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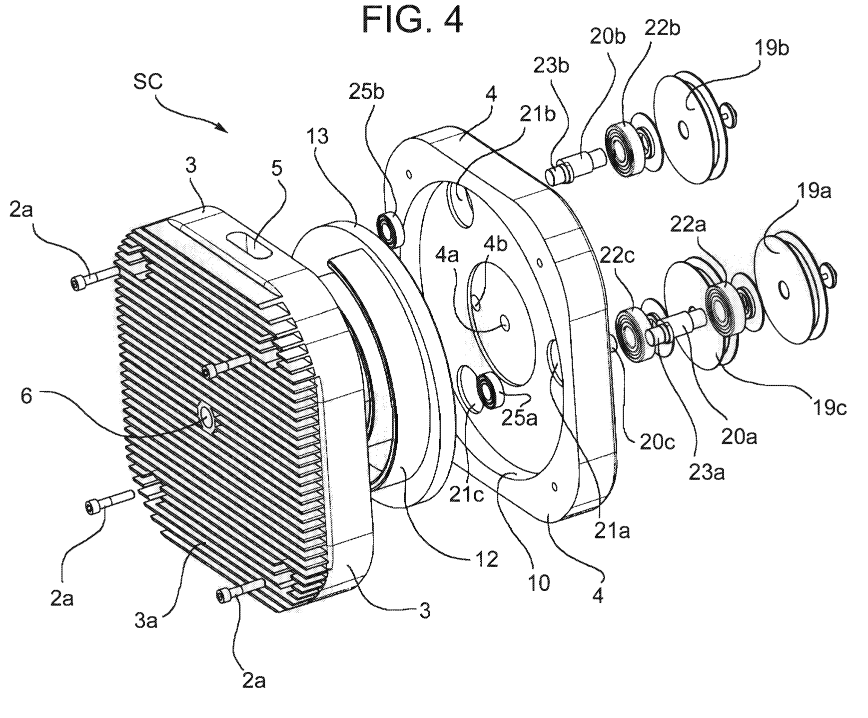
(54) **Scroll compressor and compressor unit comprising such a compressor**

(57) The compressor (SC) comprises
a rigid body (2; 3, 4) in which there is defined a working chamber (10) in which there extends a first spiral formation (11) which is of one piece with the body (2; 3, 4),
a second spiral formation (12), copenetrating and acting together with the first (11) and of one piece with a disc member (13) movably mounted in the chamber (10), and
a transmission unit comprising
a plurality of shafts (20a-20c) rotatably mounted about corresponding axes which are parallel to each other and at a distance from the axis of the disc member (13) in such a way as to leave a central area of the body (2; 3, 4) free,
each shaft (20a-20c) bearing a corresponding eccentric member (23a-23c) connected to the disc member (13) in a rotatable way about an axis parallel to the axis of the shaft (20a-20c).

FIG. 4



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Description

[0001] This invention relates to a scroll compressor of the type defined in the precharacterising clause of Claim 1.

[0002] Scroll compressors, which were invented at the beginning of the twentieth century, have in principle many advantages such as relatively simple operation, the creation of extremely uniform compression without the pulsing characteristic of compressors of the alternating type, dimensional compactness and a total absence of valves. Despite this these volumetric compressors were slow in achieving success, particularly because of the technological problems initially encountered in accurately constructing their spirals and their corresponding seals.

[0003] Thanks to the improvement of technological processes scroll compressors have found many applications in relatively recent times, in particular in motor vehicle air conditioning units.

[0004] In the scroll compressors currently manufactured orbital motion is imparted to the moving spiral through a central shaft eccentrically connected to that spiral.

[0005] This conformation gives rise to problems with balancing of the moving spiral which because of the difference in internal pressure within the variable volume compression chambers and because of its eccentric motion can find itself in conditions of dynamic imbalance, and in particular the orbiting part tends to come out of alignment. In order to overcome these disadvantages, axial supporting idling shafts which oppose movement of the moving spiral in the axial direction, have been added in many cases. This however is a complication in construction and gives rise to an increase in costs, partly because the idling shafts must be eccentric, like the central drive shaft.

[0006] One object of this invention is to provide a scroll compressor of the abovementioned type in which motion is transmitted to the orbiting spiral without a central transmission shaft.

[0007] Another object is to provide a scroll compressor which is particularly compact in the axial direction.

[0008] Another object of the invention is to provide a scroll compressor in which there is integration between the transmission and balancing means, and the number of mechanical components is appreciably reduced.

[0009] Another object of the invention is also to produce a scroll compressor whose central part, operatively the hottest part, can be effectively cooled.

[0010] These and other objects can be accomplished according to the invention through a scroll compressor whose salient features are defined in appended Claim 1.

[0011] In a compressor according to the invention, absence of the central transmission shaft makes it possible to reintroduce air which it has compressed centrally into the compressor, preferably cooled, for example using a heat exchanger. This air may in particular be returned to the compressor in such a way as to exert a pressure on the disc member bearing the moving spiral, so as to help ensure a good seal between the two spirals, avoiding disturbances and irregularity (lack of coplanarity) in the motion of the orbiting spiral through adequate dimensioning of the surfaces in relation to operating pressures. This also makes it possible to reduce stress and wear on the seals and the rotation supports. Finally this compressed air flow reintroduced into the compressor after first being cooled in a heat exchanger provides optimum cooling of the orbiting portion, in the case in point the central area which is the hottest and most stressed area of the machine when in operation.

[0012] A further object of the invention is a unit generating compressed fluid, in particular compressed air, whose essential characteristics are defined in some of the claims below.

[0013] Other advantages and characteristics of the present invention will become clear from the following detailed description which is given with reference to the appended drawings which are provided purely by way of non-limiting example and in which:

Figure 1 is a perspective view of a compressed air generating unit comprising a scroll compressor according to this invention,
Figure 2 is another perspective view of the compressed air generating unit in Figure 1,
Figure 3 is an exploded perspective view of part of a scroll compressor according to this invention,
Figure 4 is another exploded perspective view showing part of a scroll compressor according to the invention,
Figure 5 is a view in partial cross-section along the line V-V in Figure 1,
Figure 6 is a view of a detail indicated by the arrow VI in Figure 5 on a magnified scale,
Figure 7 is a view of the portion indicated by arrow VII in Figure 5 on a magnified scale, and shows a variant embodiment,
Figure 8 is a plan view from above of the compressed air generating unit according to Figures 1 and 2 incorporating a scroll compressor according to the invention, and
Figure 9 is a view in plan from above of another version of the compressed air generating unit with a scroll compressor according to the invention.

[0014] In Figures 1, 2, 8 and 9, a compressed air generating unit including a scroll compressor SC according to this invention, is indicated as a whole by 1.

[0015] With reference in particular to Figures 2, 8 and 9, compressor SC has a rigid body 2 which, in the embodiment illustrated by way of example, comprises two half-shells 3 and 4 leaktightly joined together, for example by means of screws 2a (Figure 4).

[0016] Compressor SC has at least one lateral intake port or opening 5 (Figures 1-4) and a delivery opening or connection 6 (Figures 2, 4, 5, 8 and 9) corresponding to a main finned outer surface 3a.

[0017] With reference to Figures 1, 2, 8 and 9, compressed air generating unit 1 also comprises a heat exchanger 7, for example of the air/air type, having an inlet 7a (Figures 2, 8 and 9) connected to the outlet opening 6 of compressor SC through a pipe 8. This heat exchanger 7 also has an outlet 7b (Figures 1, 8 and 9) connected by a pipe 9 to a central inlet opening 4a in compressor SC provided in half-shell 4.

[0018] Finally compressor SC has an outlet opening 4b adjacent to inlet opening 4a which acts as an outlet for the compressed air produced by generating unit 1.

[0019] With reference in particular to Figures 3 to 5, a working chamber indicated by 10 is defined between the two half-shells 3 and 4 of body 2 of compressor SC.

[0020] In Figures 3 and 5 a first spiral formation incorporated with half-shell 3 of body 2 of the compressor, which extends within chamber 10, is indicated by 11. This spiral formation 11 is of one piece with body 2 and is therefore fixed in operation.

[0021] 13 in Figures 3 to 5 indicates a disc member movably mounted within chamber 10. On the side facing half-shell 3 this member has a spiral formation 12, mutually penetrated and in operation acting together with fixed spiral formation 11 (see also Figure 6).

[0022] With reference to Figures 1, 2, 8 and 9, unit 1 also comprises a motor/fan unit 14 incorporating a motor 15, which is for example an electric motor, and a rotating bladed fan 16 keyed on the shaft of that motor. As will be apparent in Figures 8 and 9, causing fan 16 to rotate in a predetermined direction will give rise to an air flow inducing in particular a flow of air through heat exchanger 7, as indicated by the direction (by way of example) of the arrows in those figures.

[0023] Adjacent to rotor 16 the shaft of motor 15 bears a pulley 17 (Figures 1 and 8) around which runs a belt 18. This belt also runs around further pulleys 19a, 19b and 19c (Figures 1 and 4) borne on corresponding shafts 20a, 20b and 20c (Figures 4-6) rotatably mounted in corresponding openings 21a, 21b and 21c provided in half-shell 4 of the compressor body, with corresponding bearing supports 22a, 22b and 22c mounted in between.

[0024] Each of shafts 20a, 20b and 20c on the part facing disc member 13 has a corresponding eccentric longitudinal member 23a, 23b and 23c (Figures 4 to 6). The eccentric member associated with each of the aforesaid shafts has a corresponding access parallel to and at a distance from that of the associated shaft, and is engaged in a corresponding opening 24a, 24b and 24c of disc member 13 (Figures 3, 5 and 6) with corresponding supports 25a, 25b, 25c placed in between.

[0025] The arrangement is such that when pulleys 19a-19c are caused to rotate (by means of belt 18) this brings about rotation of transmission shafts 20a-20c in the same direction and, following rotation of eccentric members 23a-23c, an orbital motion with respect to body 2-4 of compressor SC is imparted to disc member 13. As a consequence, in a manner which is in itself known, the orbital motion of moving spiral 12 relative to fixed spiral 11 causes progressive compression of the air (or other gas) drawn in via opening 5. A plurality of air chambers or enclosures which progressively move inwards reducing in volume are formed between the said spirals. At the centre of the spirals the compressed air exits from body 3 of the compressor via delivery opening or connection 6. This air, which has been heated through the effect of compression, reaches the inlet of heat exchanger 7 via pipe 8. At the outlet from this exchanger the relatively cooler compressed air is reintroduced through pipe 9 into the body 4 of the compressor through inlet opening 4a in such a way that this air bathes the surfaces or surface of disc member 13 whose other side faces spiral formations 11 and 12.

[0026] With reference to Figure 3, this surface or side 13a of disc member 13 conveniently has a plurality of structures 26 in relief, for example in the form of blades, which can act as cooling fins and through centrifugal force assist the flow of air delivered centrally to the compressor body through opening 4a in the direction of outlet opening 4b which is relatively off-centre. As already mentioned previously, this opening in fact represents the actual outlet from compressed air generating unit 1.

[0027] Effective cooling of the central area of the compressor where the highest temperatures are achieved when in operation is thus achieved.

[0028] In a variant embodiment which is not illustrated part of the compressed air flowing in heat exchanger 7 is diverted from that exchanger and then delivered to the compressor in such a way that it bathes the surface or side 13a of disc member 13 causing (further) cooling, and is then discharged to atmosphere.

[0029] In all cases, the compressed air returned to the compressor exerts a pressure on disc member 13 in the direction of fixed spiral 11. This helps to ensure a good seal between the two spirals, avoiding disturbances and irregularities (lack of coplanarity) in the motion of the orbiting spiral. This also makes it possible to reduce stress and wear on the seals and the rotation supports.

[0030] Pulleys 19a-19c are conveniently angularly equally spaced and equidistant from the axis of the orbital trajectory of disc member 13.

[0031] In the variant according to Figure 9, pulley 17 for belt 18 is keyed onto the extremity of the shaft of motor 15 opposite that bearing rotor 16.

[0032] In any event, flexible transmission member 18 may be a normal flat belt, or (as in the example illustrated) a belt having an essentially V-shaped cross-section. A transmission member having a cable or toothed belt or even a chain may be used as an alternative.

[0033] According to another alternative which is not illustrated, shafts 20a-20c may be coupled to a prime mover through a rotary arrangement, in particular a rotary arrangement of the epicycloidal type. This latter option is particularly indicated for compressors which are intended to operate at high pressures and therefore require a high drive torque.

[0034] In any case, in a compressed fluid generating unit according to the invention fan 16 associated with heat exchanger 7 may be of the suction type (as in Figures 8 and 9) or the blowing type.

[0035] In the embodiments in which the disc member is driven by means of pulleys, it is possible by replacing the pulleys with others of different diameter to obtain a consequent variation in the operating speed and therefore in the throughput of the compressed air generated.

[0036] As already previously mentioned, the invention makes it possible to avoid use of a central transmission shaft driving the orbiting disc member. In addition to this the compressor is extremely compact in the axial direction, and has a relatively small number of mechanical components.

[0037] At the same time, because of the resistant torques due to the transmission shafts and the corresponding eccentric members, the known problem of reverse rotation of the machine after it has been stopped is avoided.

[0038] In addition to this, as illustrated in Figure 7, in order to avoid the consequences of any entrainment, provision may be made for the inclusion of a one-way check valve 30 directly in the delivery 6 of compressor SC, preferably (but not necessarily) in a position as close as possible to body 3 and, in an optimum arrangement which is not illustrated, directly in body 3 itself.

[0039] Any backflow of air towards the suction inlet through the effect of such entrainment at the seals, which might contribute to the abovementioned reverse rotation, is thus avoided.

[0040] The central part of the compressor is better cooled in the central area which is hotter when in operation.

[0041] Finally, the compressor may not require lubrication.

[0042] Naturally, the principle of the invention remaining the same, the forms of embodiment and details of construction may be varied widely with respect to those described and illustrated, which have been given purely by way of example, without thereby departing from the scope of the invention.

Claims

1. A scroll compressor (SC) comprising
   a rigid body (2; 3, 4) in which there is defined a working chamber (10),
   a first spiral formation (11) which is of one piece with the said body (2; 3, 4) and extends within the said chamber (10),
   a second spiral formation (12) copenetrating and co-operating with the first (11) and of one piece with a disc member (13) movably mounted within the same chamber (10), and
   drive means (15) connected to the said disc member (13) through transmission means (17-23) capable of imparting an orbital motion with respect to the said body (2; 3, 4) to the disc member (13),
   the compressor (SC) being **characterised by** the fact that the said transmission means comprise
   a plurality of transmission shafts (20a-20c) rotatably mounted about corresponding axes which are parallel with each other and at a distance from the axis of the disc member (13), in such a way as to leave a free central area in the said body (2; 3, 4),
   each transmission shaft (20a-20c) bearing a corresponding eccentric member (23a-23c) connected to the disc member (13) in a rotatable manner about an axis parallel to the axis of the shaft (20a-20c).

2. A scroll compressor according to Claim 1, in which the said transmission means comprise three shafts (20a-20c) which are angularly equally spaced and equally distant from the axis of the orbital trajectory of the disc member (13).

3. A scroll compressor according to Claim 1 or 2, in which the aforesaid shafts (20a-20c) are kinematically connected to drive means (15) through a flexible transmission member (18), such as a belt or cable or chain.

4. A scroll compressor according to Claim 3, in which the shafts (20a-20c) are connected to the said flexible transmission member (18) through corresponding pulleys (19a-19c).

5. A scroll compressor according to Claim 1 or 2, in which the aforesaid shafts (20a-20c) are kinematically attached to drive means (15) through a rotary arrangement, such as a rotary arrangement of the epicycloidal type.

6. A scroll compressor according to any one of the preceding claims, comprising means (8, 9) for reintroducing at least part of the compressed air delivered by the compressor (SC) into the said chamber (10) in such a way that the returned compressed air acts on the disc member (13) tending to press it in the direction of the fixed spiral (11).

7. A scroll compressor according to any one of the preceding claims, in which a preferably central opening (4a) is provided in the said body (2; 3, 4) for the ingress of a cooling fluid which is designed to bathe the surface or side (13a) of the disc member (13) which faces away from the said spiral formations (11, 12), and a preferably off-centre outlet opening (4b) through which the said cooling fluid may exit.

8. A scroll compressor according to Claim 7, in which the said surface or side (13a) of the disc member (13) has a plurality of structures (26) in relief to cool and convey the flow of cooling fluid from the inlet

opening (4a) to the outlet opening (4c) .

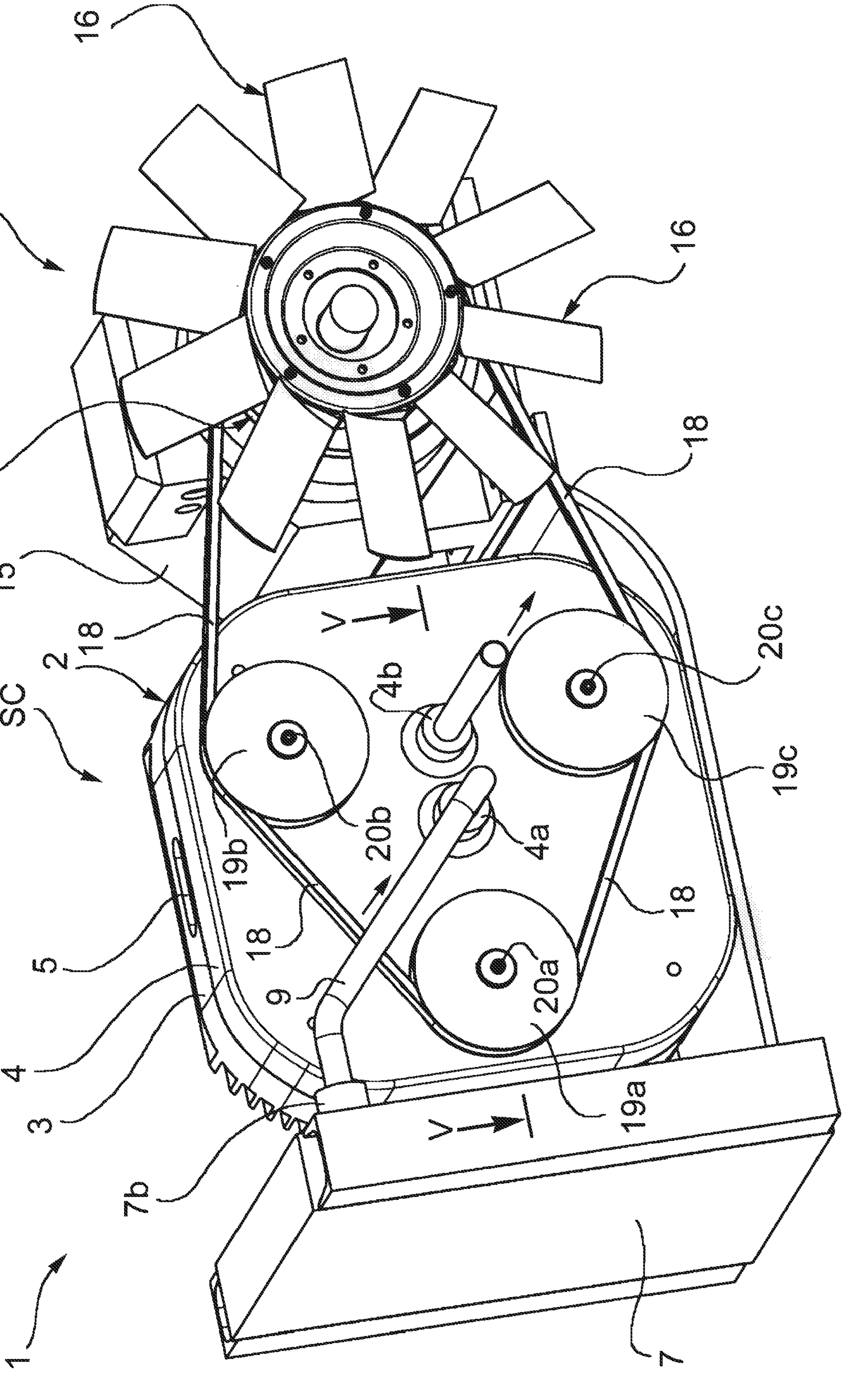
9. A scroll compressor according to Claim 6 or 7, in which the cooling fluid is at least part of the fluid compressed by the compressor (SC), and is delivered to a heat exchanger (7) and returned to the compressor (SC).

10. A scroll compressor according to any one of Claims 6 to 9, in which part of the said cooling fluid is diverted by a heat exchanger (7) and is then discharged to atmosphere after having bathed at least a portion of the surface of the disc member (13) in such a way as to cause cooling of the latter.

11. A unit generating a compressed air-like fluid (1) comprising a scroll compressor according to one or more of the preceding claims.

12. A generating unit according to Claim 11, in which the said drive means comprise the motor (15) of a motor/fan unit (14; 15, 16).

FIG. 1


16
14
16
17
18
15
18
SC
2
18
V
20c
4b
19c
19b
20b
4a
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18
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9
4
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19a
V
7b
1
7

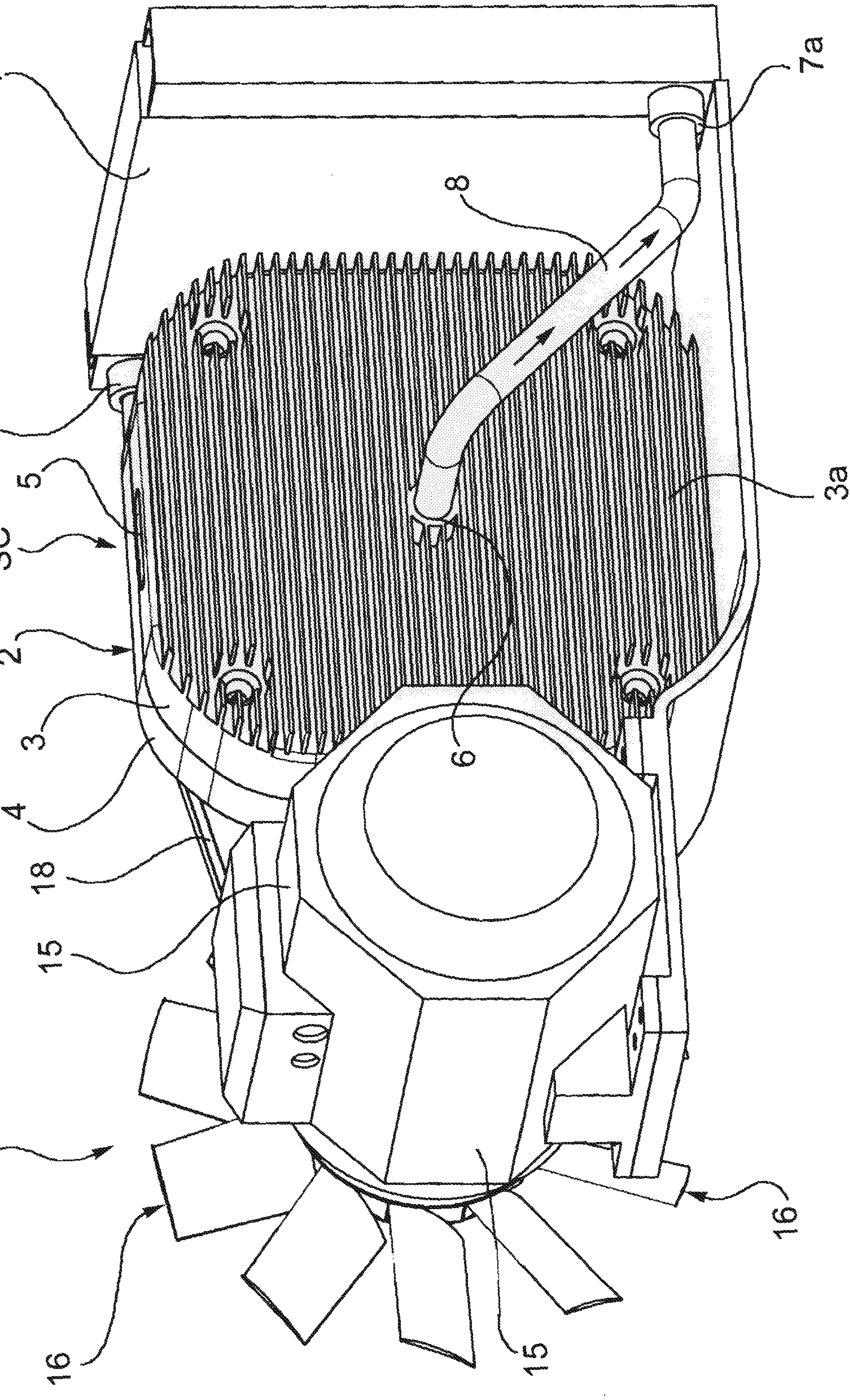

FIG. 2

FIG. 3

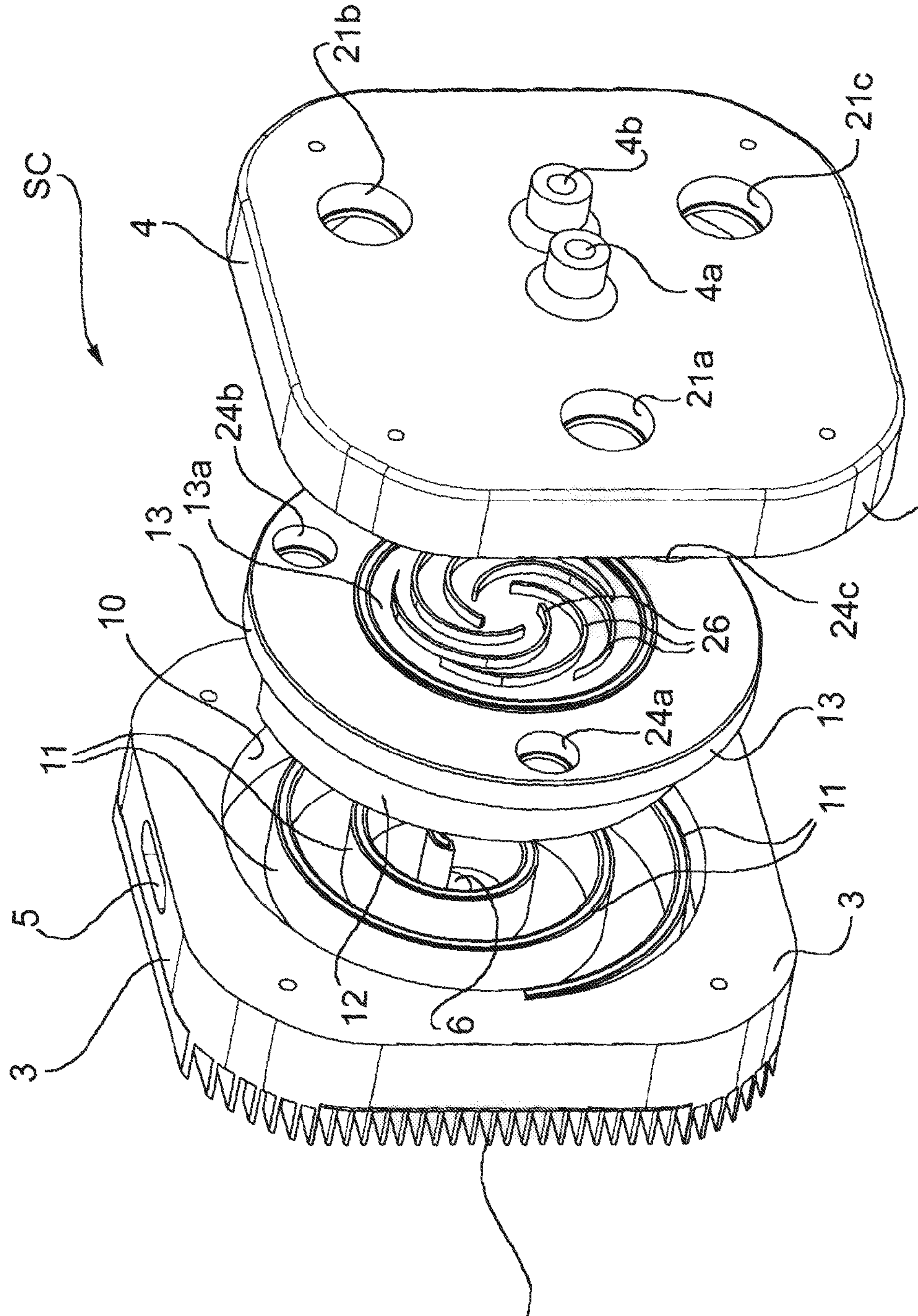

FIG. 4

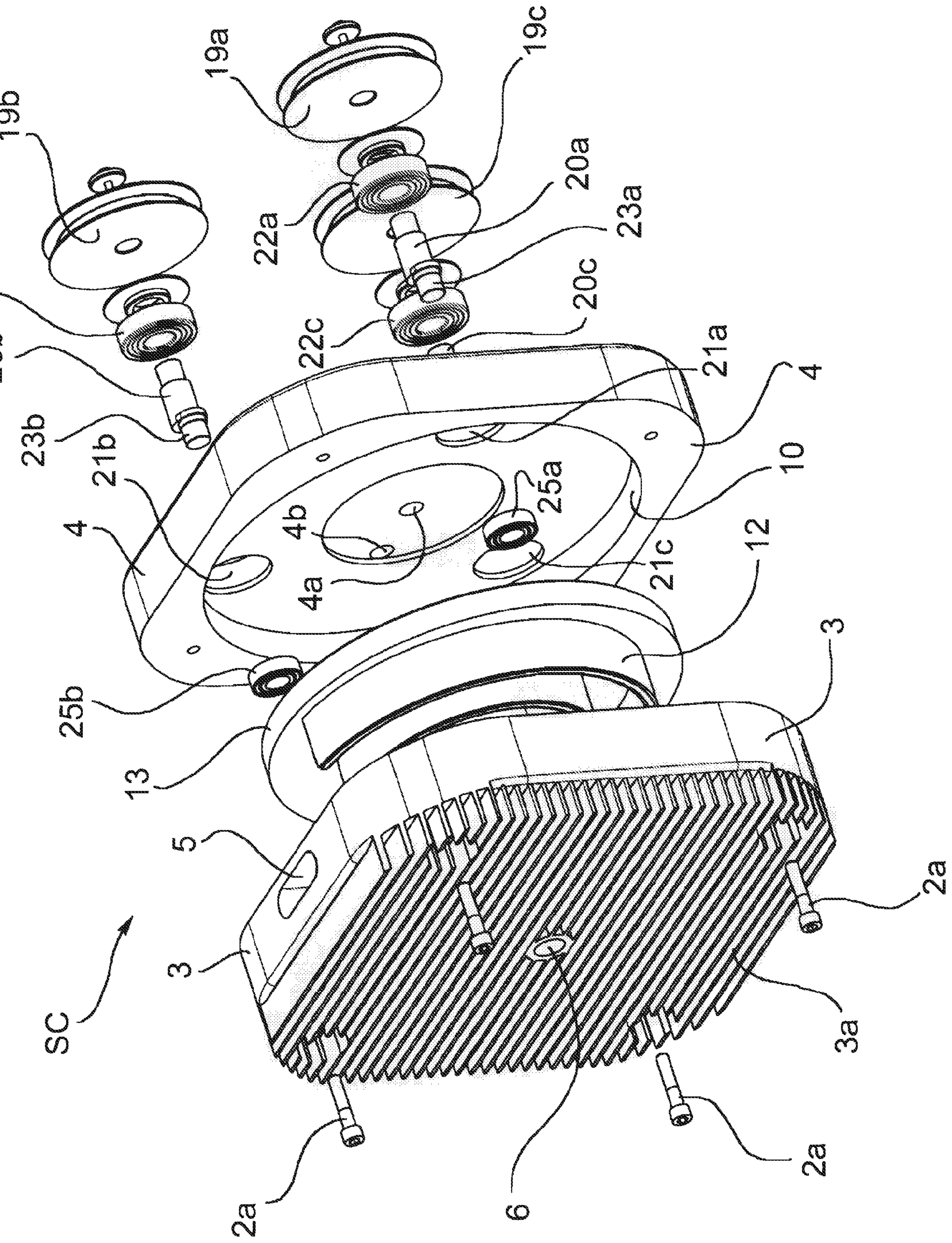
19b
19a
19c
22b
22a
20a
23a
20b
22c
20c
23b
21b
21a
4
4
25a
4b
10
4a
21c
12
25b
3
13
3
5
3
SC
2a
2a
3a
6
2a
2a

FIG. 5

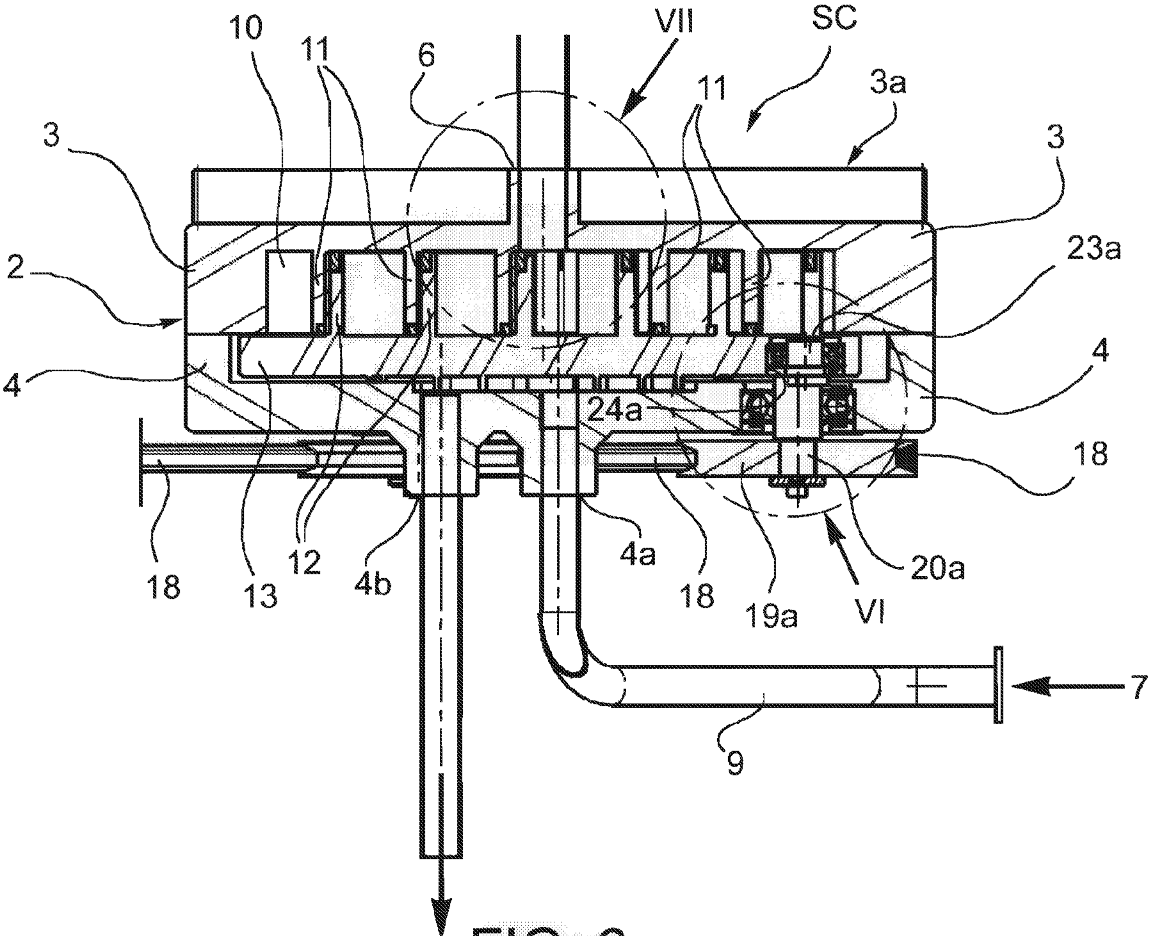
10
11
6
VII
SC
11
3a
3
3
2
23a
4
4
24a
18
18
13
12
4b
4a
18
19a
VI
20a
7
9

FIG. 6

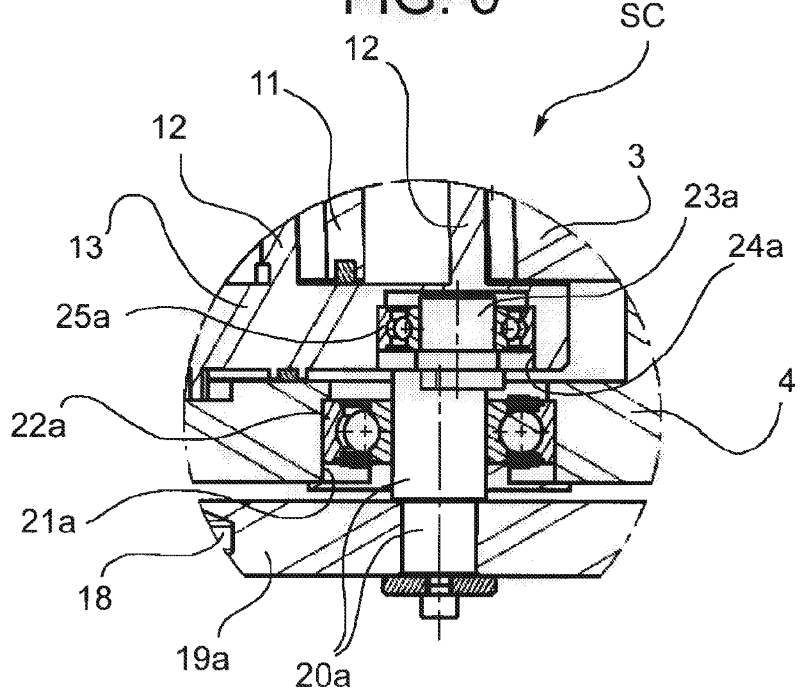
SC
12
11
12
3
23a
13
24a
25a
4
22a
21a
18
19a
20a

FIG. 7

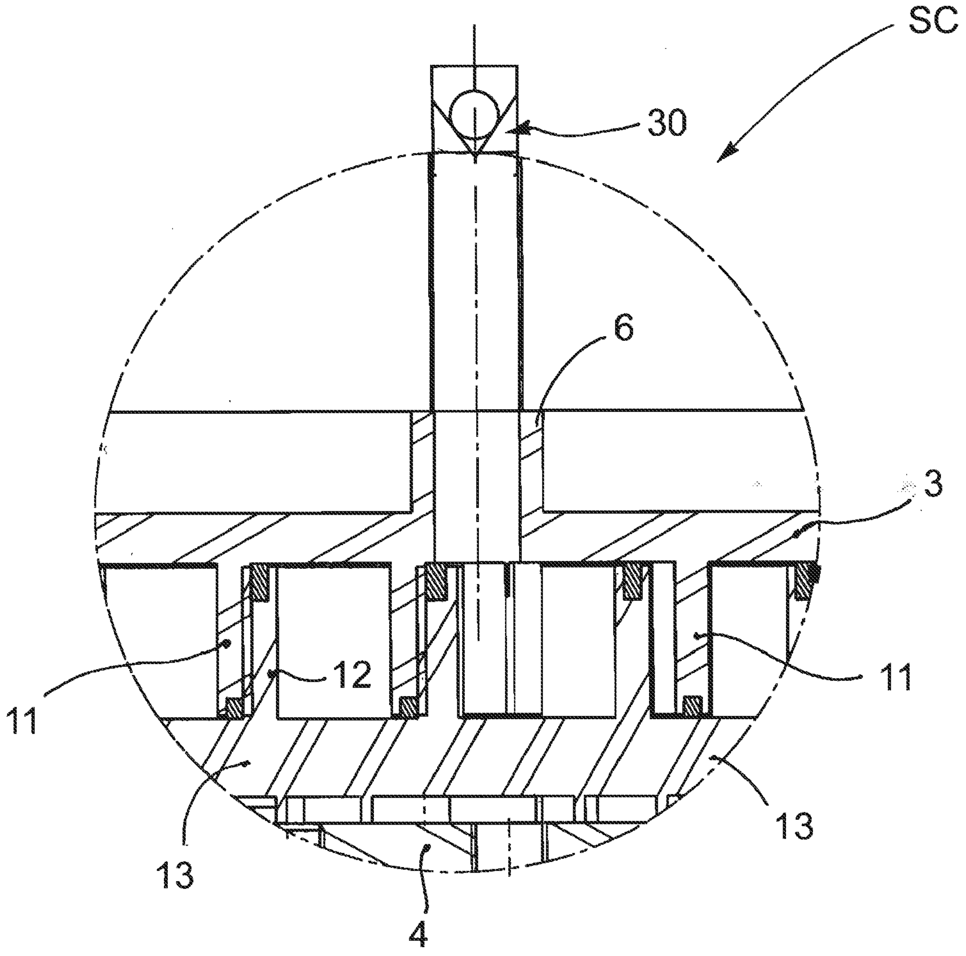

FIG. 8

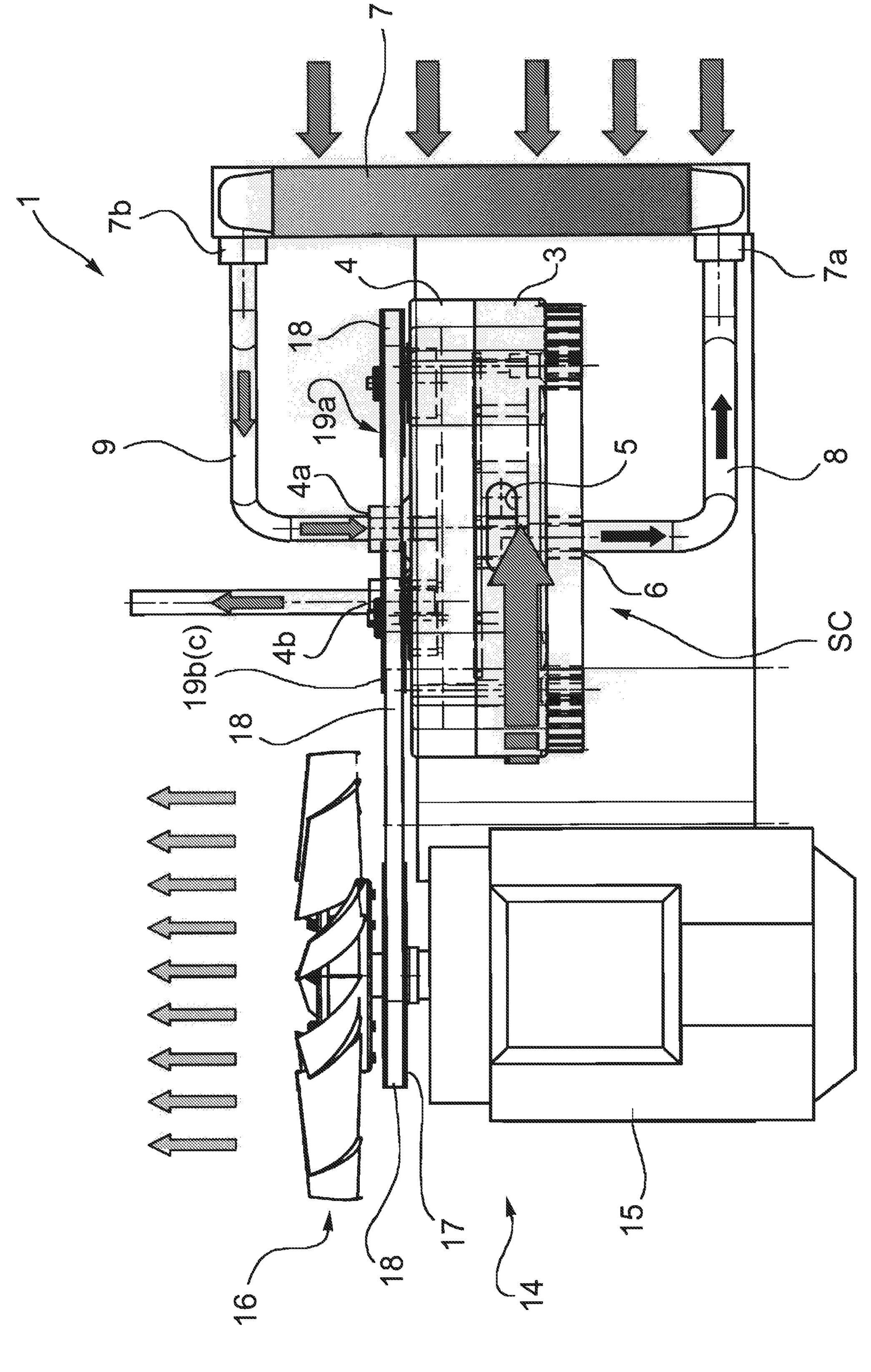

FIG. 9