

Thus, for example, upon detecting that the pressure in an 30 intercooler exceeds a certain limit value and this is detected, the pressure of this intercooler will be blown

off via a controllable drain valve provided on this intercooler.

According to a special characteristic of the invention, the 5 method also comprises the steps of determining the pressure on the feed side of at least two drain valves which are part of the compressed air unit and of controlling the different drain valves in such a way that two drain valves having different pressure values on the feed side will not 10 be open simultaneously.

An advantage of this specific method is that it avoids two drain valves to be open simultaneously, as a result of which condensate is prevented from flowing from one part of 15 the compressed air unit to another part thereof having a lower pressure.

According to another special characteristic of the invention, the method comprises the step of controlling two 20 different drain valves which are part of the compressed air unit in such a way that they can never be open simultaneously.

This can be realised for example by measuring the liquid 25 level on the feed side of said respective drain valves and by determining on the basis thereof whether a drain valve is either or not open.

The present invention also concerns a compressed air unit 30 which makes it possible to apply a method as described above, which compressed air unit, according to the specific

characteristic of the invention, is provided with at least one drain valve which is connected in a controllable manner to a controller, and whereby detection means are also connected to the above-mentioned controller for determining 5 at least one system parameter which is not a system parameter on the feed side of said drain valve, and whereby the above-mentioned controller comprises an algorithm for controlling the drain valve on the basis of this determination of said system parameter.

10

In order to better explain the characteristics of the present invention, the following preferred method according to the invention for controlling a compressed air unit is described by way of example only without being limitative 15 in any way, as well as a compressed air unit to apply such a method, with reference to the only accompanying figure.

This figure represents a compressed air unit 1 which is in this case provided with a two-stage compressor having a low 20 pressure stage 2 which is connected to a suction line 3 and which is connected to a high pressure stage 4 with its outlet side.

Between the pressure stages 2 and 4 is provided an 25 intercooler 5, as well as a first liquid separator 6 onto which is connected a first drain pipe 7 in which is provided a first drain valve 8.

In the compressed air line 9 of the high pressure stage 4 30 is provided a non-return valve 10 which allows for a flow of the high pressure stage 4 in the compressed air line 9

and which prevents compressed gas, when the two-stage compressor is switched off, from flowing from the components, which are still under pressure and which are situated downstream said two-stage compressor, back to the 5 suction line 3.

In the present example, the compressed air unit 1 also comprises a drying device to dry the gas coming from the two-stage compressor, which drying device mainly consists 10 of a dryer 11 of the type which is described in BE 1,005,64 and which is formed of a pressure vessel 12 with a drying zone 13 and a regeneration zone 14, with a rotor 15 which is built of a cylindrical drying element 16 in which is provided an adsorption and/or absorption medium which is 15 alternately guided through the drying zone 13 and the regeneration zone 14.

Further, the dryer 11 comprises a main duct 17 which is connected to the compressed air line 9 and which connects 20 the dryer 11 to the outlet of the high pressure stage 4 and which opens in a mixing device 18 whose outlet is connected to the inlet of the above-mentioned drying zone 13.

An outlet line 19 connects the outlet of the drying zone 13 25 to a consumer network 20, whereby the outlet line 19 and the consumer network 20 are separated by a non-return valve 21.

A side duct couples the compressed air line 9 to the inlet 30 of the regeneration zone 14.

This regeneration zone 14 consists of a sector of the rotor 15 which is closed off on both axial sides by means of screens 23. The remainder of the rotor 6 forms the drying zone.

5

The above-mentioned main duct 17 is in this case provided with an aftercooler 24 and a second liquid separator 25 provided downstream said aftercooler 24 which is equipped with a second drain pipe 26 in which is provided a second 10 drain valve 27.

The mixing device 18 consists of an ejector which, as is known, comprises a jet pipe 28 and a mixing pipe 29, in between which is provided a suction opening 30. The mixing 15 pipe 29 gives out at the inlet of the drying zone 13.

The mixing device 18 is used in this case, in the known manner, as the driving shaft for the rotor 15, to which end the mixing pipe 29 is connected to a motor, not represented 20 in the figure, by means of a shaft which is connected to the mixing pipe 29 by means of a coupling.

The above-mentioned outlet line 19 of the dryer 11 can be connected to the main duct 17, as is customary, by means of 25 a bypass 31 which, in this case, just as the main duct 17, the outlet line 19 and the side duct 22, comprises a shut-off valve 32.

The outlet of the regeneration zone 14 is connected to an 30 inner space 34 in the pressure vessel 12 via a cooling pipe

33, which inner space 34 is connected to the above-mentioned suction opening 30.

In this cooling pipe 33 is provided a regeneration cooler 5 35 which is for example but not necessarily air-cooled but which, in principle, may have the shape of any type of heat exchanger whatsoever.

10 Onto the pressure vessel 12 a third drain pipe 36 is connected, in which a third drain valve 37 is provided in this case.

15 Also onto the inlet of the drying zone 13 is in this case connected a fourth drain pipe 38 wherein also a fourth drain valve 39 is provided.

20 Each of the above-mentioned drain pipes 7, 26, 36 and 38 is in this example but not necessarily connected to a single common reservoir 40. However, it is also possible according to the invention to provide several reservoirs and/or to use an open reservoir.

25 The compressed air unit 1 further comprises a controller 41 with which the drain valves 8, 27, 37 and 39 are connected in a controllable manner and onto which are also connected detection means to at least determine a system parameter which is not a system parameter on the feed side of a controllable drain valve concerned, and, in this case, several system parameters, namely the measured values of 30 the system pressure and of the liquid levels on the feed sides of the respective drain valves 8, 27, 37 and 39.

To this end, the above-mentioned detection means comprise four pressure sensors 42 to 45 which are each provided on the feed side of an aforesaid drain valve 8, 27, 37 and 39.

5

In this example, the first pressure sensor 42 is provided in the intercooler 5, the second pressure sensor 43 is provided in the aftercooler 24, the third pressure sensor 44 measures the pressure in the space 34, and the fourth 10 pressure sensor 45 is mounted such that it measures the pressure at the inlet of the drying zone 13.

Further, the detection means in this case comprise two level sensors 46 and 47, provided in the respective liquid 15 separators 6, 25, and two level sensors 48 and 49 which are provided in the dryer 11, on the feed side of the drain valves 37, 39 respectively, whereby each of these level sensors 46 to 49 are also connected to the above-mentioned controller 41.

20

The invention is not limited to the use of the pressure and level sensors represented in the figures; on the contrary, also other configurations are possible. Thus, it is possible to omit one or several level sensors, for example.

25

The working of a compressed air unit 1 according to an application of the invention is very simple and as follows.

When the two-stage compressor is started, a gas, for 30 example air, is sucked in via the suction line 3, which gas is first compressed through the low pressure stage 2 and is

subsequently pressed through the intercooler 5 and the first liquid separator 6 to the high pressure stage 4 to be further compressed there.

5 Thanks to the combination of the pressure increase and the subsequent temperature drop of the compressed gas in the intercooler 5, the water vapour which is present in the gas flow may condense, as is known, as a result of which liquid drops are formed in the gas flow which are separated from
10 the gas flow in the first liquid separator 6.

In the compressed gas, which is 100% saturated just downstream the first liquid separator 6, condense drops will form again after its compression by the high pressure
15 stage 4 and its passage through the aftercooler 24, which will be removed from the gas flow in the second liquid separator 25.

The compressed, saturated gas leaving the second liquid
20 separator 25 then flows in the dryer 11, where the gas to be dried is guided through the mixing device 18 and is subsequently dried by means of adsorption and/or absorption medium which takes up moisture from the gas.

25 The dried gas is subsequently guided through the outlet line 19 to the consumer network 20.

In order to be able to regenerate the adsorption and/or absorption medium, the rotor 15 is driven at low speed by
30 the motor, as is known, whereby the adsorption and/or

absorption medium is alternately guided through the drying zone 13 and the regeneration zone 14.

The side duct 22 guides a part of the gas to be dried from 5 the compressed air line 9 to the regeneration zone 14, which part of the gas does not flow through the main duct 17 and consequently is not cooled in the aftercooler 24.

Consequently, the gas to be dried is still relatively hot 10 and unsaturated, such that it can take up moisture from the adsorption and/or absorption medium as it flows through the regeneration zone 14.

At the outlet of the regeneration zone 14, the gas is 15 guided to the regeneration cooler 35 via the cooling pipe 33, to be subsequently sucked in, via the space 34 and through the suction opening 30, in the mixing pipe 29, where this gas is mixed with gas to be dried from the main duct 17.

20

The method according to the invention for controlling a compressed air unit comprises the step of controlling the drain valve 8, 27, 37 or 39, at least on the basis of a system parameter which is not a system parameter on the 25 feed side of the drain valve 8, 27, 37 or 39 concerned, so as to discharge condensate via said drain valves 8, 27, 37 or 39 to the reservoir 40.

To this end, the controller 41 is provided with an 30 algorithm to control at least one, and in this case all the drain valves 8, 27, 37 and 39 in this way.

The above-mentioned system parameter in this case comprises measured values of the system pressure on the feed side of the respective drain valves 8, 27, 37 and 39, which 5 measured values are determined by the respective pressure sensors 42 to 45; however, in the present example, the liquid level on the feed side of the drain valves 6 and 25 is also taken into account.

10 The different drain valves 8, 27, 37 and 39 are preferably controlled such by the controller 41 that two drain valves 8, 27, 37 and 39 having different pressure values on the feed side cannot be open simultaneously.

15 However, it is also possible to control the different drain valves 8, 27, 37 and 39 such that they are never open simultaneously, which can be realized for example by measuring the liquid level on the feed side of these respective drain valves 8, 27, 37 and 39 and to determine 20 on the basis thereof whether a drain valve 8, 27, 37 or 39 is either or not open.

The method in this case also comprises the step of determining the liquid level on the feed side of a drain 25 valve 8, 27, 37 and 39, and to open the drain valve 8, 27, 37 or 39 concerned as soon as the measured liquid level exceeds a preset limit value.

This can be realised by means of the above-mentioned 30 controller 41, which is connected to level sensors 46 to 49 to this end, and which can always take the respective

measured pressure values on the feed side of the drain valves 8, 27, 37 and 39 into account when applying this method.

5 According to a special characteristic of the invention, by controlling the different drain valves 8, 27, 37 and 39 by means of a central controller 41, these drain valves 8, 27, 37 and 39 can also be used for other functions than to discharge condensate, such as for example to blow off gas.

10

In the given example of the compressed air unit 1, this can be applied for example to regenerate the dryer during a standstill, whereby gas which is sent through the drying device 16 can be blown off via the drain valves 37 and/or 15 39.

For example, the drain valve 8 which is provided immediately after, i.e. downstream the intercooler 5, can also be used to blow off the intercooler pressure in order 20 to empty the intercooler volume.

The method according to the invention preferably also comprises the step of generating an alarm when an improper measured value is registered by the above-mentioned controller 41, as the above-mentioned parameter does not change in the way intended by the controller 41, whereby at 25 least the above-mentioned system parameter which is different from the liquid level on the feed side of a drain valve is taken into account, and, possibly, the liquid 30 level on the feed side of a drain valve.

An example thereof is that, if one of the drain valves 8 or 27 is opened by the controller 41 as a too high liquid level is detected by the concerning level sensor, and the level sensor 46 or 47 on the feed side of another drain valve 8 or 27 does not detect liquid anymore, one can easily deduce that the wiring of either a drain valve 8 or 27, or a level sensor 46 or 47 was not executed correctly.

An advantage of a compressed air unit 1 according to the invention is that it makes it possible to determine the volume of condensate that has been discharged via the drain valves 8, 27, 37 and 39.

The amount of condensate to be expected in a compressor can be calculated on the basis of the humidity of the sucked-in air, the mass flow, pressure values and temperatures.

These data can be measured or calculated on the basis of measurements and are thus available together with the actually discharged amount of condensate. If this amount of discharged condensate is smaller than the calculated amount of condensate, this may indicate for example that a water separator is not working properly.

If the volume of separated condensate is larger than the calculated value, this may indicate for example that there is a liquid leak from a liquid circuit to the gas side.

Another advantage of a method according to the invention for discharging condensate consists in that no check valve must be provided in a compressor or a unit where the

pressure in the condensate reservoir could drop below atmospheric pressure. This can be detected by means of the controller 41 which takes this into account to control the drain valve concerned, such that the check valve is no 5 longer necessary on the drainage outlet.

In the example described above, the major system parameters which are used to control the drain valves 8, 27, 37 and 39 consist of system pressures and liquid levels, but it is 10 not excluded according to the invention for other system parameters to be used to this end as well, such as for example temperature values, or to use a combination of different parameters.

15 Naturally, it is not excluded for the system parameter or system parameters on the basis of which the drain valves are controlled to be measured, calculated or determined in any other way whatsoever.

20 Also the use of a combination of measured and calculated values for one or several system parameters is an option.

The present invention is by no means restricted to the method and device described by way of example and 25 illustrated by means of the accompanying drawings; on the contrary, such a method according to the invention and a device for applying such a method can be realised in many different ways while still remaining within the scope of the invention.

Claims.

1.- Method for controlling a compressed air unit which is
5 provided with at least one controllable drain valve (8, 27,
37 or 39), characterised in that this method comprises the
step of controlling the above-mentioned drain valve (8, 27,
37 or 39), at least on the basis of a system parameter
which is not a system parameter on the feed side of said
10 drain valve (8, 27, 37 or 39).

2.- Method according to claim 1, characterised in that the
above-mentioned system parameter consists of a measured
value of a system temperature or pressure.

15

3.- Method according to claim 1, characterised in that the
above-mentioned system parameter consists of an internal
status signal which is generated on the basis of a
measurable physical parameter.

20

4.- Method according to claim 1, characterised in that it
also comprises the step of measuring the liquid level on
the feed side of the above-mentioned drain valve (8, 27, 37
or 39).

25

5.- Method according to any one of claims 1 to 4,
characterised in that it also comprises the steps of
determining the pressure on the feed side of the respective
drain valves (8, 27, 37 and 39) and of the different drain
30 valves (8, 27, 37 and 39), such that two drain valves (8,

27, 37 and 39) having different pressure values on the feed side cannot be simultaneously open.

6.- Method according to any one of claims 1 to 4,
5 characterised in that it also comprises the step of controlling two different drain valves (8, 27, 37 and 39) which are part of the compressed air unit (1) in such a way that they can never be simultaneously open.

10 7.- Method according to claim 6, characterised in that it comprises the step of measuring the liquid level on the feed side of the respective drain valves (8, 27, 37 and 39) and of determining on the basis thereof whether a drain valve (8, 27, 37 and 39) is either or not open.

15

8.- Method according to any one of the preceding claims, characterised in that it comprises the step of using at least one of the above-mentioned drain valves (8, 27, 37 or 39) to blow off gas and/or to lower the pressure.

20

9.- Method according to any one of the preceding claims, characterised in that in order to control the above-mentioned drain valves (8, 27, 37 and 39), use is made of a controller (41).

25

10.- Method according to any one of the preceding claims, characterised in that it comprises the step of generating an alarm when an incorrect measured value is registered by the above-mentioned controller (41), as the above-mentioned 30 system parameter does not change in the way intended by the

controller (41), whereby the determined above-mentioned system parameter is taken into account.

11.- Method according to any one of the preceding claims,
5 characterised in that it comprises the step of determining the amount of condensate that has been discharged via the drain valves (8, 27, 37 and 39).

12.- Compressed air unit which makes it possible to apply a
10 method as described above, characterised in that this compressed air unit (1) is provided with at least one drain valve (8, 27, 37 of 39) which is connected to a controller (41) in a controllable manner, and whereby detection means are also connected to the above-mentioned controller (41)
15 to at least determine a system parameter which is not a system parameter on the feed side of said drain valve (8, 27, 37 or 39), and whereby the above-mentioned controller (41) contains an algorithm to control the drain valve (8, 27, 37 or 39) on the basis of the above-mentioned
20 determined system parameter.

13.- Compressed air unit according to claim 12,
characterised in that the above-mentioned detection means comprise at least one pressure sensor (42, 43, 44 and/or
25 45) provided on the feed side of an aforesaid drain valve (8, 27, 37 and/or 39).

14.- Compressed air unit according to claim 12 or 13,
characterised in that the above-mentioned detection means
30 comprise a pressure sensor (42 to 45) for each drain valve

(8, 27, 37 and 39) provided on the feed side of said drain valve.

15.- Compressed air unit according to any one of claims 12
5 to 14, characterised in that the above-mentioned detection
means are also designed to determine the liquid level on
the feed side of the above-mentioned drain valve (8, 27, 37
and/or 39).

10 16.- Compressed air unit according to any one of claims 12
to 15, characterised in that the above-mentioned drain
valves (8, 27, 37 and/or 39) are part of a water separator
(6 and/or 25), a dryer (11) or a cooler (5 or 24), or are
connected thereto with their feed side.

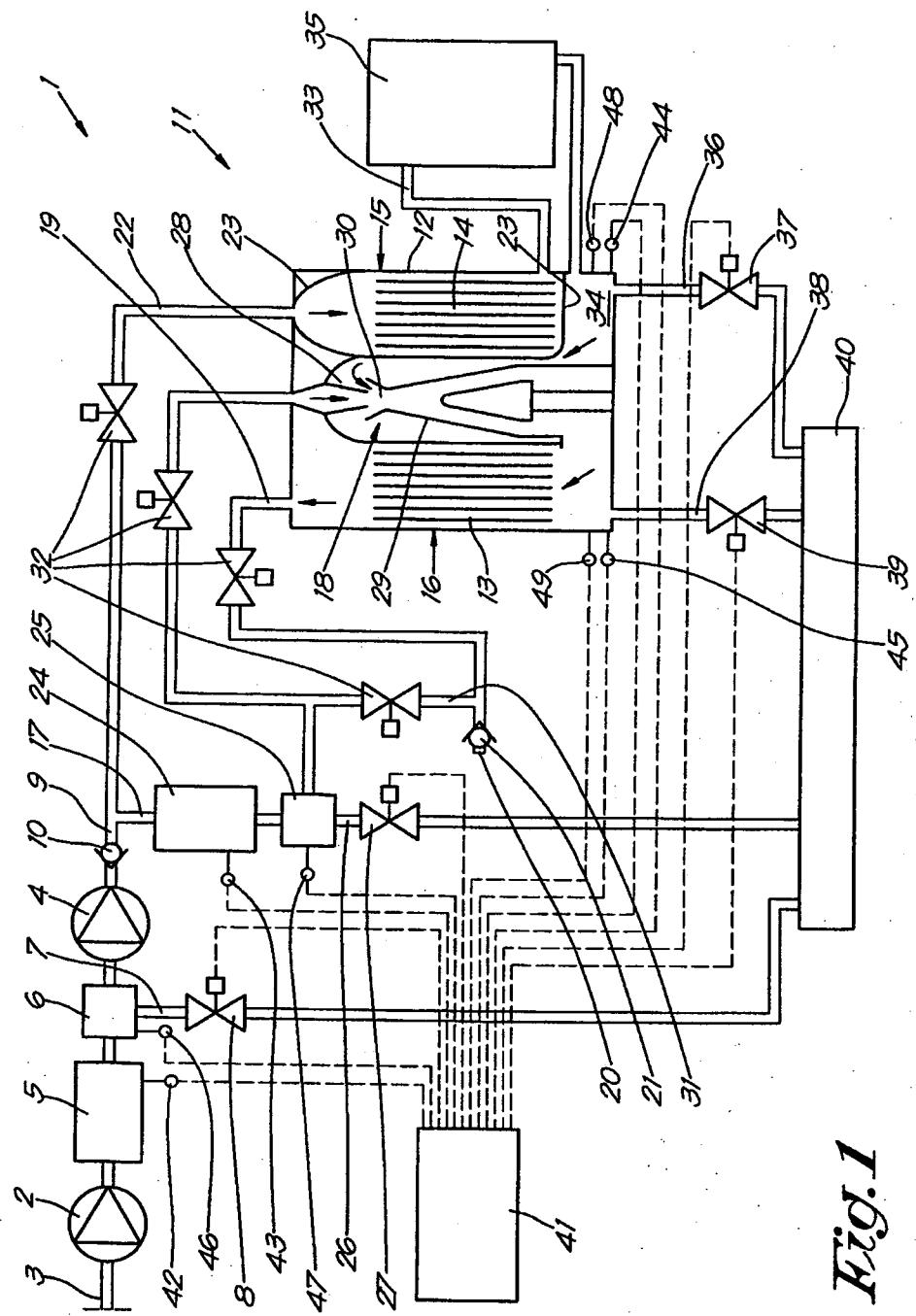


Fig. 1

INTERNATIONAL SEARCH REPORT

International application No

PCT/BE2009/000031

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16T1/00

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)
F16T

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 4 197 990 A (CARBERG WILLIAM G [US] ET AL) 15 April 1980 (1980-04-15)	1-3, 9, 12, 13
Y	column 2, line 43 - column 3, line 44; figure 1	10
X	US 5 144 974 A (GAUDIN JEFFREY [US]) 8 September 1992 (1992-09-08) claim 1	1-3, 9, 12, 13
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	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

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Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORTInternational application No
PCT/BE2009/000031**C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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