(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 214 313 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
06.09.2017 Bulletin 2017/36

(21) Application number: **17165818.0**

(22) Date of filing: **02.09.2014**

(51) Int Cl.:
F04C 23/00 *(2006.01)* ***F04C 29/12*** *(2006.01)*
F04B 39/12 *(2006.01)* ***F04B 41/06*** *(2006.01)*
F04F 5/46 *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **05.09.2013 BE 201300580**

(62) Document number(s) of the earlier application(s) in accordance with Art. 76 EPC:
14776980.6 / 3 042 080

(71) Applicant: **ATLAS COPCO AIRPOWER, naamloze vennootschap**
2610 Wilrijk (BE)

(72) Inventors:
- **DE KERPEL, Stefan Paul M.**
2610 Wilrijk (BE)
- **STOFFIJN, Jan Achiel L.**
2610 Wilrijk (BE)

(74) Representative: **Donné, Eddy**
Bureau M.F.J. Bockstael nv.
Arenbergstraat 13
2000 Antwerpen (BE)

(54) **COMPRESSOR DEVICE**

(57) Compressor device with at least one compressor (3) with an inlet (4) and an outlet (5) and a channel (6) for channelling the gas flow drawn in by the compressor and the gas flow compressed by the compressor to a consumer, characterised in that the compressor device (1) is provided with a passive element (15) that limits the backflow of the compressed gas from the consumer (7) to the inlet (4) to a set maximum flow.

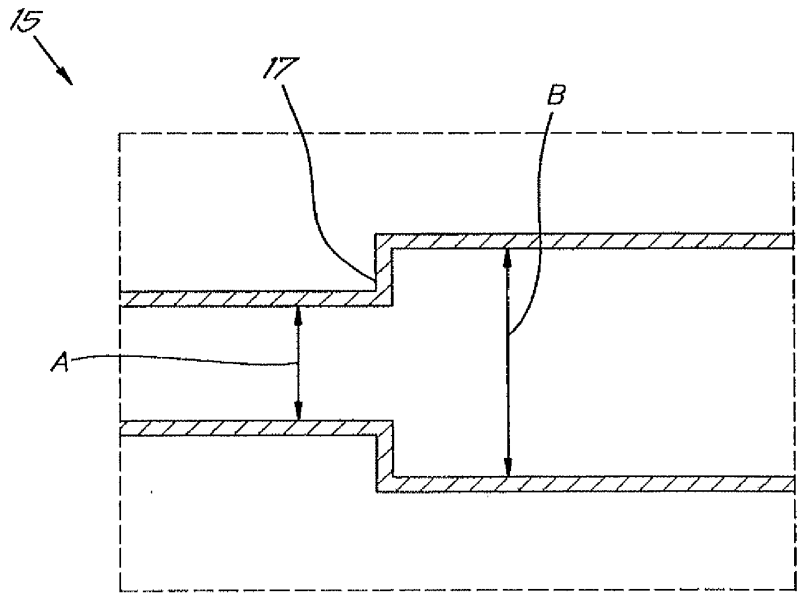

Fig.2

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The present invention relates to a compressor device with at least one compressor with an inlet and an outlet.

[0002] More specifically, the invention concerns a compressor device with at least one compressor with an inlet and an outlet and a channel for channelling the gas flow drawn in by the compressor and the gas flow compressed by the compressor to a consumer downstream from the compressor.

[0003] Such a compressor device can be used to compress air or another gas or mixture of gases for example, whereby this compressed gas can supply a compressed air installation or another consumer of compressed gas and/or compressed air for example. When compressed air is stated hereinafter it must also be taken to mean other compressed gases and/or mixture of gases.

[0004] Generally, according to the flow direction of the gas that flows through the compressor device, there is a pressure vessel between the compressor and the consumer(s) that acts as a buffer for compressed air to stabilise the pressure of the compressed air that is supplied to the consumers.

[0005] Generally a non-return valve is also provided between the compressor and the consumers that prevents compressed air from being able to flow back to the compressor from the pressure vessel when the compressor is not supplying any compressed air to this pressure vessel.

[0006] Such a non-return valve generally comprises a valve disk that is pushed against a seat by means of a spring and the pressure in the pressure vessel, and thus makes a reverse flow of compressed air from the pressure vessel to the compressor impossible.

[0007] When such a non-return valve fails there is a risk that the backflow of compressed air is not prevented when the compressor is not supplying any compressed air to the pressure vessel, and that consequently the compressed air flows back in the opposite direction through the compressor to the inlet of the compressor. As a result, the energy present in the compressed air can ensure that the compressor is driven undesirably, according to the principle of a turbine, in the opposite direction to the normal direction of rotation.

[0008] When the compressor turns backwards at high speed, this can have adverse effects on the components of the compressor. At a relatively low reverse speed there will only be limited adverse effects, if any, for example in the form of possible oil leaks that can occur around the seals for example.

[0009] When the reverse speed becomes greater, mechanical damage can occur to the components of the compressor such as bearings and gearwheels for example, such that the efficiency can be detrimentally affected.

[0010] A reverse speed higher than the maximum allowed reverse speed could lead to failure of the compressor, which could have adverse effects on the safety of the compressor device as it could lead to breakages which, in the worst case, could give rise to the breaking off of a part that is thrown out at high speed, which constitutes a risk for any bystanders.

[0011] In order to curtail the dangers of the aforementioned risk, this is taken into account in the development and calculation of the compressor, which gives rise to more expensive and heavier constructions of compressors.

[0012] One example can be found in EP 2,131,040 A having Toyota Jidoshokki KK as applicant, whereby a scroll compressor is described. The scroll compressor having a suction chamber communicating with the compression chambers, a discharge chamber, an oil separation chamber separating lubricating oil from the refrigerant gas and communicating with the discharge chamber and a back pressure chamber provided in front of the movable scroll member.

[0013] In order to endeavour to prevent such adverse effects, other additional measures are also already known.

[0014] A possible additional measure can consist of providing a release valve that can open when the compressor is not operating to allow a proportion of the compressed air to escape from the installation via this valve, such that the reverse turning of the compressor can be limited.

[0015] Another possible additional measure provides an inlet throttle or inlet vanes that automatically close when the compressor is not operating, such that too high a reverse speed of the compressor can be prevented.

[0016] A disadvantage of such a release valve and such an inlet throttle or inlet vanes is that they must be actively controlled, i.e. they must be opened or closed at the appropriate time, which makes such facilities liable to failure such that these facilities consequently must satisfy strict safety standards, which affects the cost.

[0017] Most compressors are equipped with a gearbox that exerts something of a braking effect during the backflow of compressed air and the resulting reverse turning of the compressor and gearbox.

[0018] This has a favourable effect on the aforementioned risk but has the additional adverse effect that the gearbox, when reverse turning, can be damaged around the seals or possible breakages can occur.

[0019] With directly driven compressors, in other words compressors that are driven directly by the motor without the intervention of a gearbox, the braking effect of such a gearbox is absent, which increases the risk of breakage in the compressor.

[0020] The purpose of the present invention is to provide a solution to one or more of the aforementioned and/or other disadvantages.

[0021] To this end the object of the present invention is a compressor device with at least one compressor with an inlet and an outlet and a channel for channelling the gas flow drawn in by the compressor and the gas flow compressed by the compressor to a consumer, whereby this compressor device is provided with a passive element that limits the backflow of the compressed gas from the consumer to the aforementioned inlet to a set maximum flow and whereby the passive element comprises a sonic nozzle.

[0022] An advantage is that such a passive element will be able to limit the speed of the compressor during reverse turning and will thereby be able to prevent damage or limit the risk thereof.

[0023] 'Passive element' means an element that contains no moving parts which means that such an element has a much lower risk of failure than elements with moving and/or actively controlled components, such that less stringent safety requirements are imposed and the element and the entire device can be constructed more easily and cheaply.

[0024] It is possible, but not necessary, that the device is provided with a non-return valve, which during normal operation prevents the backflow of the compressed gas to the inlet. In this case the aforementioned passive element will ensure that the reverse turning of the compressor is limited in the event of failure of the non-return valve. Preferably the passive element comprises a restriction in the channel for the backflow of the compressed gas from the pressure vessel to the aforementioned inlet.

[0025] Such a restriction has the advantage that it can be easily constructed and applied in different locations, such as for example at the level of the inlet and/or the outlet of the compressor.

[0026] Preferably the aforementioned restriction in the channel forms the minimum cross-section of the channel that is smaller than the cross-section of the inlet and/or the outlet of the compressor.

[0027] According to a preferred characteristic of the invention the set maximum flow is imposed by the maximum allowed speed for the reverse turning of the compressor.

[0028] This has the advantage that during the reverse turning of the compressor the speed can never be higher than the maximum allowed speed such that serious damage to the compressor can be prevented.

[0029] The maximum allowed speed for reverse turning is determined by the mechanical limits of the compressor, for example.

[0030] It is not excluded that the set maximum flow rate can be chosen such that the speed of the reverse turning of the compressor is limited to a speed that is less than the maximum allowed speed for reverse turning, such that during reverse turning any form of damage can be prevented.

[0031] With the intention of better showing the characteristics of the invention, a few preferred embodiments of a compressor device according to the invention are described hereinafter by way of an example, without any limiting nature, with reference to the accompanying drawings, wherein:

figure 1 schematically shows a compressor device according to the invention;

figure 2 shows a possible embodiment of the section indicated by F2 in figure 1;

figure 3 schematically shows an alternative embodiment of a compressor device according to the invention;

figure 4 shows a possible embodiment of the section indicated by F4 in figure 3;

figures 5 and 6 schematically show alternative embodiments of a compressor device according to the invention.

[0032] The compressor device 1 according to the invention shown in figure 1 comprises one compression stage 2 that comprises a compressor 3 with an inlet 4 and an outlet 5. In this case the compressor 3 concerned is constructed in the form of a screw compressor, but the invention is not limited as such and the compressor 3 concerned can also be constructed in the form of another type of compressor such as a tooth compressor, a scroll compressor, a turbocompressor or another type of compressor. It goes without saying that that the invention is not limited to application with one compression stage, but can also be applied in compressor devices with a number of compression stages, as will be described further.

[0033] The compressor device further comprises a channel 6 comprising an inlet channel 6a that is connected to the inlet 4 for channelling the gas flow drawn in by the compressor 3 and an outlet channel 6b that is connected to the outlet 5 for channelling the gas flow compressed by the compressor 3 to a consumer 7 of compressed air and/or to a pressure network or consumer network to which one or more consumers 7 are connected, such as for example pneumatic machines or appliances. It is possible that there is a pressure vessel between the compressor 3 and the consumer 7, whereby the compressed gas flow is first channelled to the pressure vessel via the outlet channel 6b before the compressed gas is supplied to the consumer 7.

[0034] In this case the inlet 4 of the compressor 3 is directly connected to the surrounding air via the inlet channel 6a to draw in the air to be compressed. However, it is not excluded that the inlet 4 of the compressor 3 is connected to a source, reservoir or similar for any type of gas or mixture of gases.

[0035] Normally the inlet channel 6a contains an inlet filter that is not shown in the drawings.

[0036] As stated, in this example the compressor 3 consists of a screw compressor with a double rotor 8 that is affixed rotatably in a housing 9.

[0037] The double rotor 8, as is known, is formed by two helical rotors 10a and 10b with lobes that mesh together, and which together with the housing 9 define a gas chamber 11 at the inlet 4, which upon the rotation of the rotors 10a and 10b moves from the inlet 4 to the outlet 5 and thereby becomes increasingly smaller so that the gas trapped in this gas chamber 11 is compressed.

[0038] The shaft 12 of one of the two rotors 10b is coupled to drive means in the form of a motor 13 for driving the screw compressor 3.

[0039] In this case, but not necessarily, a cooler 14 is placed in the outlet channel 6b, for example in the form of a heat exchanger.

[0040] According to the invention, a passive element 15 is placed in the aforementioned outlet channel 6b, in this case downstream from the compressor 3. A non-return valve 16 is also provided in the aforementioned outlet channel 6b that is configured such that it enables a flow from the compressor 2 to the pressure vessel and the consumer 7, but not in the reverse direction.

[0041] In a preferred embodiment such a non-return valve 16 comprises a valve disk 16a that is pushed against a seat 16c by means of a spring 16b when the pressure downstream from the non-return valve 16 is greater than the pressure upstream from the non-return valve 16. The invention is not limited as such, as the non-return valve 16 can also be constructed in other ways, for example whereby no spring is provided and the valve disk 16a is pushed against the seat 16c under the influence of gravity and/or under the influence of the pressure difference across this non-return valve 16, and more specifically because the pressure downstream from the non-return valve 16 is greater than the pressure upstream therefrom. It goes without saying that a construction of a non-return valve with a spring 16c can also make use of the aforementioned principles of gravity and/or pressure difference for the closing thereof.

[0042] The passive element 15 can be constructed in different ways. Figure 2 shows a practical embodiment whereby the element 15 is constructed as a step-shaped restriction 17 in the opposite flow direction Q' in the direction from the outlet 5 to the inlet 4 and thus a widening in the forward flow direction Q from the inlet 4 to the outlet 5.

[0043] Hereby the cross-section A of the outlet channel 6b upstream from the restriction 17 is smaller than the cross-section B of the channel downstream from the restriction 17. In other words the cross-section of the channel is reduced at the level of the step-shaped restriction 17 in the direction from the outlet 5 to the inlet 4.

[0044] The operation of the compressor device 1 is very simple and as follows.

[0045] During normal operation, the compressor 3 is driven by the motor 13.

[0046] Surrounding air for example is drawn in by the compressor 3 that is compressed and supplied at a higher pressure, via the passive element 15 and then the non-return valve 16, to the consumer 7 that is connected to the channel 6.

[0047] Thereby, when flowing through the passive element 15 the gas flow experiences a widening of the outlet channel 6b from a cross-section A to a cross-section B.

[0048] The passive element 15 will hereby have no or as good as no appreciable effect on the compressed air that flows through in the forward direction.

[0049] Downstream from the compressor 3, the compressed air is cooled by means of the cooler 14 to ensure that the compressed air is cold enough before being supplied to the consumer 7.

[0050] During this normal operation, the non-return valve 16 is pushed open due to the pressure of the compressed air against the force of the spring 16b such that the compressed air can flow to the consumer 7 in the forward flow direction Q.

[0051] When the consumer 7 no longer needs a gas flow, the compressor 3 can be stopped such that the pressure downstream from the non-return valve 16 is greater than the pressure upstream therefrom. This pressure difference, together with the force of the spring 16b ensures that the valve disk 16a is pushed against the seat 16c. The non-return valve 16 is thus closed, which prevents compressed air flowing back from the consumer 7 through the compressor 3 to the inlet 4 in the reverse flow direction Q'.

[0052] If the non-return valve 16 fails, the backflow in the reverse flow direction Q' is no longer prevented by this non-return valve 16 and air inevitably flows from the consumer 7 back to the inlet 4 through the compressor 3.

[0053] The presence of the passive element 15 prevents the compressed air from flowing back through the compressor 3 in the reverse flow direction Q' at too high a rate.

[0054] Indeed, during the backflow the gas flow will experience a sudden cross-section reduction or narrowing of the outlet channel 6b at the location of the passive element 15. At this cross-section reduction or narrowing a saturation occurs as of a certain flow rate, whereby the narrowing will not allow more flow through than this specific saturation flow, which depends on the dimensions of the restriction 17.

[0055] The restriction may be dimensioned such that the saturation flow rate of the passive element 15 during a backflow from the outlet 5 to the inlet 4 is less than the maximum flow rate imposed by the maximum allowed speed for the reverse turning of the compressor 3.

[0056] As the backflow rate is determined by the total flow resistance in the total backflow path through the passive element 15, the outlet channel 6b, the compressor 3 and the inlet channel 6a, the passive element 15 must be dimensioned such that the total backflow resistance is large enough to limit the backflow rate such that the reverse turning speed of the compressor 3 is kept below a limit value.

[0057] This will ensure that the speed with which the compressor 3 turns in the reverse under the effect of this backflowing compressed air will be limited. As a result the compressor 3 is protected against possible damage.

[0058] Figure 3 shows a variant of the compressor device 1 of figure 1, whereby in this case two compression stages 2a and 2b are provided, each consisting of a compressor 3a, respectively 3b, whereby the compressors

3a and 3b are connected together in series by means of a channel section 6c, such that the first compressor 3a forms a low-pressure stage 2a, while the second compressor 3b forms a highpressure stage 2b.

[0059] In this example the compressors 3a and 3b are directly driven turbocompressors.

[0060] In this example the passive element 15 is between the two compressors 3a and 3b in the channel section 6c, upstream from the second compressor 3b, whereby in this case a cooler 14 is also provided in the aforementioned channel section 6c, whereby in this case this cooler 14 acts as an 'intercooler'.

[0061] According to the invention it is also possible for the passive element 15 to be in the inlet channel 6a, upstream from the first compressor 3a, or for the passive element 15 to be in the outlet channel 6b, downstream from the second compressor 3b.

[0062] In this example the passive element 15 is constructed as a sonic nozzle 18 as shown in figure 4, whereby the nozzle 18 is integrated in the channel section 6c whereby this channel section 6c has a constant cross-section C.

[0063] In this case, the sonic nozzle 18 is formed by a nozzle whose flow cross-section gradually decreases in the forward flow direction towards the consumer 7 to a minimum cross-section D, which for a forward gas flow in the flow direction Q forms the outlet 19 of the nozzle and which opens out into a wider channel section 6c to the consumer 7.

[0064] The sonic nozzle 18 causes a small pressure loss in the forward flow direction Q, but in the reverse flow direction Q' behaves as a step-shaped restriction 17 in the channel section 6c whereby the cross-section of this channel section 6c decreases suddenly.

[0065] The design of the sonic nozzle 18 is such that the speed of a gas that flows through in the forward direction will accelerate, whereby the speed of sound can be reached at the level of the outlet 19 of the nozzle 18. The diameter of the minimum cross-section D at the outlet 19 of the sonic nozzle 18 is such that the maximum flow rate that can flow through the sonic nozzle 18 at the speed of sound in the forward direction is at least equal to the maximum flow rate that can flow through the compressors 3a and 3b in the forward direction.

[0066] In this case too, the nozzle 18 is designed such that the maximum flow rate that can flow back through it in the reverse flow direction is imposed by the maximum allowed speed for the reverse turning of the compressors 3a and 3b. After all, the sonic nozzle 18 will behave as a step-shaped restriction 17 in the cross-section of the channel section 6c to prevent or limit the reverse turning speed of the compressors 3a and 3b.

[0067] It is not excluded that in this embodiment the passive element 15 is constructed as a step-shaped restriction 17, as shown in figure 2.

[0068] It is further clear that a cooler can be provided at the outlet 5b of the second compressor 3b to cool the compressed air before the supply to the consumer 7, whereby this cooler thus acts as an aftercooler of the compressor device 1.

[0069] Figures 5 and 6 show two alternative embodiments of a compressor device 1 according to the invention, whereby in this case the compressor device 1 comprises two compressors 3a and 3b that are connected together in parallel. They can be screw compressors, directly driven turbocompressors or another suitable type of compressor, or any combination of different types of compressors.

[0070] In the case of figure 5 the compressors 3a and 3b are each placed in a parallel branch 6c', respectively 6c" of the channel 6, whereby the compressors 3a and 3b are connected via a common section of the inlet and outlet channel 6a and 6b, both downstream and upstream from the compressors 3a and 3b.

[0071] In this example the passive element 15 is provided in the common outlet channel 6b located downstream from the compressors 3a and 3b, and can be constructed as a step-shaped restriction 17 as shown in figure 2, or as a sonic nozzle 18 as shown in figure 4, or in the form of another type of passive element that is configured such that in a normal flow direction of the compressed air it causes no or practically no flow resistance, but in a reverse flow direction Q' provides such a resistance that the reverse turning speed of the compressors 3a and 3b is limited to a safe value.

[0072] According to the invention it is not excluded that the passive element 15 is provided in the upstream common inlet channel 6a.

[0073] The operation of the compressor device 1, as shown in figure 5, is analogous to the embodiments described above.

[0074] In this case the compressors 3a and 3b will simultaneously compress the air drawn in instead of in subsequent stages, as shown in figure 3.

[0075] In figure 5 the drawn in gas originates from the same common inlet channel 6a. In the event of a backflow of the compressed air, the passive element 15 will prevent both compressors 3a and 3b from reverse turning at too high a speed by limiting the flow rate of the gas flow that flows back via the outlet channel 6b to the parallel branches 6c' and 6c". This has the advantage that both compressors 3a and 3b can be protected by means of one passive element 15.

[0076] In the example of figure 6 the compressors 3a and 3b are also placed in parallel analogous to figure 5, with the difference that each of the compressors 3a and 3b has a separate inlet channel 6a', respectively 6a", and that each of these inlet channels 6a' and 6a" is provided with a passive element 15a, respectively 15b, that limits the backflow rate through each of the compressors 3a and 3b in the event of a failure of the non-return valve 16.

[0077] In this case it is not excluded either that the passive elements 15a and 15b are placed in the outlet channel 6b', respectively 6b", downstream from the compressor 3a and 3b concerned.

[0078] The operation of the compressor device 1, as shown in figure 6, is analogous to the embodiment of figure 5 described above.

[0079] In this embodiment it is possible for example that the first inlet channel 6a' draws in air while the inlet channel 6a" draws in another type of gas from a source, reservoir or similar.

[0080] The passive elements 15a and 15b will now each prevent the corresponding compressor 3a and 3b from turning again at too high a speed. This has the advantage that each passive element 15a and 15b can be adapted to the specific requirements of the corresponding compressor 3a, respectively 3b.

[0081] It is clear that in all embodiments, as shown in figures 1, 3, 5 and 6, more than one or more than two compressors 3, 3a, 3b can be provided, whereby these compressors 3, 3a, 3b can be directly driven screw compressors or other types of compressors. The compressor device 1 can hereby be provided with one or more coolers 14 or otherwise, between or after one or more of the compressors 3, 3a, 3b.

[0082] It is also clear that the invention can also be applied to all possible combinations of serial and parallel connected compressors. As a result a passive element 15 can be provided per group of compressors and/or per individual compressor.

[0083] It is also clear that the passive element 15 in all embodiments described above can be placed at different locations in the compressor device 1, and if desired can be in the inlet or outlet of a compressor 3, 3a, 3b or can be integrated in one of the compressor housings 9. This last one has the advantage that the passive element 15 does not have to be built into the channel 6a, 6b, 6c.

[0084] It is not excluded either that the passive element 15 is integrated in a component of the compressor device 1, such as in the non-return valve 16 itself or in the cooler 14 or in the inlet filter or similar.

[0085] Alternatively, the non-return valve 16 can be replaced by movable inlet vanes, an adjustable inlet throttle and/or a release valve that is activated in order to divert the back flowing air to the environment before it can flow back through the compressor.

[0086] As already stated above, it is also clear that in all the examples described the compressor device 1 can also be used to compress another gas or mixture of gases other than air.

[0087] The restriction as shown in figure 2 does not need to be limited to one single step-shaped restriction 17, but can also comprise a number of successive step-shaped restrictions 17 or a gradual transition of diameter, in combination or otherwise with one or more step-shaped restrictions 17.

[0088] The present invention is by no means limited to the embodiments described as an example and shown in the drawings, but a compressor device according to the invention can be realised in all kinds of forms and dimensions, without departing from the scope of the invention.

Claims

1. Compressor device with at least one compressor (3) with an inlet (4) and an outlet (5) and a channel (6) for channelling the gas flow drawn in by the compressor and the gas flow compressed by the compressor to a consumer, **characterised in that** the compressor device (1) is provided with a passive element (15) that limits the backflow of the compressed gas from the consumer (7) to the inlet (4) to a set maximum flow and whereby the passive element (15) comprises a sonic nozzle (18).

2. Compressor device according to claim 1, **characterised in that** the passive element (15) comprises a restriction in the channel (6) for the backflow of the compressed gas from the consumer (7) to the inlet (4).

3. Compressor device according to claim 2, **characterised in that** the aforementioned restriction forms a step-shaped restriction (17) in the channel (6), in the direction from the outlet (5) to the inlet (4).

4. Compressor device according to any one or more of the previous claims, **characterised in that** the sonic nozzle (18) comprises a nozzle whose flow cross-section decreases in the direction towards the consumer (7) to a minimum cross-section (C) that forms the outlet (19) of the nozzle and which opens into a wider channel (6) towards the consumer (7).

5. Compressor device according to claim 4, **characterised in that** the aforementioned nozzle is provided with a constant cross-section in a section of the channel (6).

6. Compressor device according to one or more of the previous claims, **characterised in that** the set maximum flow rate is imposed by the maximum speed for the reverse turning of the compressor (3).

7. Compressor device according to one or more of the previous claims, **characterised in that** the passive element (15) is downstream from the compressor (3) in the channel (6) or in the outlet (5) of the compressor (3).

8. Compressor device according to one or more of the claims 1 to 6, **characterised in that** the passive element (15) is upstream from the compressor (3) in the channel (6) or in the inlet (4) of the compressor (3).

9. Compressor device according to any one of the previous claims, **characterised in that** the device (1) is provided with a non-return valve (16) that prevents the backflow of the compressed gas to the inlet (4)

during normal operation.

10. Compressor device according to any one of the previous claims, **characterised in that** the device (1) is provided with a number of compressors (3a, 3b) that are connected in series to one another by means of the channel (6a, 6b, 6c).

11. Compressor device according to claim 10, **characterised in that** the passive element (15) is between two compressors (3a, 3b).

12. Compressor device according to any one of the previous claims 1 to 11, **characterised in that** the device (1) is provided with a number of compressors (3a, 3b) that are connected in parallel to one another, by means of the channel (6a, 6b, 6c), to a common outlet section (6b) downstream from the compressors (3a, 3b) and/or a common inlet section (6a) upstream from the compressors (3a, 3b), whereby a passive element (15) is applied in an aforementioned common inlet section and/or outlet section (6a and/or 6b).

13. Compressor device according to any one of the previous claims 1 to 12, **characterised in that** the device (1) is provided with a number of compressors (3a, 3b) that are connected in parallel to one another by means of the channel (6a, 6b, 6c) whereby a passive element (15) is provided for each compressor (3a, 3b).

14. Compressor device according to any one of the previous claims, **characterised in that** the compressor (3) is a directly driven turbocompressor.

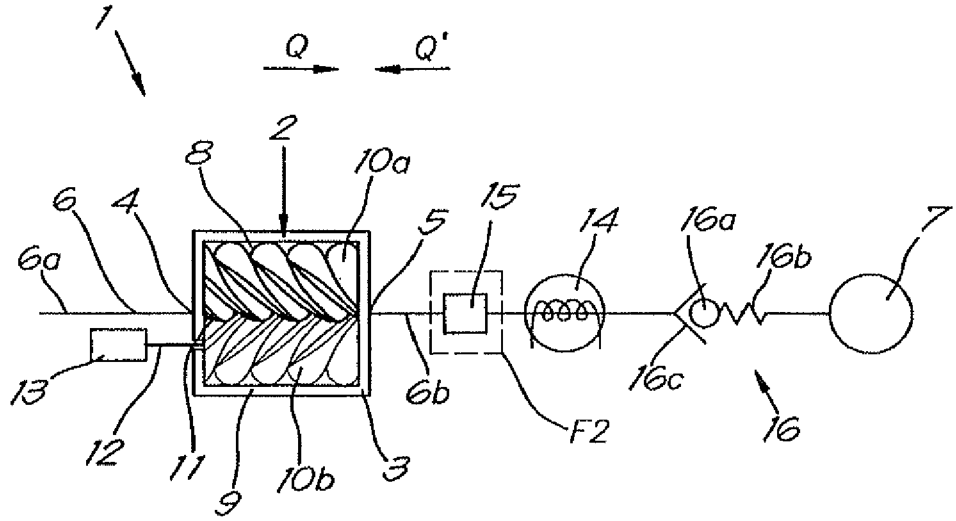
1
Q
Q'
2
8
10a
6
4
5
15
14
16a
16b
7
6a
13
12
11
9
10b
3
6b
F2
16c
16

Fig.1

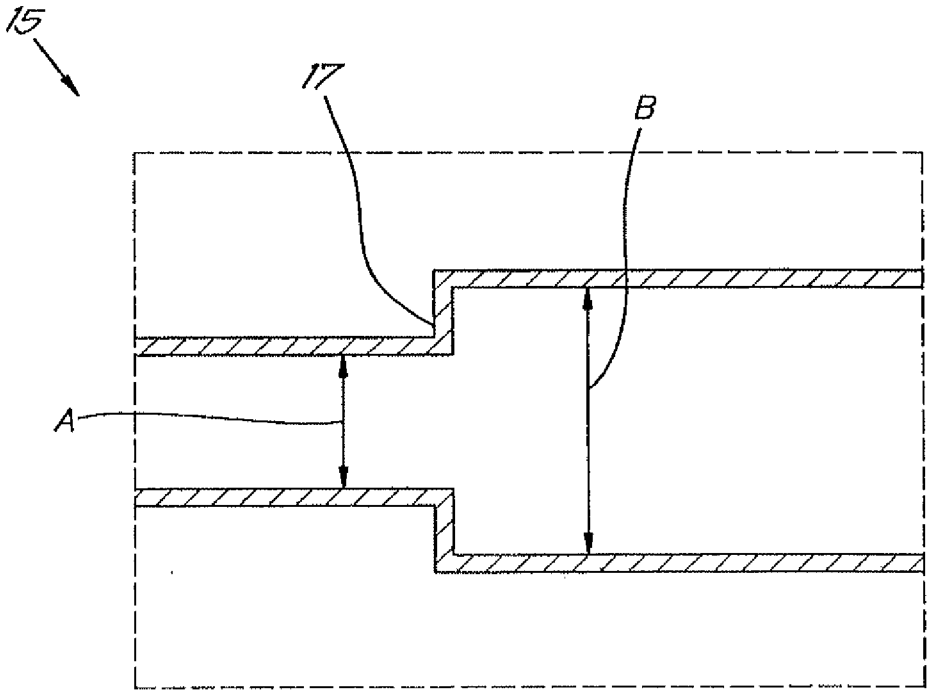
15
17
B
A

Fig.2

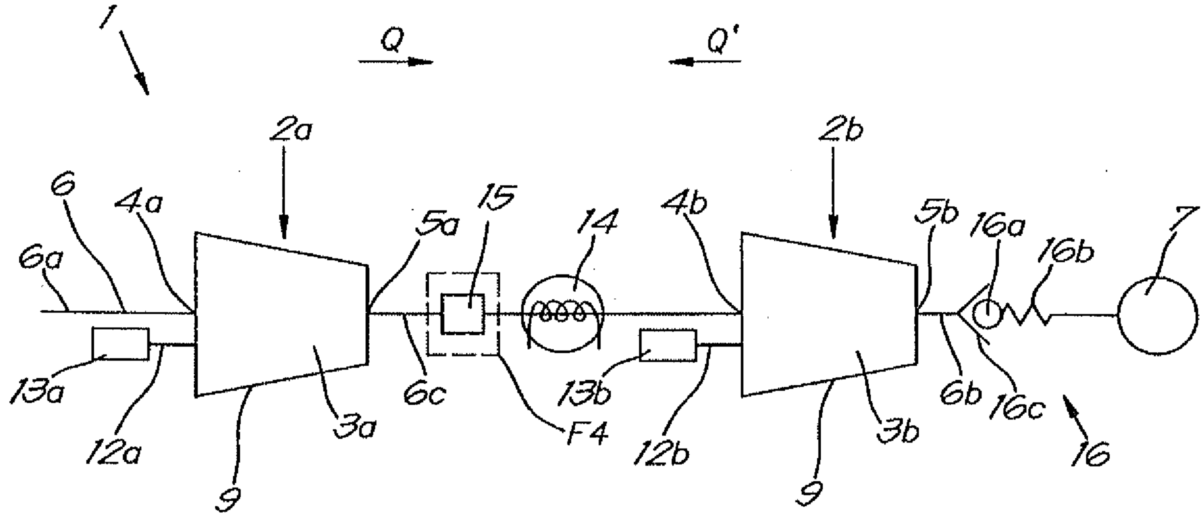
1
Q
Q'
2a
2b
6
4a
15
14
4b
5b
16a
16b
7
6a
5a
13a
12a
9
3a
6c
F4
13b
12b
3b
6b
16c
16

Fig.3

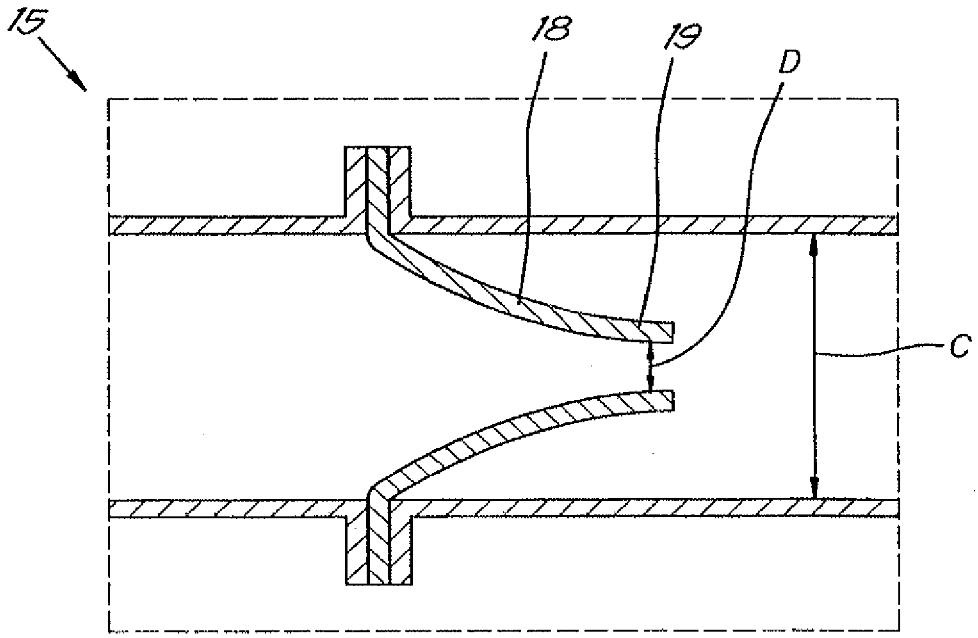
15
18
19
D
C

Fig.4

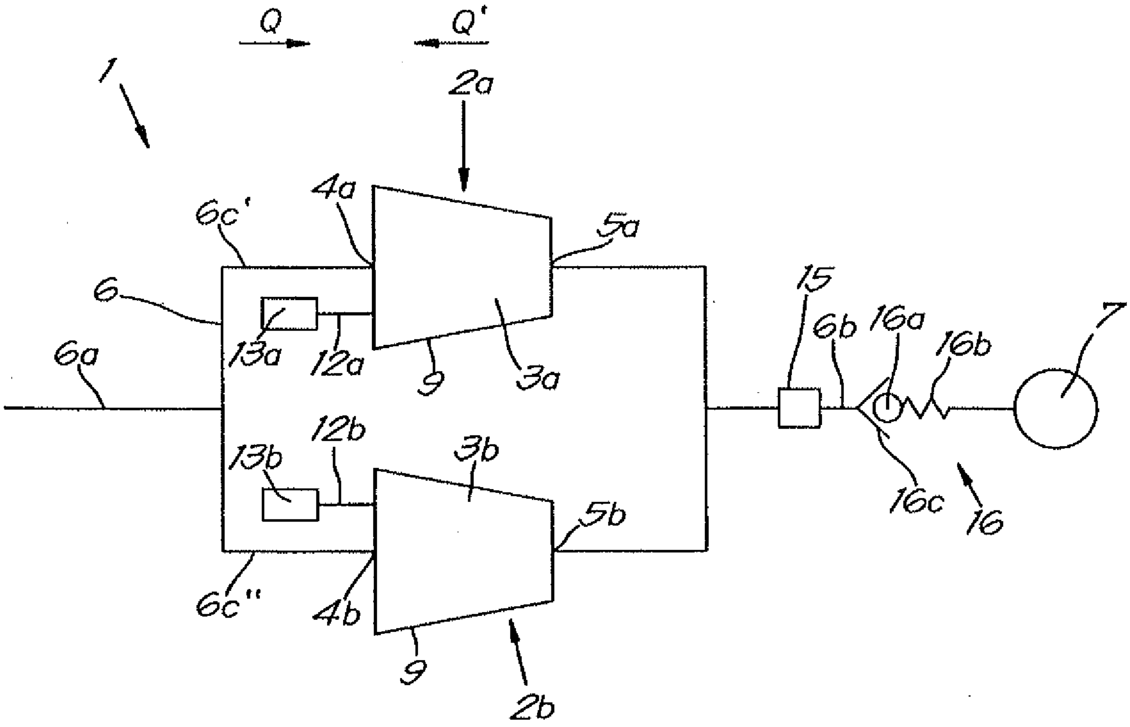
Q
Q'
1
2a
4a
6c'
5a
6
13a
12a
9
3a
6a
15
6b
16a
16b
7
12b
13b
3b
5b
16c
16
6c''
4b
9
2b

Fig.5

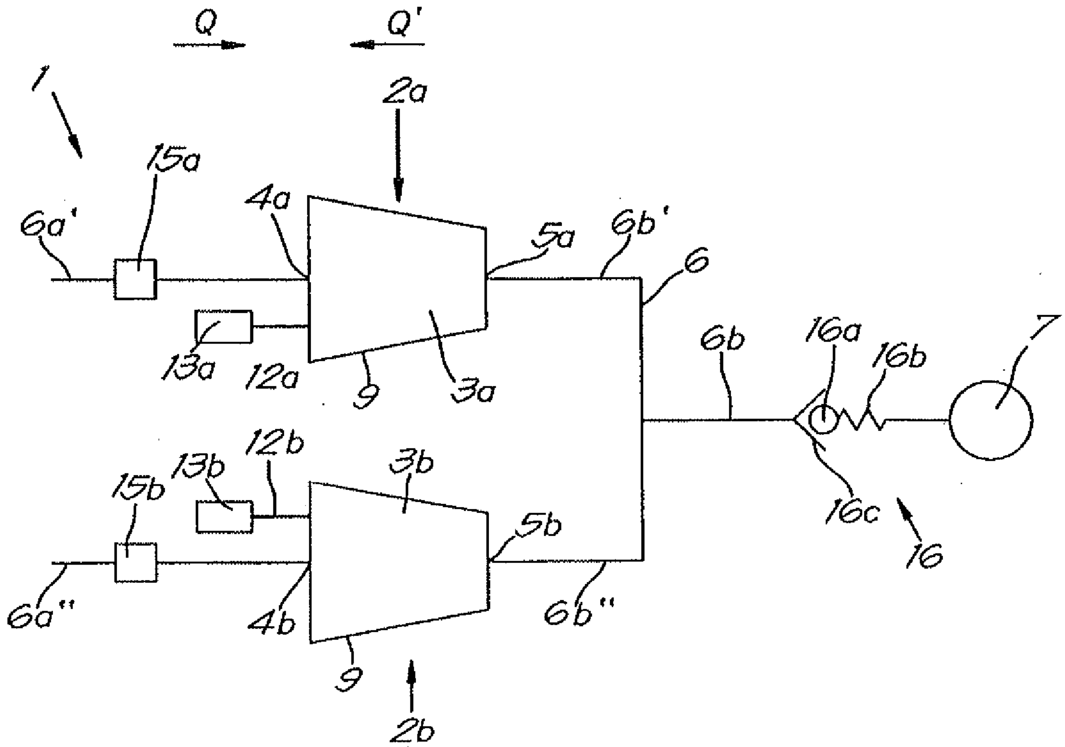
Q
Q'
1
2a
15a
4a
6a'
5a
6b'
6
13a
12a
9
3a
6b
16a
16b
7
12b
13b
15b
3b
5b
16c
16
6a''
4b
6b''
9
2b

Fig.6

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 17 16 5818

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	CN 101 644 627 A (UNIV BEIHANG) 10 February 2010 (2010-02-10)	1,2,4,6, 7,9,10, 12-14	INV. F04C23/00 F04C29/12 F04B39/12 F04B41/06 F04F5/46
A	* the whole document * -----	3	
A	GB 1 407 887 A (BARODYNE INC) 1 October 1975 (1975-10-01) * the whole document * -----	1-14	
A	EP 2 131 040 A2 (TOYOTA JIDOSHOKKI KK [JP]) 9 December 2009 (2009-12-09) * paragraph [0024] * * figure 1 * -----	1-14	
A	EP 1 491 769 A1 (TOYOTA JIDOSHOKKI KK [JP]) 29 December 2004 (2004-12-29) * paragraphs [0021] - [0024] * * figures 1-5a * -----	1-14	
A	JP 2006 105064 A (SANDEN CORP) 20 April 2006 (2006-04-20) * abstract * -----	1-14	TECHNICAL FIELDS SEARCHED (IPC)
A	JP S59 218380 A (HITACHI LTD) 8 December 1984 (1984-12-08) * abstract * -----	1-14	F04C F04B F04F
A	WO 2010/067174 A1 (TEK GLOBAL SRL [IT]; LOLLI SERGIO [IT]) 17 June 2010 (2010-06-17) * page 6, line 17 - page 7, line 5 * * figures 3,4 * -----	1,9	
A	DE 29 45 857 A1 (SCHLECHT KARL) 21 May 1981 (1981-05-21) * page 9, paragraph 1 * * figures 1,2 * ----- -/--	1,10	

The present search report has been drawn up for all claims

3

Place of search	Date of completion of the search	Examiner
Munich	27 July 2017	Lange, Christian

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

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 17 16 5818

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2006/140791 A1 (DEMING GLENN I [US] ET AL) 29 June 2006 (2006-06-29) * paragraph [0042] * * figure 1 * -----	1,9	

TECHNICAL FIELDS SEARCHED (IPC)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	27 July 2017	Lange, Christian

3

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)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 17 16 5818

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.

27-07-2017

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 101644627 A	10-02-2010	NONE	
GB 1407887 A	01-10-1975	NONE	
EP 2131040 A2	09-12-2009	EP 2131040 A2	09-12-2009
		JP 5315933 B2	16-10-2013
		JP 2010014108 A	21-01-2010
		US 2009304539 A1	10-12-2009
EP 1491769 A1	29-12-2004	DE 602004001929 T2	01-03-2007
		EP 1491769 A1	29-12-2004
		JP 2005016454 A	20-01-2005
		US 2005002800 A1	06-01-2005
JP 2006105064 A	20-04-2006	NONE	
JP S59218380 A	08-12-1984	JP H045833 B2	03-02-1992
		JP S59218380 A	08-12-1984
WO 2010067174 A1	17-06-2010	DE 112009003670 T5	20-08-2015
		US 2012034124 A1	09-02-2012
		WO 2010067174 A1	17-06-2010
DE 2945857 A1	21-05-1981	NONE	
US 2006140791 A1	29-06-2006	CA 2588256 A1	06-07-2006
		EP 1831561 A2	12-09-2007
		JP 2008525720 A	17-07-2008
		KR 20070086950 A	27-08-2007
		US 2006140791 A1	29-06-2006
		WO 2006071929 A2	06-07-2006

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

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 2131040 A **[0012]**