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(54) Title: IMPROVED TURBO-COMPRESSOR

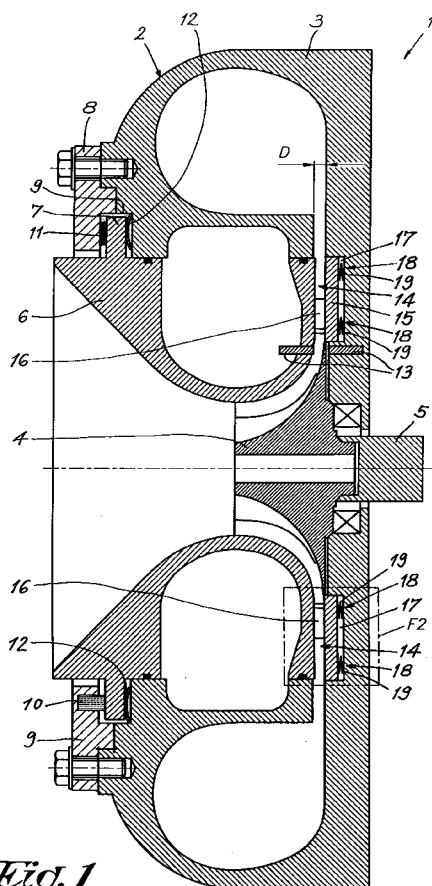


Fig. 1

(57) Abstract: Improved turbo compressor which is formed of a housing (2) with a volute casing (3) in which a rotor (4) has been provided such that it can turn by means of a shaft (5), and an inlet piece (6) forming an axial guide for the gas which is sucked in by the rotor (4), whereby a diffuser (14) with a number of outlet guide vanes (16) is provided on the delivery side of the rotor (4), characterised in that the turbo compressor (1) comprises means (18) which constantly keep the diffuser (14) with its outlet guide vanes (16) against the inlet piece (6).

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Improved turbo compressor.

The present invention concerns an improved turbo compressor, in particular a radial turbo compressor which
5 consists of a housing with a volute casing in which has been provided a rotor which can turn by means of a shaft and an inlet piece forming an axial guide for the gas which is sucked in by the rotor.

10 In order to restrict losses with the known turbo compressors, the play between the rotor and the inlet piece, or what is called the "shroud play", is set with great precision.

15 With turbo compressors which are moreover provided with a diffuser having a number of outlet guide vanes on the delivery side, plays between said outlet guide vanes and the inlet piece must be avoided in order to prevent losses.

20 It is known that, during the assembly of turbo compressors, use is made of spacers or shims in order to adjust the play between the inlet piece and the rotor and to adjust the diffuser height, and to moreover compensate tolerance deviations of the rotor.

25

However, a disadvantage of such an adjustment is that setting the play in this manner between the inlet piece and the rotor and of the diffuser height is very time-consuming because of the many measuring and control operations.

30

With the known turbo compressors, the axial deformation of

the outer edge of the rotor, which occurs while the turbo compressor is operational due to high peripheral velocities, is compensated somewhat by selecting the axial play between the inlet piece and the rotor such that it is
5 optimal at the maximum speed of the rotor.

This is disadvantageous, however, in that the play is larger than necessary at low speeds, which results in additional losses and thus a lower output.

10

The present invention aims to remedy one or several of the above-mentioned and other disadvantages.

To this end, the present invention concerns an improved
15 turbo compressor which is formed of a housing with a volute casing in which has been provided a rotor which can turn around an axis and an inlet piece forming an axial guide for the gas which is sucked in by the rotor, whereby a diffuser with a number of outlet guide vanes has been
20 provided on the delivery side of the rotor and whereby the turbo compressor comprises means which constantly keep the diffuser with its outlet guide vanes against the inlet piece.

25 An advantage of such an improved turbo compressor according to the invention is that, thanks to the presence of the above-mentioned means, after the once-only setting of the play between the rotor and the inlet piece, no separate setting of the diffuser height is required, which
30 simplifies and quickens the assembly of the turbo compressor as compared to that of conventional turbo

compressors.

According to a preferred characteristic of a turbo compressor according to the invention, the above-mentioned
5 inlet piece can be axially moved in relation to the rotor and the turbo compressor comprises means to adjust the axial play between the inlet piece and the rotor.

The above-mentioned means for adjusting the axial play
10 between the inlet piece and the rotor preferably comprise an actuator to axially move the inlet piece, whereas the turbo compressor, either or not combined with said actuator, is preferably provided with measuring means to determine the axial play between the inlet piece and the
15 rotor, such that the above-mentioned play can be set at a desired value as a function of the above-mentioned findings of the measuring means.

These preferred characteristics are advantageous in that a
20 precise setting of the axial play between the inlet piece and the rotor is made possible and/or in that one can immediately react on changes of speed and/or deformations of the rotor by adjusting the play between the inlet piece and the rotor in an appropriate manner.

25

In order to better explain the characteristics of the present invention, the following preferred embodiments of an improved turbo compressor according to the invention are represented by way of example only without being limitative
30 in any way, with reference to the accompanying drawings, in which:

figure 1 is a section of an improved turbo compressor according to the invention;

figure 2 represents the part indicated by F2 in figure 1 to a larger scale;

figure 3 shows a view according to figure 2, but for another position of the inlet piece.

Figures 1 to 3 represent an improved turbo compressor 1 according to the invention, provided with a housing 2 with a volute casing 3 in which has been provided a rotor 4 or "impeller" such that it can turn by means a shaft 5, whereby the shaft 5 consists for example of a motor shaft or a driven shaft of a reduction gearbox.

The turbo compressor 1 further comprises an inlet piece 6, also called "shroud", which is axially opposite the above-mentioned rotor 4 when mounted and which forms an axial guide for the gas that is sucked in by the rotor 4.

In this embodiment, the inlet piece 6 on the radial peripheral edge is provided with a flange 7 which is fixed to the volute casing 3 by means of an end flange.

To this end, the end flange 8 and the volute casing 3 are provided with a recess, such that when the end flange 8 and the volute casing 3 are fixed to one another, a space 9 is created in which the above-mentioned flange 7 of the inlet piece 6 extends with an axial play, such that the inlet piece 6 can axially move in relation to the rotor 4.

In this embodiment, the turbo compressor 1 further comprises means to adjust the axial play between the inlet piece 6 and the rotor 4 while the turbo compressor 1 is operational, which in this case comprise an actuator 10
5 made for example in the shape of a pneumatic, hydraulic, electrical and/or electronic actuator provided in the above-mentioned space 9 in the present embodiment, in particular between the flange 7 of the inlet piece 6 and the end flange 8.

10

In the above-mentioned space 9 is in this case also provided a stop 11 for the flange 7 of the inlet piece 6, which is positioned such that, when the actuator 10 falls out, a preset axial play between the inlet piece 6 and the
15 rotor 4 will still be guaranteed.

On the other side of the flange 7, a spring 12 is in this case provided in the above-mentioned space 9, exerting a pressure on the flange 7, away from the direction of the
20 rotor 4. This is advantageous in that, if the actuator 10 falls out, for example in case of a defect, the inlet piece 6 will not be pressed against the rotor 4.

The turbo compressor 1 according to the invention
25 preferably also comprises measuring means to determine the axial play between the inlet piece 6 and the rotor 4.

In the given example, the above-mentioned measuring means are made in the form of one or several distance sensors 13
30 which are either mounted on the inlet piece 6 or on the volute casing 3 respectively, and which make it possible to

determine the axial play between the inlet piece 6 and the rotor 4.

In this case, a diffuser 14 is provided on the delivery
5 side of the rotor 4, between the inlet piece 6 and the volute casing 3, which is made in the form of a diffuser plate 15 on which are provided a number of outlet guide vanes 16.

10 In this embodiment, the above-mentioned diffuser plate 15 is at least partially provided in a recess 17 provided to that end in the volute casing 3, such that this diffuser plate 15 can shift according to the axial direction of the rotor 4.

15 Preferably, the turbo compressor 1 comprises means 18 which constantly keep the diffuser 14 with its outlet guide vanes 16 against the inlet piece 6, which means 18 are in this case made in the form of elastic means, for example a
20 spring 19 provided in the above-mentioned recess 17, between the diffuser plate 15 and the volute casing 3, and which pushes the diffuser 14 against the inlet piece 6.

According to a preferred characteristic which is not
25 represented in the drawings, an improved turbo compressor 1 according to the invention is finally also provided with a controller which is connected to the above-mentioned measuring means to determine the axial play between the inlet piece 6 and the rotor 4 on the one hand, and to the
30 above-mentioned actuator 10 in order to axially move the inlet piece 6 on the other hand.

The working of an improved turbo compressor 1 according to the invention is very simple and as follows.

5 While the rotor 4 is being driven, the turbo compressor 1 sucks in a gas via the inlet piece 6 which is flung away by the rotor 4 as a result of the centrifugal forces and which subsequently flows through the outlet guide vanes 16 towards the volute casing 3, such that the kinetic energy
10 is converted into pressure.

The above-mentioned spring 12 hereby constantly pushes against the flange 7, such that, when there is no control signal from the actuator 10, the inlet piece 6 will be
15 constantly pressed against the stop 11 so as to guarantee a preset axial play between the inlet piece 6 and the rotor 4.

Should there be an axial movement of the rotor 4 and/or an
20 axial deformation of the rotor 4 at high rotational speeds, this will be detected by means of the above-mentioned measuring means.

Should it turn out that the above-mentioned determined play
25 between the inlet piece 6 and the rotor 4 may not be optimal, an appropriate signal will be sent to the actuator 10 in order to obtain an axial movement of the inlet piece 6.

30 The above-mentioned control signal for the actuator 10 may for example originate from the above-mentioned controller

which compares the measured axial play between the inlet piece 6 and the rotor 4 to a preset desired value and, if both values differ, it will command the actuator 10 to adjust said play.

5

The above-mentioned desired value may hereby be a constant value, but it may also be a variable value as a function of for example the rotational speed of the rotor, the outlet pressure of the turbo compressor 1 and/or the like.

10

Naturally, the above-mentioned measuring means can be made in other ways to this end than in the form of distance sensors, such as in the form of a rotational speed sensor or a pressure sensor or a combination of different types of sensors and/or meters.

15

Since the diffuser 14 is constantly pressed with its outlet guide vanes 16 against the inlet piece 6, a constant diffuser height D will be maintained, whereas the play between the inlet piece 6 and the rotor 4 is constantly adjusted, depending on the immediate conditions while the turbo compressor 1 is operational.

20

The above-mentioned means 18 which constantly keep the diffuser 14 with its outlet guide vanes 16 against the inlet piece 6 can also be realised in other ways according to the invention than in the shape of the above-mentioned spring, such as in the shape of screws which, according to a special characteristic of the invention, are screwed through the above-mentioned outlet guide vanes 16.

25

30

Such a variant of a turbo compressor 1 whereby screws are screwed through the outlet guide vanes 16 may be interesting for example in applications having broad outlet guide vanes 16.

5

According to another special characteristic of the invention, the diffuser 14 can be fixed in an almost inseparable manner to the inlet piece 6, for example by means of gluing, welding or the like.

10

In the above-described embodiment of an improved turbo compressor 1 according to the invention, the inlet piece 6 can be axially moved, but it is also possible according to the invention to provide the turbo compressor 1 with a fixed inlet piece 6, whereby the play between the rotor 4 and the inlet piece 6 is set only once, but whereby, thanks to the presence of the above-mentioned means 18 which constantly keep the diffuser against the inlet piece 6, the diffuser height no longer has to be set as separate.

20

Consequently, such an improved turbo compressor 1 according to the invention is advantageous in that it can be assembled in a faster and simpler way than conventional turbo compressors.

25

Naturally, an improved turbo compressor 1 can be used to compress any sort of gas or mixture of gases such as air or the like.

30 The present invention is by no means restricted to the embodiments described as an example and represented in the

accompanying drawings; on the contrary, such an improved turbo compressor according to the invention can be made in various shapes and dimensions while still remaining within the scope of the invention.

Claims.

- 1.- Improved turbo compressor which is formed of a housing
5 (2) with a volute casing (3) in which a rotor (4) has been
provided such that it can turn by means of a shaft (5), and
an inlet piece (6) forming an axial guide for the gas which
is sucked in by the rotor (4), whereby a diffuser (14) with
a number of outlet guide vanes (16) is provided on the
10 delivery side of the rotor (4), characterised in that the
turbo compressor (1) is provided with means (18) which
constantly keep the diffuser (14) with its outlet guide
vanes (16) against the inlet piece (6).
- 15 2.- Improved turbo compressor according to claim 1,
characterised in that the above-mentioned means (18) which
constantly keep the diffuser (14) with its outlet guide
vanes (16) against the inlet piece (6) are made as screws.
- 20 3.- Improved turbo compressor according to claim 2,
characterised in that the above-mentioned screws are
screwed through the above-mentioned outlet guide vanes
(16).
- 25 4.- Improved turbo compressor according to claim 1,
characterised in that the above-mentioned means (18) which
constantly keep the diffuser (14) with its outlet guide
vanes (16) against the inlet piece (6) are made as elastic
means which push the diffuser (14) against the inlet piece
30 (6).

5.- Improved turbo compressor according to any one of the preceding claims, characterised in that the above-mentioned inlet piece (6) can be axially moved in relation to the rotor (4) and in that the turbo compressor (1) comprises means to adjust the axial play between the inlet piece (6) and the rotor (4) while the turbo compressor (1) is operational.

6.- Improved turbo compressor according to claim 5, characterised in that the above-mentioned means for adjusting the axial play between the inlet piece (6) and the rotor (4) comprise an actuator (10) to axially move the inlet piece (6).

7.- Improved turbo compressor according to claim 5 or 6, characterised in that it is provided with means to determine the axial play between the inlet piece (6) and the rotor (4), and in that this play is set to a desired value as a function of the above-mentioned findings.

20

8.- Improved turbo compressor according to claim 7, characterised in that the above-mentioned means to determine the axial play between the inlet piece (6) and the rotor (4) are realised as one or several of the following measuring means: a distance sensor (13) which determines the axial play between the inlet piece (6) and the rotor (4), a rotational speed sensor and/or a pressure sensor.

9.- Improved turbo compressor according to claim 6, characterised in that the above-mentioned actuator (10) is

realised as a pneumatic, hydraulic, electrical and/or electronic actuator.

10.- Improved turbo compressor according to any one of
5 claims 6 to 9, characterised in that it is provided with a controller which is connected to the above-mentioned means to measure the axial play between the inlet piece (6) and the rotor (4), and to the above-mentioned actuator (10) to axially move the inlet piece (6), and in that this
10 controller is provided with an algorithm which compares the measured play between the inlet piece (6) and the rotor (4) to a desired value and which controls the actuator (10) to adjust said play in case both values differ.

15 11.- Improved turbo compressor according to claim 6, characterised in that the above-mentioned inlet piece is provided with a flange (7) or other fixing means with which said inlet piece (6) is mounted on the volute casing (3) such that it can move in relation to said volute casing (3)
20 and/or an end flange (8), and in that the above-mentioned actuator (10) is provided at the height of said flange (7).

12.- Improved turbo compressor according to claim 5,
characterised in that it is provided with a stop (11) for
25 the inlet piece (6), positioned such that in case of a standstill of the turbo compressor (1), a preset axial play between the inlet piece (6) and the rotor (4) is always guaranteed.

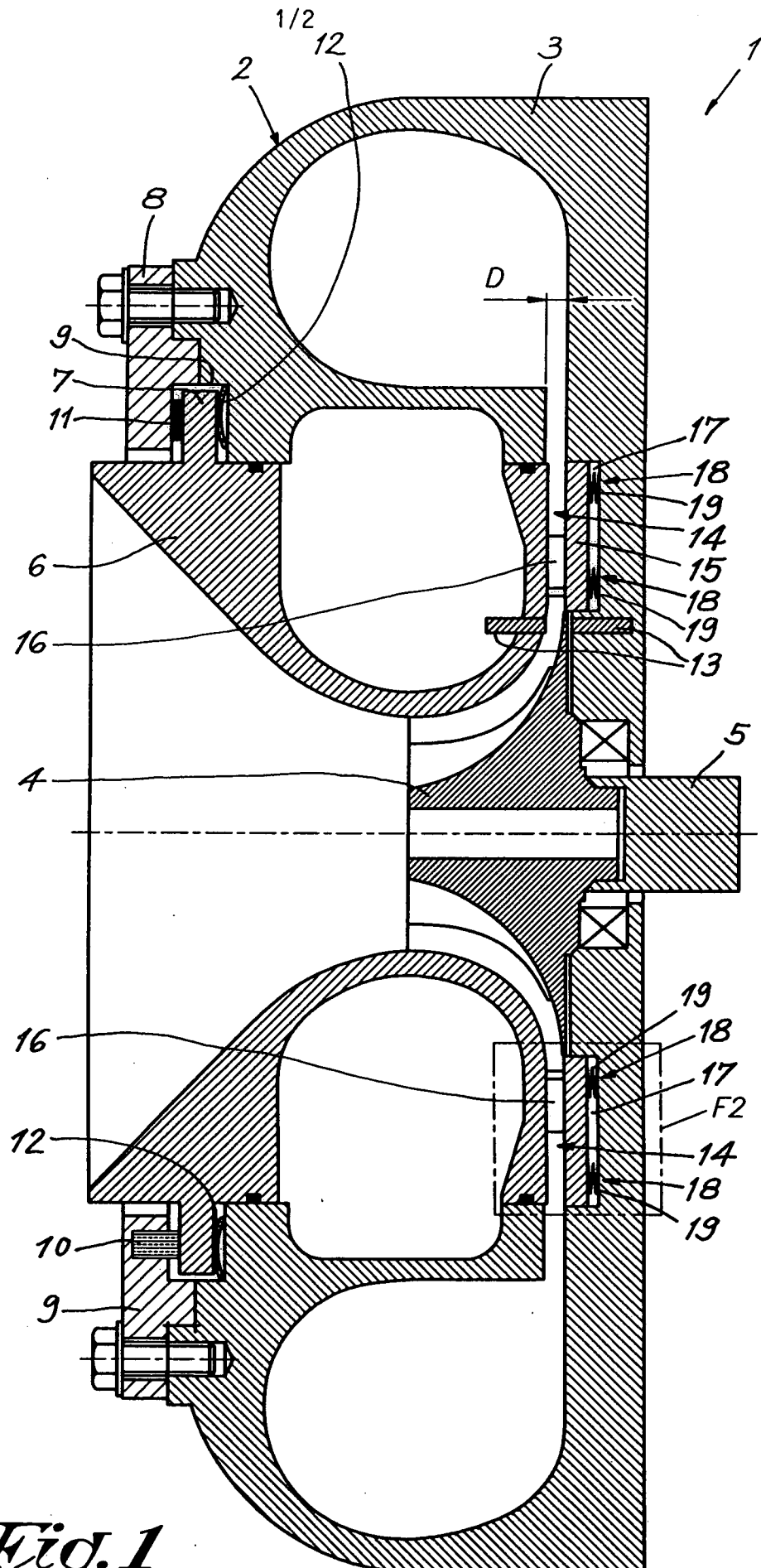


Fig. 1

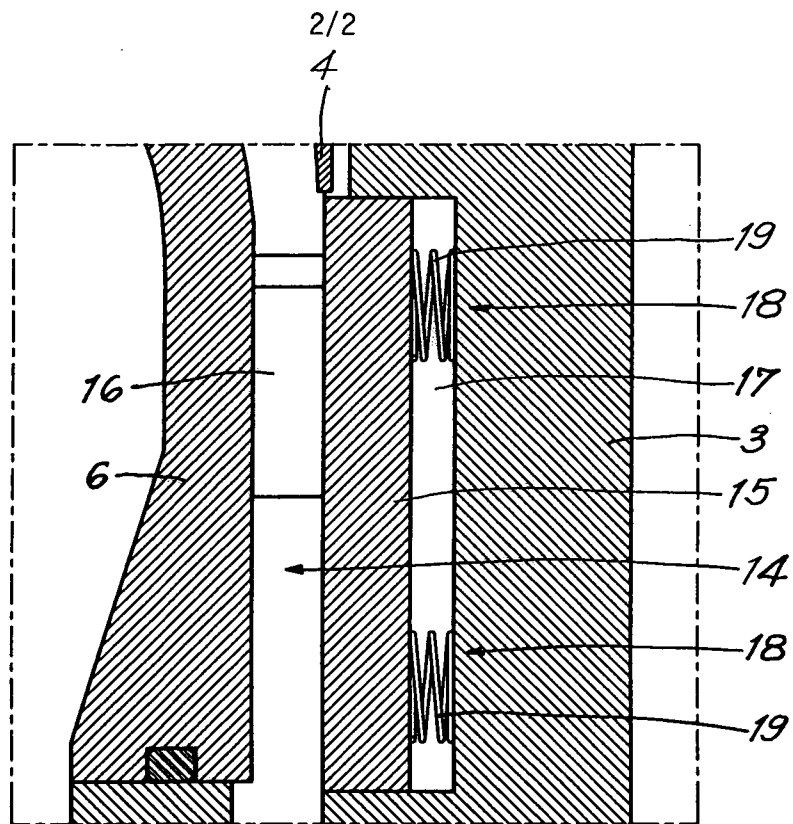


Fig. 2

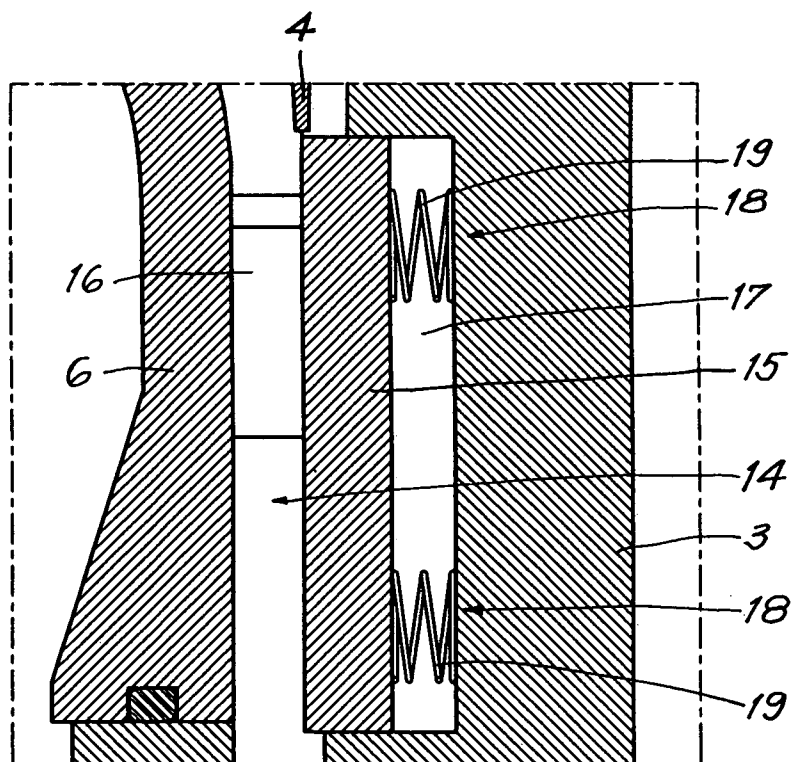


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No

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A. CLASSIFICATION OF SUBJECT MATTER

INV. F04D27/02 F04D29/44 F04D29/62 F04D29/08

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)

F04D F01D

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

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 11 257293 A (KOBE STEEL LTD) 21 September 1999 (1999-09-21) abstract figure 1	1-12
X	WO 00/19107 A (ALLIED SIGNAL INC [US]) 6 April 2000 (2000-04-06) the whole document	1,4
X	US 2007/196206 A1 (MARTIN STEVEN P [US] ET AL) 23 August 2007 (2007-08-23) figure 3	1
X	US 2005/232762 A1 (SMOKE JASON C [US] ET AL) 20 October 2005 (2005-10-20) figure 2 paragraph [0008]	1-3
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☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 01/09488 A (ALLISON ADVANCED DEV CO [US]; RESS ROBERT A JR [US]) 8 February 2001 (2001-02-08) the whole document -----	5-12
A	US 5 263 816 A (WEIMER MATTHEW M [US] ET AL) 23 November 1993 (1993-11-23) the whole document -----	5-12
A	JP 60 003405 A (NISSAN MOTOR) 9 January 1985 (1985-01-09) the whole document -----	5,9

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/BE2008/000075

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
JP 11257293	A	21-09-1999	NONE	
WO 0019107	A	06-04-2000	AU 6411799 A BR 9914244 A CN 1321225 A DE 69919187 D1 DE 69919187 T2 EP 1117934 A1 JP 2003526037 T US 6168375 B1	17-04-2000 29-01-2002 07-11-2001 09-09-2004 11-08-2005 25-07-2001 02-09-2003 02-01-2001
US 2007196206	A1	23-08-2007	WO 2007098363 A1	30-08-2007
US 2005232762	A1	20-10-2005	NONE	
WO 0109488	A	08-02-2001	AU 6502200 A GB 2369410 A US 6273671 B1	19-02-2001 29-05-2002 14-08-2001
US 5263816	A	23-11-1993	NONE	
JP 60003405	A	09-01-1985	NONE	