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

(11) **EP 4 112 933 A1**

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
04.01.2023 Bulletin 2023/01

(21) Application number: **21182863.7**

(22) Date of filing: **30.06.2021**

(51) International Patent Classification (IPC):
F04B 39/06 *(2006.01)* ***F04B 53/08*** *(2006.01)*
F25B 31/00 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F04B 39/064; F04B 53/08; F25B 31/006

(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
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

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(54) INTEGRATED COOLING OF A COMPRESSOR

(57) A compressor comprising a housing (2) forming at least one compressor chamber (3), wherein the compressor is configured to compress a working fluid contained in the at least one compressor chamber (3), wherein at least one part of the housing (2) further comprises a cooling channel (4) configured to contain a cooling fluid flowing through the cooling channel (4).

Further, a pneumatic system and a vehicle are disclosed.

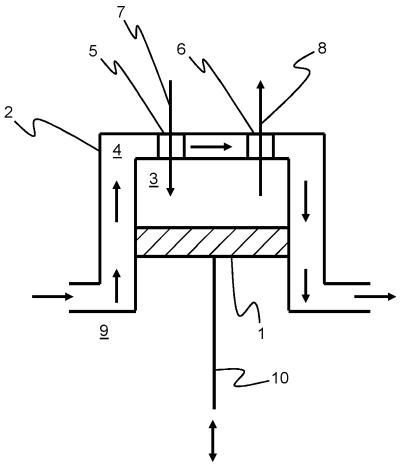

Fig. 1

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Description

[0001] The current invention relates to a compressor with an integrated cooling, a pneumatic system and a vehicle with such a compressor.

[0002] Compressors, in particular pneumatic compressors, are used for several vehicle applications. For example, compressors are used to supply a working fluid, such as air, to a system, in particular a pneumatic braking system, an air suspension, a container for compressed air and/or an air supply system for a fuel cell.

[0003] During operation, the compressor can heat up in particular due to the compressor work, which is transferred to and heats up the working fluid. This causes stress of the compressor.

[0004] It is therefore the object of the current invention to solve this problem.

[0005] This object is solved by the subject matters of the independent claims. Advantageous embodiments of the invention are the subject matters of the dependent claims.

[0006] According to the invention, a compressor is provided comprising a housing forming at least one compressor chamber, wherein the compressor is configured to compress a working fluid contained in the at least one compressor chamber, wherein at least one part of the housing further comprises a cooling channel configured to contain a cooling fluid flowing through the cooling channel.

[0007] Hence, a compressor is provided comprising an integrated cooling that is realised by a cooling channel that is provided in the housing, e.g. in at least a part of the housing wall. Thereby, cooling of the compressor and/or the working fluid can be realised.

[0008] Preferably, the cooling fluid comprises a liquid, in particular water, a mixture of water or oil. As a mixture of water, the cooling fluid preferably comprises a glycol-water mixture.

[0009] Preferably, at least one part of the cooling channel extends around at least one part of the compressor chamber.

[0010] Preferably, the housing comprises an inlet port and/or an outlet port that are/is flown around, at least partially, by the cooling fluid. In particular, the cooling channel can extend around the inlet port and/or around the outlet port, preferably circularly. To increase the cooling effect, in particular on the working fluid, the cooling channel can extend, preferably helically, along a flowing direction of the inlet port and/or the outlet port.

[0011] Further preferably, the ratio of the length of the inlet port and/or of the outlet port to the average width of the inlet port and/or of the outlet port is equal to or more than 1. In other words, the inlet port and/or the outlet port preferably extend/extends in its flow direction at least as far as the diameter of the corresponding port. This leads to a design of the corresponding port, wherein an increased boundary surface of the ports to the cooling fluid in the cooling channel is provided. The cooling fluid in particular flows by the boundary surface. Thus, the cooling effect to the ports and/or to the working fluid is increased, since the cooling fluid is in contact with an increased boundary surface, whereby an increased amount of heat can be absorbed by the cooling fluid.

[0012] Preferably, the compressor comprises a rotatable shaft, which is preferably provided in a cavity of the housing, and which is configured to move at least one compressing element of the compressor in the compressor chamber to compress the working fluid. The compressing element preferably limits the compressor chamber and affects the volume of the compressor chamber according to its movement. The shaft and the at least one compressing element are connected directly or via intermediate elements to each other to move the compressing element according to the rotation of the shaft.

[0013] Preferably, the compressing element comprises a piston guided in the compressing chamber, wherein the piston limits the compressor chamber and wherein the piston is configured to be moved between a maximum lifting position and a minimum lifting position and wherein the volume of the compressor chamber is changed by the movement of the piston. According to this embodiment, the compressor can be configured as a piston compressor, in particular a multi tumble piston compressor. In particular, the compressing chamber is configured as a cylinder, wherein the cylinder is moved in the direction of the axis of the cylinder.

[0014] Preferably, the piston comprises at least one inlet port configured to supply the working fluid to the compressor chamber, in particular from a cavity of the housing. The cavity is preferably the same cavity the shaft is provided in. Providing the inlet port in the piston has the advantage that a housing less complex can be formed compared with a housing comprising at least one inlet port. Therefore, a designer has more flexibility designing the compressor.

[0015] Preferably, the compressing element comprises an impeller wheel and/or a screw element.

[0016] Preferably, the compressor comprises a pump configured to supply the cooling fluid to the cooling channel. The pump can be driven by the shaft of the compressor or by another driving device.

[0017] To reduce weight of the compressor, the housing preferably comprises different materials. For example, a part of the housing that is only exposed to atmospheric pressure can comprise a lighter material compared to parts that are exposed to a pressure higher than atmospheric pressure. Preferably, if these materials comprise different thermal expansion coefficients, the cooling channel is configured to adjust the temperature of the materials to adjust an equal thermal expansion of the materials. This increases advantageously the durability of the compressor.

[0018] Preferably, the cooling channel is adjusted to cool working fluid that is intended to be supplied to and/or exhausted from the compressor chamber and/or that is contained in the compressor chamber. Advantageously,

this allows to reduce or to eliminate separate coolers for the working fluid. For this purpose, the cooling channel can be designed as a heat exchanger the working fluid is guided through.

[0019] Preferably, the working fluid comprises air and further preferably, the compressor is configured to supply the working fluid to a pneumatic system, in particular a pneumatic braking system, an air suspension, a container for compressed air and/or an air supply system for a fuel cell.

[0020] According to the invention, a pneumatic system, in particular a pneumatic braking system, an air suspension, a container for compressed air and/or an air supply system for a fuel cell, is provided. This pneumatic system comprises a compressor as described above.

[0021] According to a further aspect of the invention, a vehicle, in particular a commercial vehicle, is provided. This vehicle comprises a compressor as described above or a pneumatic system as described above.

[0022] Preferably, the compressor of the vehicle is configured to supply air to at least one of these systems of the vehicle:

- a fuel cell,
- a pneumatic braking system,
- an air suspension,
- a compressed air reservoir.

[0023] Preferably, the vehicle is configured as a commercial vehicle, a truck, a trailer, a bus, and/or a combination of a towing vehicle and a trailer.

[0024] Additionally or alternatively, the vehicle is configured as an electric, hybrid or conventional vehicle. As an electric or hybrid vehicle, the vehicle can be driven by a fuel cell based system and/or by a battery system.

[0025] In particular, the compressor can act as an air supply unit, preferably exclusively, for a trailer, wherein the compressor is installed in the trailer or in a corresponding towing vehicle.

[0026] In the following advantageous embodiments of the invention are described referring to the attached drawings.

Fig. 1 shows a first embodiment of the invention,

Fig. 2 shows a second embodiment of the invention, and

Fig. 3 shows a third embodiment of the invention.

[0027] **Fig. 1** shows a first embodiment of the invention. This embodiment refers to a piston compressor.

[0028] A housing 2 is shown in a sectional view comprising a piston 1 that is guided in the housing and configured to be movable in a perpendicular direction between a maximum lifting position and a minimum lifting position as indicated by the double arrow in the drawing. The piston 1 is moved generally according to the movement of a driving device (not shown) of the compressor. In this embodiment, the driving device comprises a rotatable shaft (not shown) provided in a cavity 9 of the housing 2, wherein the movement is transmitted to the piston 1 via a connection rod 10. The housing 2 and the piston 1 form a compressor chamber 3 for compressing a working fluid, wherein the movement of the piston 1 adjusts the volume of the compressor chamber 3.

[0029] Further, the housing 2 comprises an inlet port 5 and an outlet port 6, wherein non-compressed working fluid 7 can flow into the compressor chamber 3 and compressed working fluid can flow out of the compressor chamber 3. Valves or in general devices controlling the working fluid flowing through the ports 5, 6 are not shown to keep the drawing simple.

[0030] The housing 2 comprises a cavity formed as a cooling channel 4, extending around the compressor chamber 3 and the ports 5, 6. In the drawing, a cooling fluid flows through the cooling channel 4 from the left to the right as indicated by the arrows. The cooling fluid can comprise a liquid, in particular water or oil.

[0031] The compressor can further comprise a pump (not shown) configured to pump the cooling fluid through the cooling channel 4. Preferably, to be driven, the pump is connected to the shaft but a separate driving device for the pump can be provided as well.

[0032] The part of the housing 2 forming the compressor chamber 3 is exposed to a pressure higher than atmospheric pressure due to the compression of the fluid in the compressor chamber 3. If the part of the housing 2 forming the compressor chamber 3 comprises a heavier or more durable material compared to other parts of the housing 2, which are e.g. only exposed to atmospheric pressure, mechanical tension due to different thermal expansion coefficients can be reduced by a design of the cooling channel 4 cooling the parts with the higher thermal expansion coefficient accordingly.

[0033] **Fig. 2** shows a second embodiment of the invention. As this embodiment is similar to the embodiment shown in Fig. 1, only the differences thereto are explained in the following. Otherwise, reference is made to the description of Fig. 1.

[0034] In this embodiment, the ports 5, 6 are formed in such way that the ratio of the length (the extension in the up-down-direction) to the average width (the diameter when the cross section is a circle) of the ports 5, 6 is equal to or more than 1.

[0035] This leads to a bigger boundary surface of the ports 5, 6 to the cooling fluid in the cooling channel 4. Thus, the cooling effect to the ports 5, 6 and/or to the working fluid 7, 8 is increased.

[0036] According to another embodiment (not shown), the cooling channel 4 can further be configured to extend along the ports 5, 6 and/or circular and/or helical around the ports 5, 6.

[0037] **Fig. 3** shows a third embodiment of the invention. As this embodiment is similar to the embodiment shown in Fig. 1, only the differences thereto are explained

in the following. Otherwise, reference is made to the description of Fig. 1.

[0038] The housing 2 of this embodiment does not comprise an inlet port 5 as shown in Fig. 1 or Fig. 2. Instead, an inlet port 11 is provided in the piston 1. Valves or in general devices controlling the working fluid flowing through the ports 6, 11 are not shown to keep the drawing simple.

[0039] According to this embodiment, working fluid can be supplied from a cavity 9 of the compressor into the compressor chamber 3. The cavity 9 is identical to the cavity comprising the shaft, but other embodiments are possible comprising a separate cavity for supplying the working fluid to the compressing chamber 3.

[0040] According to this embodiment, the cavity 9 can act as a reservoir for the working fluid, wherein the piston 1 and optionally at least one further piston comprising an inlet port are provided. This allows the design of a compact compressor.

[0041] The embodiments shown in the Figures 1 to 3 are not limiting the invention. Furthermore, further embodiments of the invention can be obtained, by combining individual features, of the embodiments.

[0042] For example, an embodiment can comprise an inlet port 11 and an inlet port 5, which are connected to the same or to different compressor chambers 3.

[0043] The embodiment according to Fig. 2 concerning the shape or design of the ports 5, 6, can be related exclusively either to the inlet port 5 or to the outlet port 6 as well. The same applies to the design of the cooling channel 4.

[0044] According to particular embodiments according to the Figures 1 to 3, the working fluid comprises air and the compressors are configured for supplying the working fluid to a pneumatic system, in particular a pneumatic braking system, an air suspension, a container for compressed air and/or an air supply system for a fuel cell.

LIST OF REFERENCE SIGNS

[0045]

1	piston
2	housing
3	compressor chamber
4	cooling channel
5	inlet port
6	outlet port
7	inflowing working fluid
8	outflowing working fluid
9	cavity of the housing
10	connection rod
11	inlet port

Claims

1. Compressor comprising a housing (2) forming at least one compressor chamber (3), wherein the compressor is configured to compress a working fluid contained in the at least one compressor chamber (3), wherein at least one part of the housing (2) further comprises a cooling channel (4) configured to contain a cooling fluid flowing through the cooling channel (4).

2. Compressor according to claim 1, wherein the cooling fluid comprises a liquid, in particular water, a mixture of water or oil.

3. Compressor according to claim 1 or 2, wherein at least one part of the cooling channel (4) extends around at least one part of the compressor chamber (3).

4. Compressor according to one of the preceding claims, wherein the housing (2) comprises an inlet port (5) and/or an outlet port (6), that are/is flown around, at least partially, by the cooling fluid.

5. Compressor according to claim 4, wherein the ratio of the length to the average width of the inlet port (5) and/or of the outlet port (6) is equal to or more than 1.

6. Compressor according to one of the preceding claims, wherein the compressor comprises a rotatable shaft, which is preferably provided in a cavity (9) of the housing (2), and which is configured to move at least one compressing element in the compressor chamber (3) to compress the working fluid.

7. Compressor according to claim 6, wherein the compressing element comprises a piston (1) guided in the compressing chamber (3), wherein the piston (1) limits the compressor chamber (3), wherein the piston (1) is configured to be moved between a maximum lifting position and a minimum lifting position, wherein the volume of the compressor chamber (3) is changed by the movement of the piston (1).

8. Compressor according to claim 7, wherein the piston (1) comprises at least one inlet port (11) configured to supply the working fluid to the compressor chamber (3), in particular from a cavity (9) of the housing (2).

9. Compressor according to one of the claims 6 to 8, wherein the compressing element comprises an impeller wheel and/or a screw element.

10. Compressor according to one of the preceding claims, wherein

the compressor comprises a pump configured to supply the cooling fluid to the cooling channel (4).

11. Compressor according to one of the preceding claims, wherein
the housing (2) comprises different materials with different thermal expansion coefficients and the cooling channel (4) is configured to adjust the temperature of the materials to adjust an equal thermal expansion of the materials.

12. Compressor according to one of the preceding claims, wherein
the cooling channel (4) is adjusted to cool working fluid that is intended to be supplied to and/or exhausted from the compressor chamber (3) and/or that is contained in the compressor chamber (3).

13. Compressor according to one of the preceding claims, wherein
the working fluid comprises air and the compressor is configured to supply the working fluid to a pneumatic system, in particular a pneumatic braking system, an air suspension, a container for compressed air and/or an air supply system for a fuel cell.

14. Pneumatic system, in particular a pneumatic braking system, an air suspension, a container for compressed air and/or an air supply system for a fuel cell, comprising a compressor according to one of the claims 1 to 13.

15. Vehicle, in particular a commercial vehicle, comprising a compressor according to one of the claims 1 to 13 or a pneumatic system according to claim 14, wherein preferably,
the compressor is configured to supply air to at least one of these systems of the vehicle:

- a fuel cell,
- a pneumatic braking system,
- an air suspension,
- a compressed air reservoir, and/or wherein

the vehicle is preferably configured as a commercial vehicle, a truck, a trailer, bus, and/or a combination of a towing vehicle and a trailer, and/or wherein
the vehicle is preferably configured as an electric, hybrid or conventional vehicle.

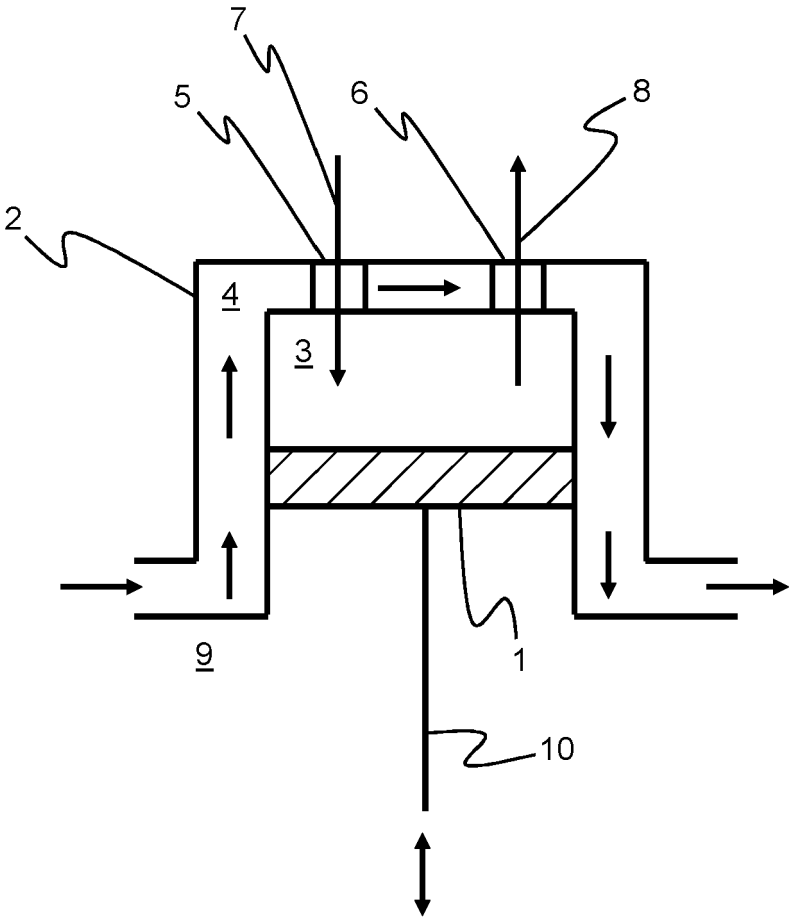

Fig. 1

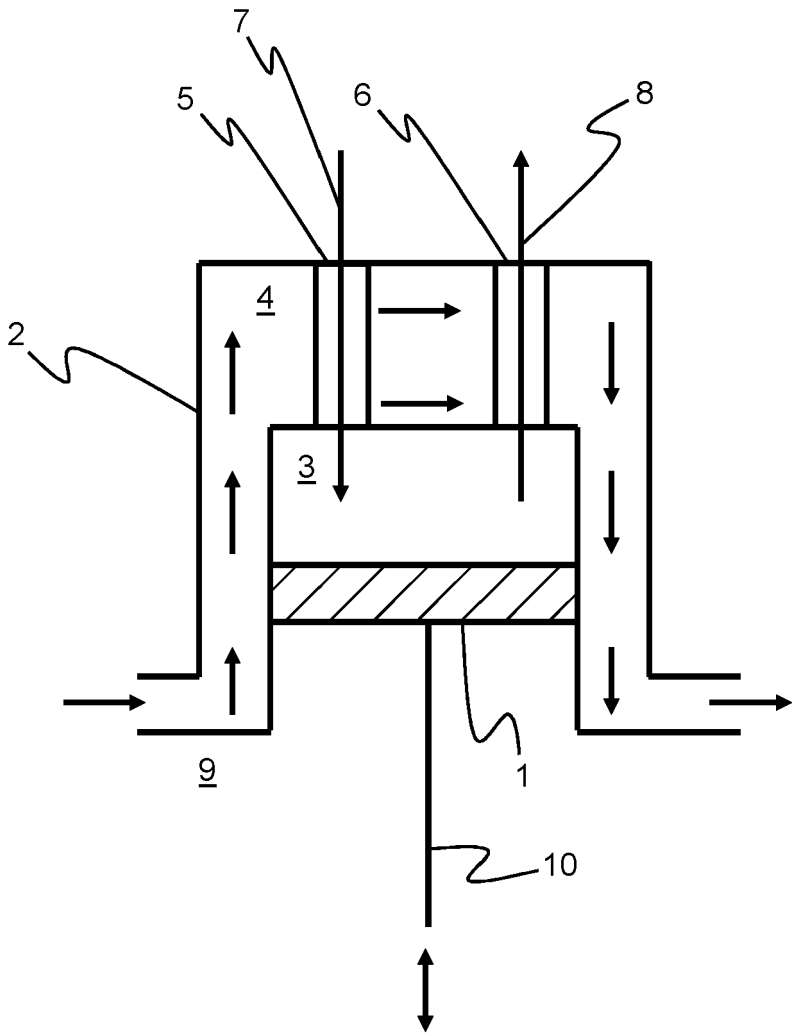

Fig. 2

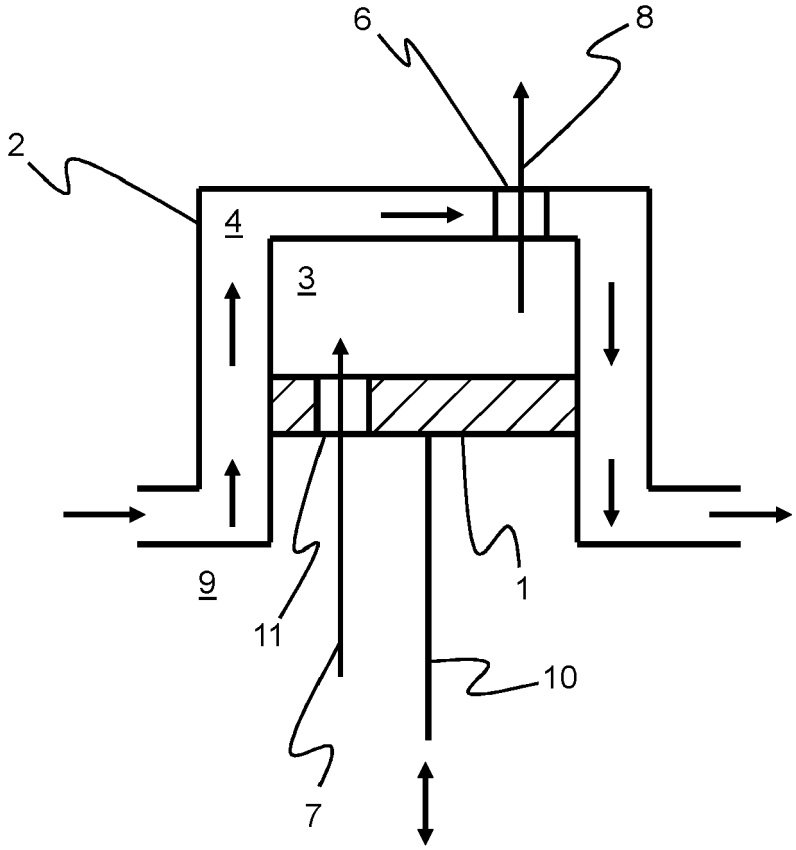

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 21 18 2863

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

Place of search	Date of completion of the search	Examiner
Munich	22 December 2021	Gnüchtel, Frank

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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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
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