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

(11) EP 2 105 584 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
30.09.2009 Bulletin 2009/40

(51) Int Cl.:
F01D 25/28 *(2006.01)*

(21) Application number: **09156080.5**

(22) Date of filing: **24.03.2009**

(84) Designated Contracting States:
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 SE SI SK TR
Designated Extension States:
AL BA RS

(30) Priority: **28.03.2008 IT MI20080540**

(71) Applicant: **ANSALDO ENERGIA S.P.A.**
16152 Genova (IT)

(72) Inventors:
- **Calcagno, Andrea**
  17100, Savona (IT)
- **Lagostena, Matteo**
  16164, Genova (IT)
- **Valerio, Fulvio**
  16152, Genova (IT)

(74) Representative: **Jorio, Paolo et al**
Studio Torta S.r.l.
Via Viotti 9
10121 Torino (IT)

(54) Tool for assembling and disassembling an inlet stage of a compressor of a gas turbine unit, method for disassembling and method for assembling said stage

(57) A tool for assembling and disassembling an inlet stage (6) of a compressor (1) of a gas turbine unit is provided with a reinforcement element (18) adapted to be coupled to the inlet stage (6) to increase the stiffness of the inlet stage (6) and with a holding element (19) rigidly connected to the reinforcement element (18).

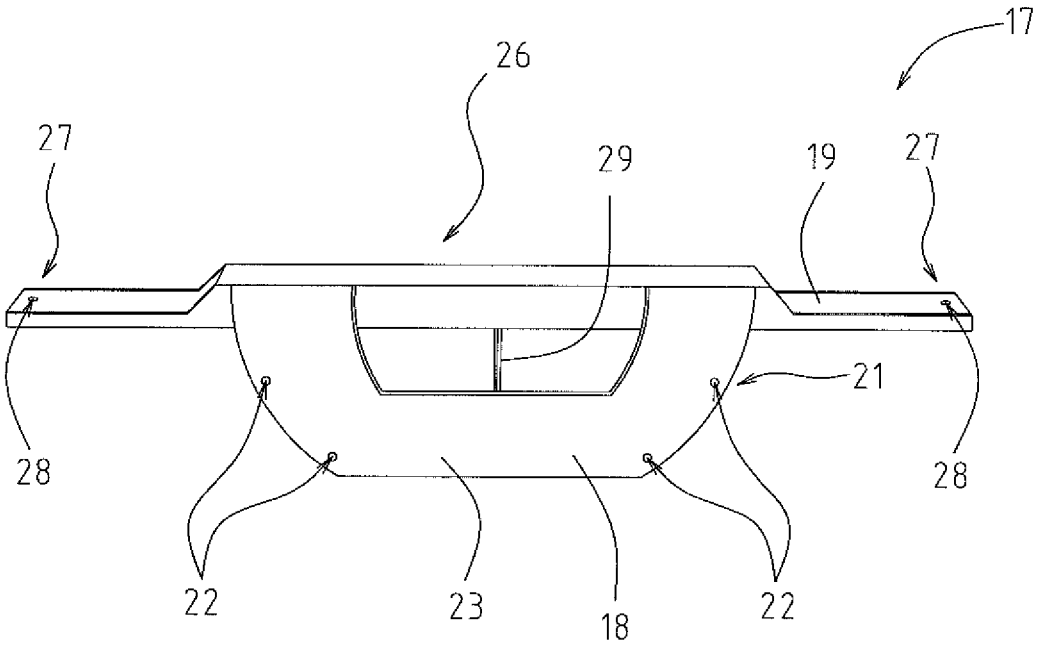

Fig.2

EP 2 105 584 A2

Description

[0001] The present invention relates to a tool for assembling and disassembling an inlet stage of a compressor of a gas turbine unit, to a method for disassembling and to a method for assembling said stage.

[0002] After a first life cycle, the electric power plants comprising gas turbine units are generally subjected to service and maintenance operations.

[0003] During these operations the compressor must often be disassembled in order to carry out an inspection of the state of the parts of the compressor and, if necessary, perform maintenance or reconditioning operations of some parts of the compressor.

[0004] The disassembly of the compressor and the subsequent assembly upon completion of the maintenance operations are particularly complex manoeuvres, during which there is a very high risk of damaging parts of the compressor.

[0005] In particular, the most critical manoeuvres are the disassembly and the assembly of compressor inlet stage. The compressor inlet stage comprises an inner ring, an outer ring and an array of orientable vanes, more commonly designated as IGVs (Inlet Guide Vanes), which are arranged radially between the inner ring and the outer ring. The presence of orientable vanes considerably reduces the structural stiffness of the inlet stage with respect to the remaining stages of the compressor in which the vanes are fixed. Therefore, the handling of the compressor inlet stage is very difficult as the poor stiffness of the inlet stage increases the risk of compromising the structural integrity of the inlet stage itself. Moreover, the inlet stage of the compressor comprises fine handling mechanisms for the orientable vanes, which easily suffer damages during the assembly and disassembly manoeuvres.

[0006] The known methods for disassembling and assembling the inlet stage of the compressor require the intervention of operators during all of the assembly and disassembly manoeuvres with a significant waste of time.

[0007] It is an object of the present invention to provide a tool for disassembling and assembling an inlet stage of a compressor of a gas turbine unit allowing to simplify the disassembly and assembly operations of the inlet stage.

[0008] According to this object, the present invention relates to a tool for assembling and disassembling an inlet stage of a compressor of a gas turbine unit; the inlet stage comprising an inner ring, defined by two coupled inner half-rings, an outer ring, defined by two coupled outer half rings, and an array of orientable vanes arranged radially between the inner ring and the outer ring; the tool being characterised by comprising a reinforcement element adapted to be coupled to the inlet stage in order to increase the stiffness of the inlet stage, and a holding element rigidly connected to the reinforcement element.

[0009] It is a further object of the invention to provide a fast and cost-effective method for disassembling an inlet stage of a compressor of a gas turbine unit.

[0010] According to this object, the present invention relates to a method for disassembling an inlet stage of a compressor of a gas turbine unit characterised by comprising the steps of:

coupling at least one reinforcement element adapted to increase the stiffness of the inlet stage to the inlet stage; and removing the inlet stage.

[0011] It is a further object of the invention to provide a fast and cost-effective method for assembling an inlet stage of a compressor of a gas turbine unit.

[0012] According to this object, the present invention relates to a method for assembling an inlet stage of a compressor of a gas turbine unit; the inlet stage comprising an inner ring, an outer ring and an array of orientable vanes arranged radially between the inner ring and the outer ring; the method being characterized in that it comprises the steps of:

coupling at least one reinforcement element adapted to increase the stiffness of the inlet stage to the inlet stage; and
housing the outer ring of the inlet stage of the compressor in an annular guide of an outer cylindrical casing of the compressor defined by two coupled half shells.

[0013] Further features and advantages of the present invention will be apparent from the following disclosure of a non-limitative embodiment thereof, with reference to the figures of the accompanying drawings, in which:

- Figure 1 is a front view, with parts in section and parts removed for clarity, of a compressor of a gas turbine unit;
- Figure 2 is a front perspective view of a tool for assembling and disassembling an inlet stage of a compressor according to the present invention;
- figure 3 is a back perspective view of the tool of figure 2;
- Figure 4 is a perspective view, with parts in section and parts removed for clarity, of the tool of figure 2 in a first operative position; and
- Figure 5 is a perspective view, with parts in section and parts removed for clarity, of the tool of figure 2 in a second operative position.

[0014] Figure 1 shows a compressor 1 of the multistage axial type of a gas turbine unit (not shown in the accompanying figures) which comprises a shaft 2, extending along a longitudinal axis A, an inner cylindrical casing 3, which extends about a portion of shaft 2, and an outer cylindrical casing 4, which extends about shaft 2 and is defined by two half shells 5a, 5b which may be coupled to one another.

[0015] Compressor 1 comprises a plurality of stages (not shown in the accompanying figures) and an inlet stage 6, which comprises an inner ring 7, an outer ring 8 and an array of orientable vanes 9, which are commonly designated as IGVs (Inlet Guide Vanes).

[0016] Inner ring 7 is defined by two inner half rings 11a, 11b coupled to one another, and outer ring 8 is defined by two outer half rings 12a, 12b coupled to one another and adapted to be housed in an annular guide 13 of outer cylindrical casing 4. In particular, outer half rings 12a, 12b are adapted to be housed respectively in a first portion 13a of annular guide 13 defined in half shell 5a and in a second portion 13b of annular guide 13 defined in half shell 5b.

[0017] Inlet stage 6 may therefore be separated into a first half 14 and a second half 15. First half 14 comprises an inner half ring 11a, an outer half ring 12a and orientable vanes 9 comprised between inner half ring 11a and outer half ring 12a. Second half 15 comprises an inner half ring 11b, an outer half ring 12b and orientable vanes 9 comprised between inner half ring 11b and outer half ring 12b.

[0018] Figure 2 shows a tool 17 for disassembling and assembling an inlet stage 6. Tool 17 comprises a reinforcement element 18, in particular a plate adapted to be coupled to inlet stage 6 to increase the stiffness of inlet stage 6, and a holding element 19, in particular a crossbar rigidly connected to plate 18.

[0019] In particular, plate 18 has a substantially semicircular shape and is adapted to be coupled to one of inner half rings 11a, 11b of inlet stage 6. Plate 18 has a peripheral edge 21 provided with four holes 22 for the housing of screws (not shown) for the attachment of one of inner half rings 11a, 11b of inlet stage 6 and has a front face 23 and a back face 24.

[0020] Crossbar 19 is adapted to be arranged in abutment against the ends of one of inner half rings 11a, 11b and of one of outer half rings 12a, 12b.

[0021] Crossbar 19 has a central portion 26 which is rigidly connected to plate 18 and two end portions 27, each of which is provided with a hole 28 for housing a screw and a bolt provided with an eyelet coupled to a ring (not shown in the accompanying figures).

[0022] Plate 18 is arranged substantially orthogonal with respect to cross bar 19.

[0023] With reference to figure 3, tool 17 comprises three support elements 29, in particular three support wings of support plate 18, which are connected to back face 24 of plate 18 and to crossbar 19 and are adapted to give greater structural stiffness to plate 18.

[0024] Tool 17 according to present invention is mainly used during the maintenance operations of a compressor 1 of a gas turbine unit.

[0025] The maintenance method of compressor 1 substantially comprises disassembling inlet stage 6, performing the required maintenance and renewal operations of inlet stage 6 and reassembling inlet stage 6.

[0026] In particular, the step of disassembling inlet stage 6 substantially comprises separating half shells 5a, 5b defining outer cylindrical casing 4, separating inner half rings 11a, 11b and separating outer half rings 12a, 12b, so that first half 14 of inlet stage 6 is housed in half shell 5a. Subsequently, the step of disassembling inlet stage 6 comprises removing half shell 5a of outer cylindrical casing 4, comprising first half 14 of inlet stage 6, and positioning it somewhere dedicated in a substantially vertical position.

[0027] At this point, the step of disassembling inlet stage 6 comprises disassembling first half 14 of inlet stage 6 coupled to half shell 5a and subsequently disassembling second half 15 of inlet stage 6 coupled to half shell 5b.

[0028] In particular the step of disassembling first half 14 of inlet stage 6 comprises:

coupling plate 18 of tool 17 to inner half ring 11a of first half 14 of inlet stage 6 (see figure 4); and

removing first half 14 of inlet stage 6 with plate 18 coupled, by applying a torque to crossbar 19 to rotate tool 17 so as to extract outer half ring 12a of first half 14 of inlet stage 6 from respective first portion 13a of annular guide 13 (see figure 5).

[0029] The step of disassembling second half 15 of inlet stage 6 comprises:

coupling plate 18 to inner half ring 11b of second half 15 of inlet stage 6; and

removing second half 15 of inlet stage 6 with plate 18 coupled, by applying a torque to crossbar 19 to rotate tool 17 so as to extract outer half ring 12b of second half 14 of inlet stage 6 from respective second portion 13b of annular guide 13.

[0030] In particular, the torque is applied by exerting a tractive force to an end portion 27 of crossbar 19, for instance by means of at least one tie-rod fixed to the ring of the nut connected to end portion 27, and pushing end portion 27 opposite to crossbar 19, for instance manually.

[0031] Once extracted, first and second halves 14, 15 of inlet stage 6 are displaced in respective positions in which the maintenance and reconditioning operations are performed. The displacement of first and second halves 14, 15 of inlet stage 6 is performed by using tie-rods, connected to end portions 27 of crossbar 19 and to outer half ring 12a, 12b, and displaced by appropriate machines for lifting and displacing materials (for instance a bridge-crane).

[0032] Once the maintenance operations are finished, inlet stage 6 is reassembled.

[0033] The method for assembling the inlet stage substantially comprises coupling inlet stage 6 to plate 18; and housing outer ring 8 of inlet stage 6 of compressor 1 in annular guide 13 of outer cylindrical casing 4.

[0034] In particular the method for assembling comprises:

attaching plate 18 to inner half ring 11a of first half 14 of inlet stage 6;
housing outer half ring 12a of first half 14 of inlet stage 6 in first portion 13a of annular guide 13 by applying a torque to crossbar 19 to rotate tool 17 so as to insert outer half ring 12a of first half 14 of inlet stage 6 in respective first portion 13a of annular guide 13 in half shell 5a;
attaching plate 18 to inner half ring 11b of second half 15 of inlet stage 6;
housing outer half ring 12b of second half 15 of inlet stage 6 by applying a torque to crossbar 19 to rotate tool 17 so as to insert outer half ring 12b of second half 15 of inlet stage 6 in respective second portion 13b of annular guide 13.

[0035] Similarly to disassembling, the torque is applied by exerting a tractive force to an end portion 27 of crossbar 19, for instance by means of at least one tie-rod fixed to the ring of the nut connected to end portion 27, and pushing end portion 27 opposite to crossbar 19, for instance manually.

[0036] It is finally apparent that modifications and variants may be made to tool 17 for disassembling and assembling and to the methods for disassembling and assembling the inlet stage of a compressor disclosed herein, without departing from the scope of the appended claims.

Claims

1. A tool for assembling and disassembling an inlet stage (6) of a compressor (1) of a gas turbine unit; the inlet stage (6) comprising an inner ring (7), defined by two coupled inner half rings (11a, 11b), an outer ring (8), defined by two coupled outer half rings (12a, 12b), and an array of orientable vanes (9) arranged radially between the inner ring (7) and the outer ring (8); the tool (17) being **characterised by** comprising a reinforcement element (18) adapted to be coupled to the inlet stage (6) to increase the stiffness of the inlet stage (6), and a holding element (19) rigidly connected to the reinforcement element (18).

2. The tool according to claim 1, **characterised in that** the reinforcement element (18) is a plate having a substantially semicircular shape that may be connected to one of the inner half rings (11a; 11b) of the inlet stage (6).

3. The tool according to claim 1 or 2,
characterised in that the holding element (19) is a crossbar, which has a central portion (26) rigidly connected to the reinforcement element (18) and two end portions (27).

4. The tool according to claim 3, **characterised in that** the crossbar (19) is provided, at each end portion (27), with a hole (22) adapted to house a screw and a nut provided with an eyelet coupled to a ring for the connection to handling means.

5. The tool according to claim 3 or 4,
characterised by comprising at least one support element (29) connected to the reinforcement element (18) and to the crossbar (19); the reinforcement element (18) being substantially orthogonal to the crossbar (19).

6. A method for disassembling an inlet stage (6) of a compressor (1) of a gas turbine unit **characterised by** comprising the steps of:

coupling at least one reinforcement element (18) adapted to increase the stiffness of the inlet stage (6) to the inlet stage (6); and
removing the inlet stage (6).

7. The method according to claim 6, **characterised in that** the inlet stage (6) comprises an inner ring (7), defined by two coupled inner half rings (11a, 11b), an outer ring (8), defined by two coupled outer half rings (12a, 12b), and an array of orientable vanes (9) radially arranged between the inner ring (7) and the outer ring (8); the outer ring (8) being housed in an annular guide (13) of an outer cylindrical casing (4) of the compressor (1), defined by two coupled half shells (5a, 5b); the method comprising the steps of separating the half shells (5a, 5b) defining the outer cylindrical casing (4), separating the inner half rings (11a, 11b) and separating the outer half rings (12a, 12b), so that a first half (14) of the inlet stage (6), comprising one of the inner half rings (11a) and one of the outer half rings (12a), is housed in a first one of the half shells (5a) with the respective outer half ring (12a) in a first portion (13a) of the annular guide (13) defined in the first half shell (5a), and a second half (15) of the inlet stage (6), comprising the other inner half ring (11b) and the other outer half ring (12b), is housed in a second one of the half shells (5b), with the respective outer half ring (12b) in a second portion (13b) of the annular guide (13) defined in the second half shell (5b).

8. The method according to claim 7, **characterised in that** the step of coupling the reinforcement element (18) to the inlet stage (6) comprises the step of coupling the reinforcement element (18) to the first half (14) of the inlet stage (6) and **in that** the step of removing the inlet stage (6) comprises the step of removing the first half (14) of the inlet stage (6) with the reinforcement element (18) coupled to the first half (14) of the inlet stage (6).

9. The method according to claim 8, **characterised in that** the step of coupling the reinforcement element (18) to the first half (14) of the inlet stage (6) comprises the step of attaching the reinforcement element (18) to the inner half ring (11a) of the first half (14) of the inlet stage (6).

10. The method according to claim 8 or 9, **characterised in that** the step of removing the first half (14) of the inlet stage (6) comprises applying a torque to the reinforcement element (18) to rotate the reinforcement element (18) so as to extract the outer half ring (12a) to the first half (14) of the inlet stage (6) from the respective first portion (13a) of annular guide (13).

11. The method according to one of claims 7 to 10, **characterised in that** the step of coupling the reinforcement element (18) to the inlet stage (6) comprises the step of coupling the reinforcement element (18) to the second half (15) of the inlet stage (6) and **in that** the step of removing the inlet stage (6) comprises the step of removing the second half (15) of the inlet stage (6) with the reinforcement element (18) coupled to the second half (15) of the inlet stage (6).

12. The method according to claim 11, **characterised in that** the step of coupling the reinforcement element (18) to the second half (15) of the inlet stage (6) comprises the step of attaching the reinforcement element (18) to the inner half ring (11b) of the second half (15) of the inlet stage (6).

13. The method according to claim 11 or 12, **characterised in that** the step of removing the second half (15) of the inlet stage (6) comprises applying a torque to the reinforcement element (18) to rotate the reinforcement element (18) so as to extract the outer half ring (12b) to the second half (15) of the inlet stage (6) from the respective second portion (13b) of annular guide (13).

14. A method for assembling an inlet stage (6) of a compressor (1) of a gas turbine unit; the inlet stage (6) comprising an inner ring (7), an outer ring (8) and an array of orientable vanes (9) arranged radially between the inner ring (7) and the outer ring (8); the method being **characterized by** comprising the steps of:

    coupling at least one reinforcement element (18) adapted to increase the stiffness of the inlet stage (6) to the inlet stage (6); and
    housing the outer ring (8) of the inlet stage (6) of the compressor (1) in an annular guide (13) of an outer cylindrical casing (4) of the compressor (1).

15. The method according to claim 14, **characterised in that** the inner ring (7) is defined by two inner half rings (11a, 11b), the outer ring (8) is defined by two outer half rings (12a, 12b) and the outer cylindrical casing (4) is defined by two half shells (5a, 5b); and **in that** the step of coupling at least one reinforcement element (18) to the inlet stage (6) comprises the step of coupling the reinforcement element (18) to a first half (14) of the inlet stage (6), comprising one of the inner half rings (11a) and one of the outer half rings (12a), and **in that** the step of housing the outer ring (8) comprises housing the outer half ring (12a) of the first half (14) of the inlet stage (6) in a first portion (13a) of the annular guide (13) defined in the first half shell (5a).

16. The method according to claim 15, **characterised in that** the step of coupling the reinforcement element (18) to the first half (14) of the inlet stage (6) comprises the step of attaching the reinforcement element (18) to the inner half ring (11a) of the first half (14) of the inlet stage (6).

17. The method according to claim 15 or 16, **characterised in that** the step of housing the outer half ring (12a) comprises the step of applying a torque to the reinforcement element (18) to rotate the reinforcement element (18) so as to insert the outer half ring (12a) of the first half (14) of the inlet stage (6) in the respective first portion (13a) of annular guide (13) defined in the second half shell (5b).

18. The method according to one of claims 14 to 17, **characterised in that** the inner ring (7) is defined by two inner half rings (11a, 11b), the outer ring (8) is defined by two outer half rings (12a, 12b) and the outer cylindrical casing (4) is defined by two half shells (5a, 5b); and **in that** the step of coupling the reinforcement element (18) to the inlet stage (6) comprises the step of coupling the reinforcement element (18) to a second half (15) of the inlet stage (6), comprising the other one of the inner half rings (11b) and the other one of the outer half rings (12b), and **in that** the step of housing the outer ring (8) comprises housing the outer half ring (12b) of the second half (15) of the inlet stage (6) in a second portion (13a) of the annular guide (13) defined in the second half shell (5b).

19. The method according to claim 18, **characterised in that** the step of coupling the reinforcement element (18) to the second half (15) of the inlet stage (6) comprises the step of attaching the reinforcement element (18) to the inner half ring (11b) of the second half (15) of the inlet stage (6).

20. The method according to claim 18 or 19, **characterised in that** the step of housing the outer

half ring (12b) of the second half (15) of the inlet stage (6) comprises the step of applying a torque to the reinforcement element (18) to rotate the reinforcement element (18) so as to insert the outer half ring (12b) of the second half (15) of the inlet stage (6) in the respective second portion (13b) of annular guide (13) defined in the second half shell (5b).

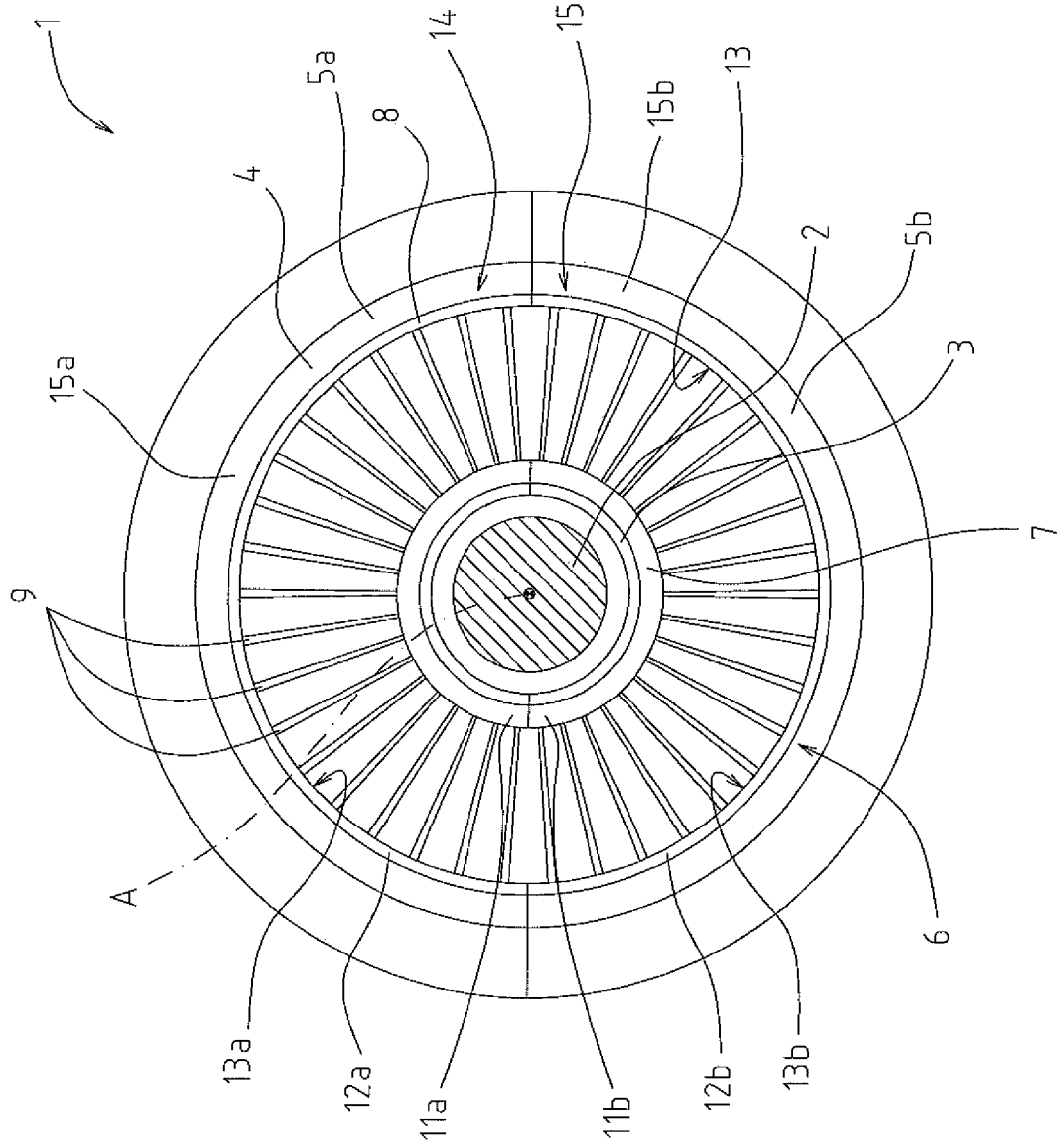

Fig.1

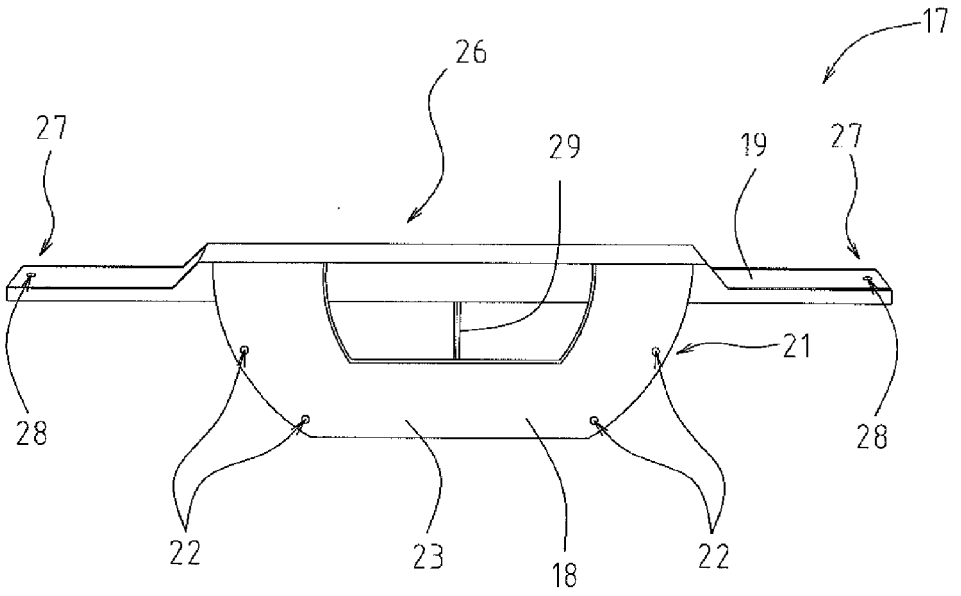
17
26
27
29
19
27
21
28
28
22
23
18
22

Fig.2

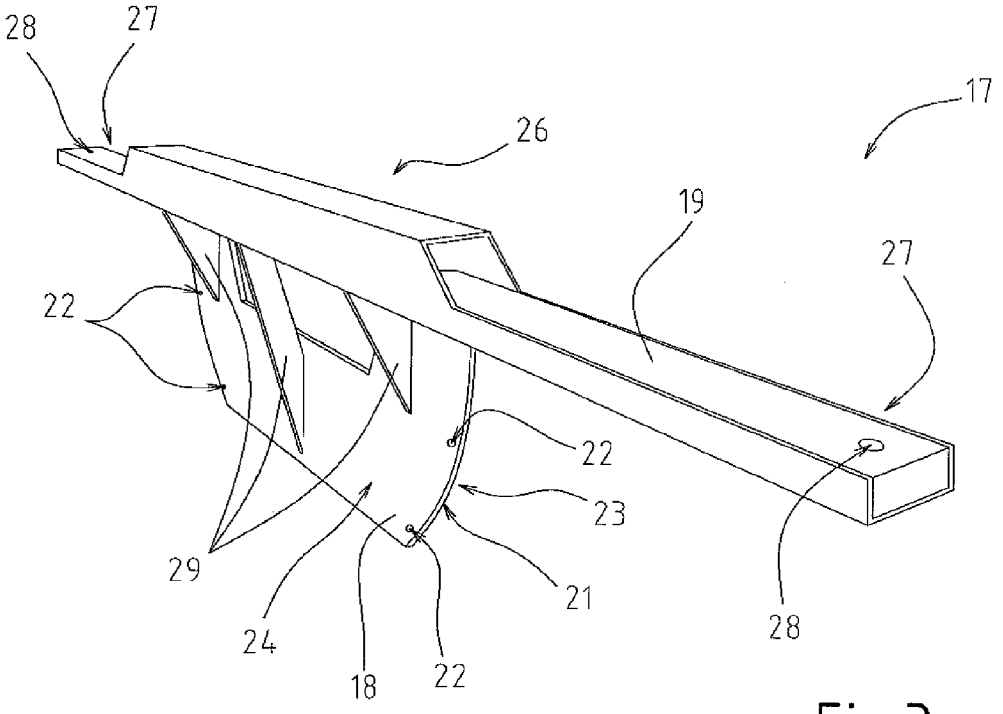
28
27
17
26
19
27
22
22
23
29
21
24
28
18
22

Fig.3

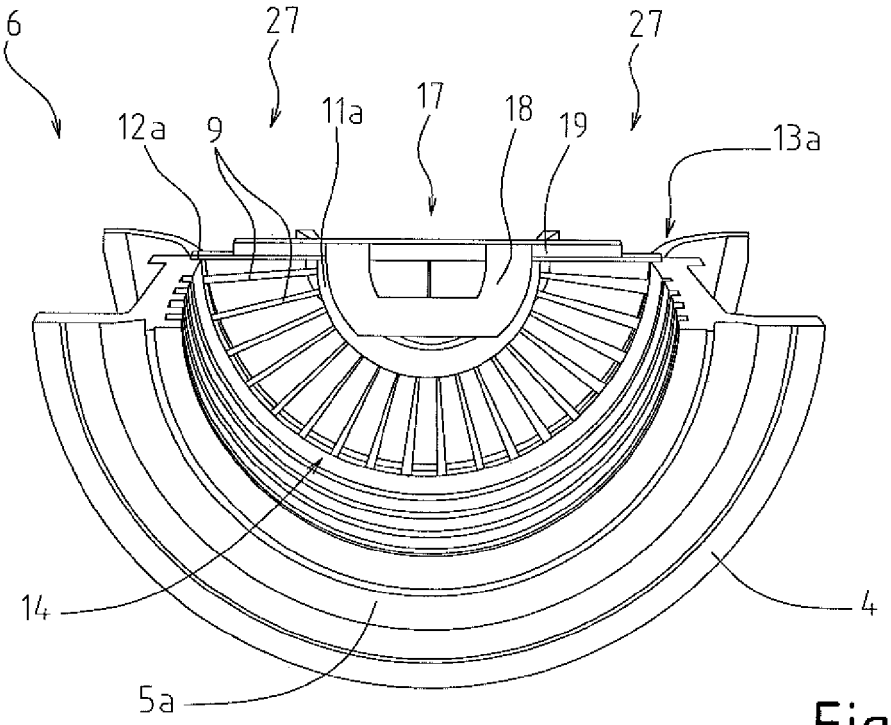
6
27
27
12a
9
11a
17
18
19
13a
14
4
5a

Fig.4

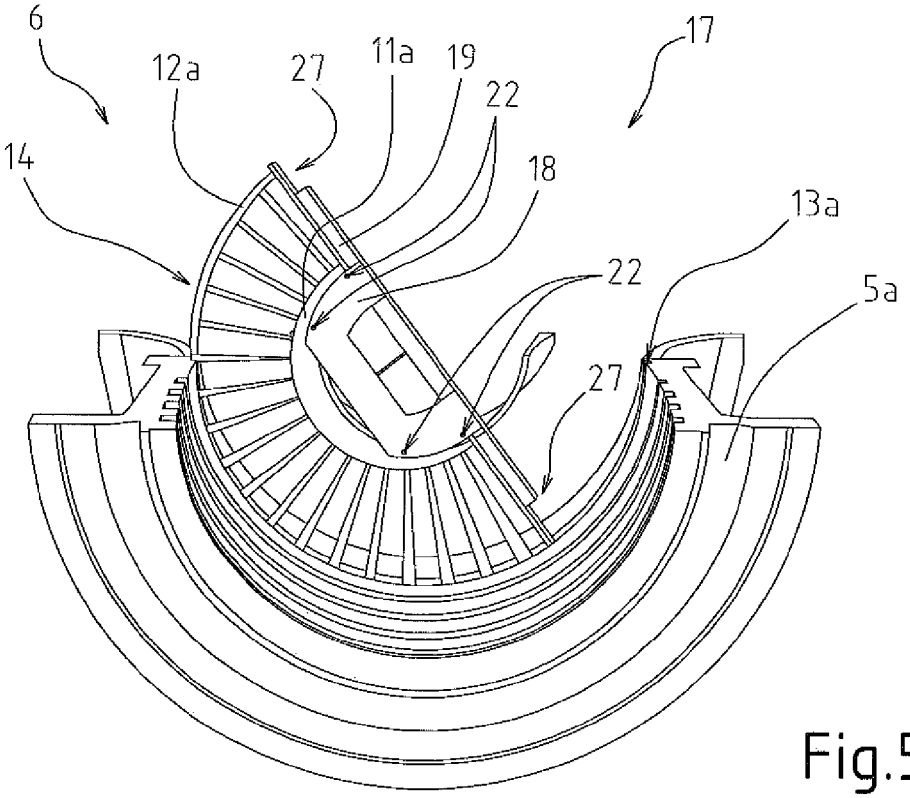
6
12a
27
11a
19
22
17
14
18
13a
22
5a
27

Fig.5