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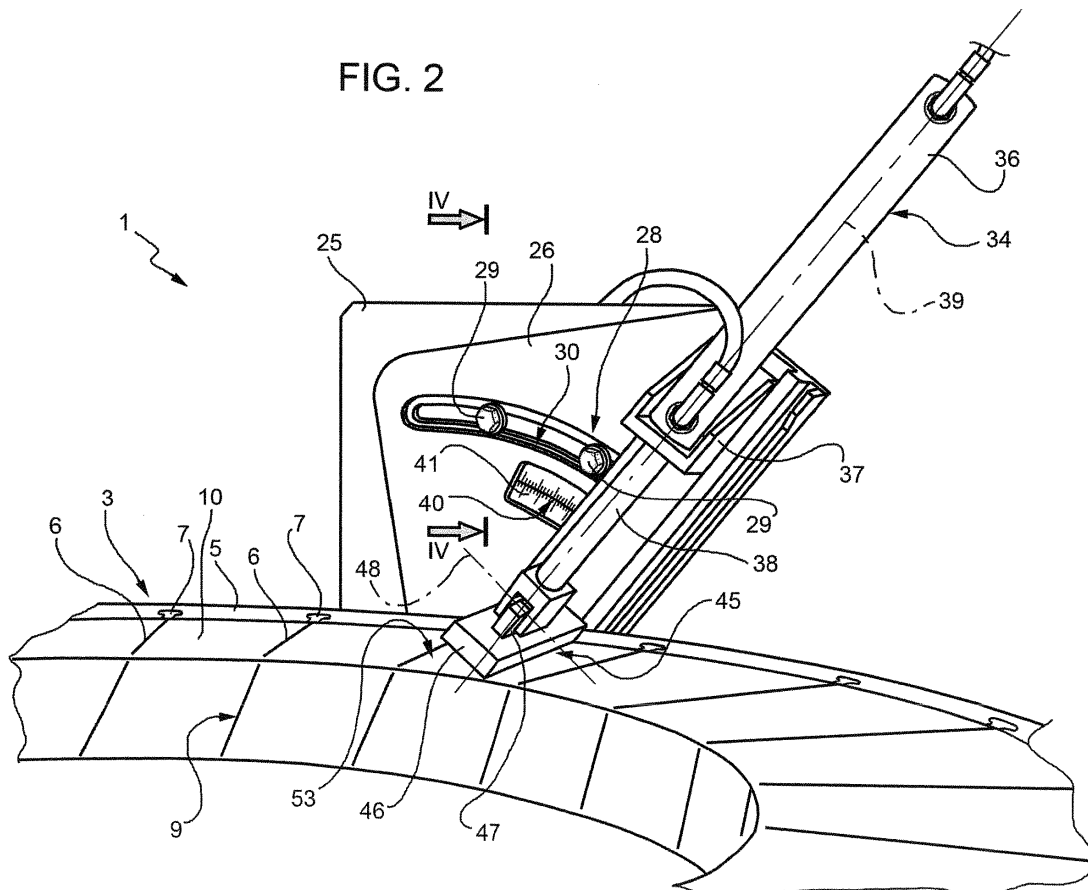
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PT RO SE SI SK SM TR**(30) Priority: **31.07.2008 IT TO20080602**(71) Applicant: **Ansaldo Energia S.p.A.
Genova (IT)**(72) Inventor: **Margiocco, Marco
16164 Genova (IT)**(74) Representative: **Jorio, Paolo et al
Studio Torta S.r.l.
Via Viotti 9
10121 Torino (IT)**(54) **Cleaning assembly for removing wax from a bladed ring**

(57) A cleaning assembly (1) for removing wax from a bladed ring (3) has a rest and/or a seat (22) for placing the bladed ring with its axis (8) set vertically; the bladed ring is rotated about its axis (8) so as to arrange a nozzle (9) to be cleaned in a position aligned with a thrust mem-

ber (45) carried by an actuator (34); once the bladed ring (3) has been blocked by means of releasable retention devices (50), the actuator (34) is actuated so as to press and discharge the wax contained in the nozzle (9) to be cleaned.

FIG. 2**EP 2 149 714 A1**

Description

[0001] The present invention relates to a cleaning assembly for removing wax from a bladed ring, in particular a bladed ring of a compressor stator.

[0002] The stators of a gas turbine compressor each comprise a corresponding bladed ring having an inner annular wall, an outer annular wall and a series of blades fixed to these walls and spaced from one another in a circumferential direction. Once the blades have been mounted, the two walls must be machined to obtain the dimensions and tolerances required in design. For machining, the void between the two walls is sealed by means of wax, in order to avoid damages to the blades. The wax is then removed after machining to obtain the finished ring to be mounted onto a casing of the compressor.

[0003] According to a known solution, the wax is manually removed by striking a surface of the wax with a maul. However, these operations risk damaging the rings and/or blades if they are not carried out with the due care and take a relatively long time.

[0004] According to another known solution, the wax is detached from the bladed ring by heating in an furnace. This procedure is however relatively complex and expensive.

[0005] It is the object of the present invention to provide a cleaning assembly for removing wax from a bladed ring, which allows to simply and cost-effectively solve the aforementioned problems.

[0006] According to the present invention, a cleaning assembly for removing wax from a bladed ring is provided; the assembly being characterized by comprising:

- supporting means for placing said bladed ring with its axis set vertically;
- a thrust member;
- angular-positioning means for rotating, with respect to one another, said bladed ring and said thrust member about the axis of said bladed ring;
- releasable retention means for blocking the relative rotation of said bladed ring and said thrust member; and
- actuator means controlled for displacing said thrust member in a direction of thrust and, in use, pressing the wax contained in a nozzle of said bladed ring.

[0007] The invention will now be described with reference to the accompanying drawings which illustrate a non-limitative embodiment thereof, in which:

- figure 1 is a diagram of a preferred embodiment of the cleaning assembly for removing wax from a bladed ring according to the present invention;
- figures 2 and 3 are perspective views which show respective details of the assembly in figure 1 on enlarged scale and in a simplified manner; and
- figure 4 is a cross section, on enlarged scale and

with parts removed for clarity, taken along line IV-IV in figure 2.

[0008] In figures 1 and 2, numeral 1 indicates as a whole a cleaning assembly for removing wax from a bladed ring 3 which belongs, in particular, to a compressor stator.

[0009] Ring 3 comprises an outer cylindrical wall 5 and a plurality of blades 6, which have respective ends 7 fixed to the wall 5 in a known manner not described in detail, and are radially and overhangingly arranged towards the axis 8 of wall 5. Ring 3 may also comprise an inner cylindrical wall, fixed to the blades 6, at the opposite end with respect to the end 7.

[0010] The blades 6 are spaced in a circumferential direction so as to define a series of compartments 9 therebetween which, in use, convey a fluid in an inclined direction with respect to a direction parallel to axis 8. Compartments 9 are at least partially filled with wax 10, to avoid vibrations and damages to the blades 6 while machining operations (known and not described in detail) carried out on the ring 3.

[0011] Assembly 1 comprises a work bench 11, which comprises, in turn, a lower structure 12 defining a container 13 for receiving the pieces of wax 10 removed from the ring 3. Work bench 11 further comprises a plurality of bearings 14, which are carried by the structure 12 and are defined, in particular, by rollers for resting an axial face of the wall 5, so as to place the ring 3 with the axis 8 vertically oriented. The resting surface defined by the bearings 14 is higher than the upper surface 16 of the structure 12 to avoid any friction between the ring 3 and the surface 16 itself.

[0012] With reference to figures 1 and 3, work bench 11 further comprises a plurality of rollers 20, which are carried by the structure 12, may idly rotate about respective vertical axes 21, and define, as a whole, a rest for the outer cylindrical surface of the wall 5 and therefore a centring seat 22 for the ring 3.

[0013] Bearings 14 may idly rotate about respective horizontal axes 15 radially directed with respect to the centre of the seat 22, while rollers 20 maintain the axis 8 in a substantially fixed position in the middle of the seat 22, whereby the ring 3 is pivoting about the axis 8 and may be manually pushed in rotation.

[0014] With reference to figures 2 and 4, an attachment structure 25 is arranged outside the seat 22. Structure 25 passes through an opening made in the surface 16, is fixed to the structure 12 in a manner not described in detail, possibly in an adjustable manner, and carries a vertical plate 26 facing the seat 22.

[0015] Plate 26 is hinged to the structure 25 in a not illustrated manner in order to rotate about a horizontal axis 27, which is substantially radial with respect to the centre of the seat 22. Plate 26 is held in an angularly fixed position by a releasable blocking device 28, preferably comprising two parallel screws 29, which may slide within a slot 30 made in the plate 26, with an arc-

shaped profile and centre coinciding with the axis 27, and are screwed into respective threaded holes 31 of the structure 25 to secure the plate 26 against the structure 25.

[0016] Plate 26 carries an actuator 34 defined by a hydraulic or pneumatic jack, which comprises: a liner 36 fixed to the plate 26 by means of a bracket 37; and a stem 38 fluid-tightly coupled to the liner 36 so as to translate along an axis 39 orthogonal to axis 27 between an extracted position and a retracted position. Plate 26 has a window 40, through which a graduated scale 41 carried by the structure 25 may be seen. The graduated scale 41 indicates the inclination of the axis 39 with respect to the vertical, i.e. the angular position of the plate 26 about the axis 27.

[0017] Stem 38 carries a thrust member 45 comprising a lower plate 46 and an upper attachment appendix 47, which is coupled to the lower end of the stem 38 by means of a hinge with cylindrical pin, so as to be able to freely rotate about a horizontal axis 48 orthogonal to axis 39, and directed in a substantially radial direction with respect to the centre of the seat 22.

[0018] The cylindrical pin of the hinge (not shown) is removable so as to be able to replace the thrust member 45. Thrust member 45 is chosen from a series of available thrust members, so as to have a plate 46 with dimensions such as to enter and exit from each compartment 9 along the axis 39 without touching the blades 6. At the same time, the inclination of the axis 39 of jack 34 is adjusted by rotating the plate 26 about the axis 27 so as to make the axis 39 substantially coincide with the inclination of the blades 6 in the ring 3.

[0019] Once these choices and/or adjustments have been made, any of the compartments 9 may be positioned to be aligned with the thrust member 45 along the axis 39 by rotating the ring 3 about the axis 8 on the rollers 14,20.

[0020] After positioning, the ring 3 is blocked by actuating one or more releasable retention devices 50 (figure 3) carried by the structure 12 over the surface 16. Each device 50 preferably comprises an actuator 51 and a stop element 52, which is actuated by the actuator 51 to move between a lowered position, in which it engages the wall 5 to block the ring 3, and a raised position (not shown), in which it leaves the ring 3 free to rotate on the rollers 14,20.

[0021] Once ring 3 has been blocked, the jack 34 is actuated so as to extract the stem 38 from the liner 36 and lower the thrust member 45.

[0022] During such a lowering, the plate 46 comes in contact with the upper surface 53 of the piece of wax 10 contained in the compartment 9 to be cleaned, and then pushes such a piece of wax downwards, until it is discharged into the container 13 underneath. When resting the plate 46 on the surface 53, by virtue of the hinge between the stem 38 and the appendix 47, the thrust member 45 automatically adapts its position about the axis 48 according to the orientation and shape of the

surface 53.

[0023] Once the wax has been discharged from the compartment 9, the jack 34 is actuated so as to retract the stem 38 back into the liner 36. Therefore, the thrust member 45 returns outside the newly cleaned compartment 9.

[0024] At this point, the devices 50 are released, and the ring 3 is rotated about its axis 8 by an angle equal to the angular pitch between the compartments 9, so as to place a next compartment 9 to be cleaned in an aligned position with respect to the thrust member 45. The operations for blocking ring 3 and actuating jack 34 are repeated to discharge the wax from the new compartment to be cleaned. In particular, the cleaning operations are repeated in a similar manner for all compartments 9, one after the other.

[0025] From the above it is apparent that the assembly 1 allows to reduce the risks of damaging the ring 3 and allows to reduce the cleaning time as compared to the known solutions in which cleaning is carried out by manually striking the wax with a maul, essentially by virtue of the use of an actuator and to the possibility of accurately positioning the ring 3 with respect to the thrust member 45.

[0026] Assembly 1 is relatively cost-effective with respect to the use of a possible furnace for removing the wax, because it uses components and equipments which are individually easily available at low cost, and does not require high powers and/or complex control and safety systems.

[0027] The adjustment of the inclination of plate 26 and the possibility of easily replacing the thrust member 45 allow to relatively quickly adapt the assembly 1 to different types of compartments 9.

[0028] Since it has a flat, substantially horizontal surface and/or a substantially horizontal, rectilinear edge at its bottom, plate 46 rests and distributes the pressure on a relatively large part of wax. Therefore, the thrust tends to detach the wax from the blades 6 without the plate 46 sinking into the wax, and thus effectively causes the discharging.

[0029] The relative mobility in the coupling between the stem 38 and the thrust member 45 also allows the thrust member 45 to distribute the pressure without locally sinking into the wax at the time of contact.

[0030] Finally, from the above, it is apparent that changes and variations may be made to the described assembly 1 without departing from the scope of protection of the present invention, as defined in the appended claims.

[0031] In particular, the thrust member 45 could have a different shape from that described and illustrated, e.g. it could be provided with one or more tips; and/or could be coupled to the lower end of the stem 38 in a different manner, e.g. in a fixed position or by means of other articulated joints different from the hinge indicated by way of example.

[0032] An actuator different from a jack may be pro-

vided to displace the thrust member 45, e.g. an electric actuator and/or a rotary motor provided with a transmission which transforms the motion from rotational to translational; and/or several actuators arranged in positions spaced along the circular periphery of the ring 3 could be provided to simultaneously discharge the wax from a number of compartments 9, therefore over a shorter time.

[0033] Ring 3 could be rotated about its axis 8 in a motorized manner, instead of manually, e.g. by feeding through the actuation of the rollers 14 and/or 20; and/or could be supported by a piece-holder table which may rotate and be blocked by means of releasable retention means, instead of being supported by the rollers 14, 20; and/or could be substantially fixed, but with a system for positioning the actuator 34 about the ring 3 at the various compartments 9 to be cleaned.

[0034] Furthermore, the inclination of plate 25 could be adjusted by means of a guide or slot carried by the structure 25, instead of by means of the slot 30; or by means of adjustment devices which are distinct from the coupling of the structure 25, e.g. associated with the actuator which actuates the thrust members 45.

[0035] Finally, the position of the rollers 14, 20 and possibly of the devices 50 on the work bench 11 could be adjustable, so as to adapt the assembly 1 to rings 3 of different diameter.

Claims

1. A cleaning assembly (1) for removing wax from a bladed ring (3); the assembly being **characterized by** comprising:

- supporting means (14, 20) for placing said bladed ring with its axis (8) set vertically;
- a thrust member (45);
- angular-positioning means (15, 21) for rotating, with respect to one another, said bladed ring (3) and said thrust member (45) about the axis (8) of said bladed ring (3);
- releasable retention means (50) for blocking the relative rotation of said bladed ring (3) and said thrust member (45); and
- actuator means (34) controlled for displacing said thrust member (45) in a direction of thrust (39) and, in use, pressing the wax contained in a nozzle (9) of said bladed ring (3).

2. The assembly according to Claim 1, **characterized by** comprising adjustment means (28) for varying the inclination of said direction of thrust (39) about a horizontal axis (27).

3. The assembly according to Claim 2, **characterized by** comprising:

- an attachment structure (25), and

- coupling means for coupling said actuator means (34) to said attachment structure (25); said adjustment means (28) forming part of said coupling means.

4. The assembly according to Claim 3, **characterized in that** said coupling means comprise:

- a vertical plate (26) fixed to said actuator means (34) and coupled to said attachment structure (25) in such a way that it can turn about said horizontal axis (27);
- a slot (30) made in one between said vertical plate (26) and said attachment structure (25); and
- gripping means that are slidable in said slot and can be actuated for releasing/locking said vertical plate (26) with respect to said attachment structure (25).

5. The assembly according to any one of the preceding claims, **characterized in that** said thrust member (45) comprises a bottom plate (46) having, for contact and thrust of said wax, a substantially horizontal bottom edge.

6. The assembly according to Claim 5, **characterized in that** said bottom plate (46) has, for contact and thrust of said wax, a substantially horizontal bottom surface.

7. The assembly according to Claim 5 or Claim 6, **characterized in that** said thrust member (45) comprises a top portion coupled to said actuator means (34) via a hinge so that it can turn about a horizontal hinge axis (48) orthogonal to said direction of thrust (39).

8. The assembly according to any one of the preceding claims, **characterized in that** said actuator means (34) are defined by a linear actuator comprising a stem (38) that translates in said direction of thrust (39) and carries at one end thereof said thrust member (45).

9. The assembly according to any one of the preceding claims, **characterized in that** said supporting means and said angular-positioning means, as a whole, are constituted by:

- a plurality of resting rollers (14) that are able to turn about horizontal axes; and
- a plurality of centring rollers (20) that are able to turn about vertical axes.

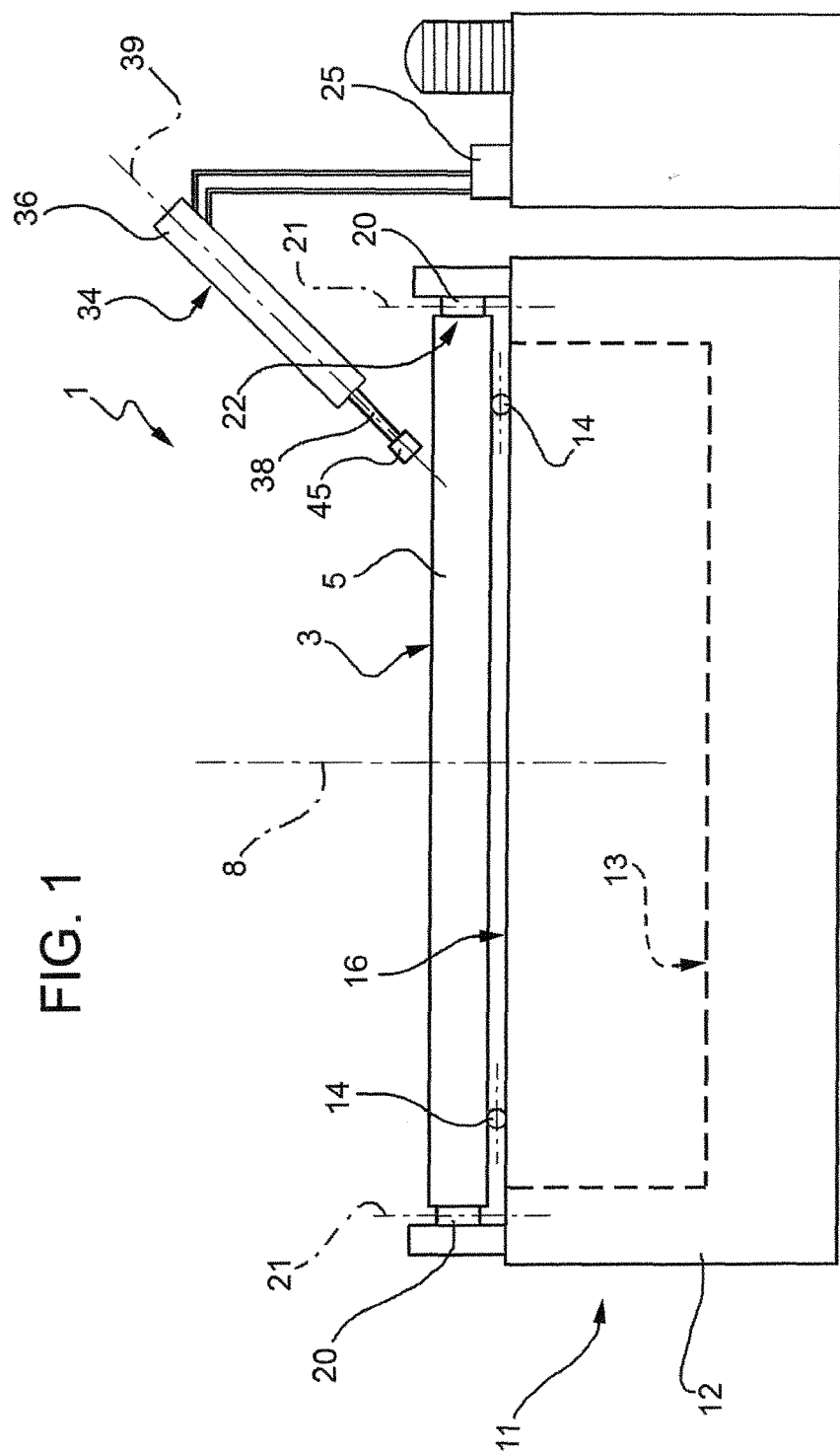


FIG. 1

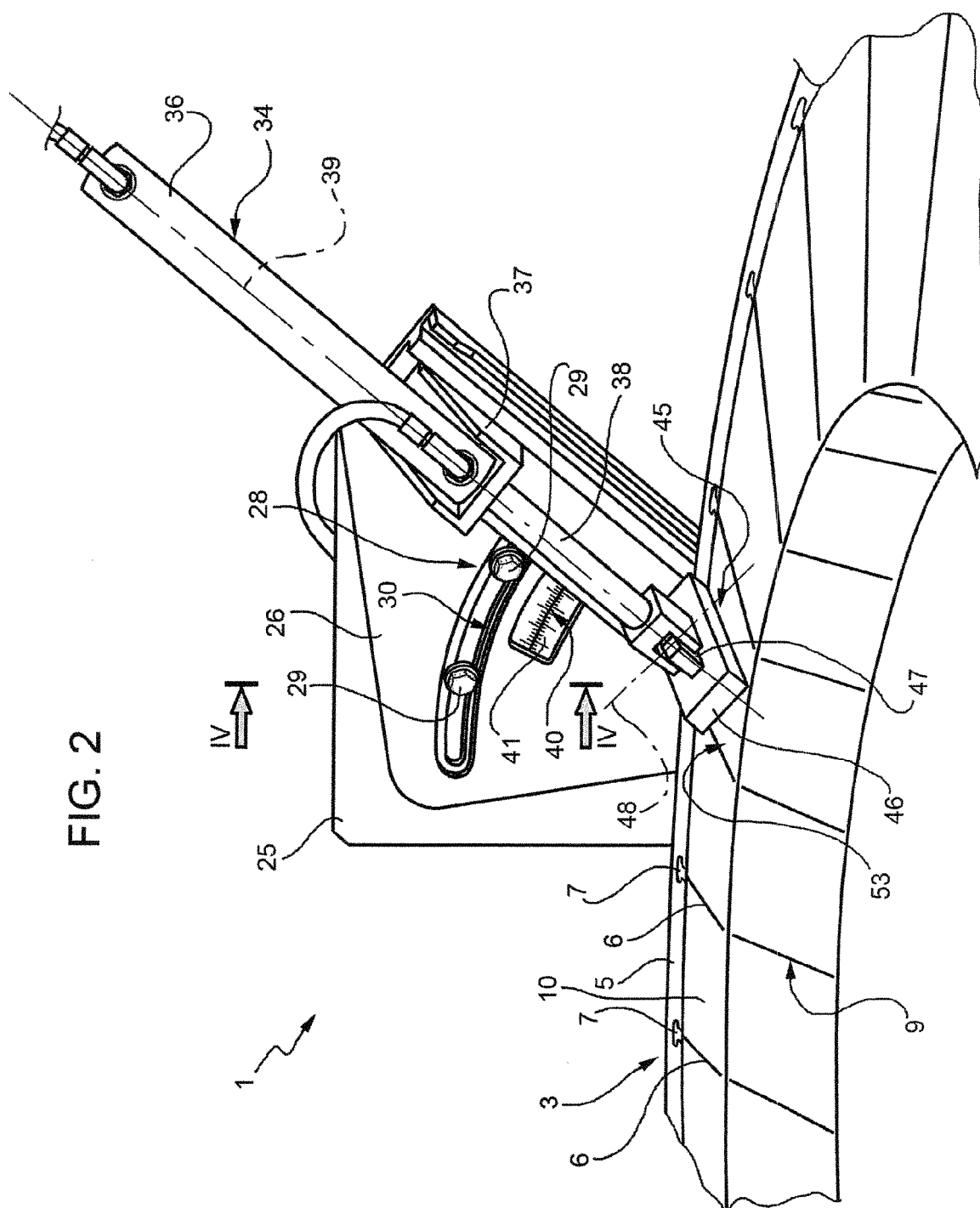


FIG. 3

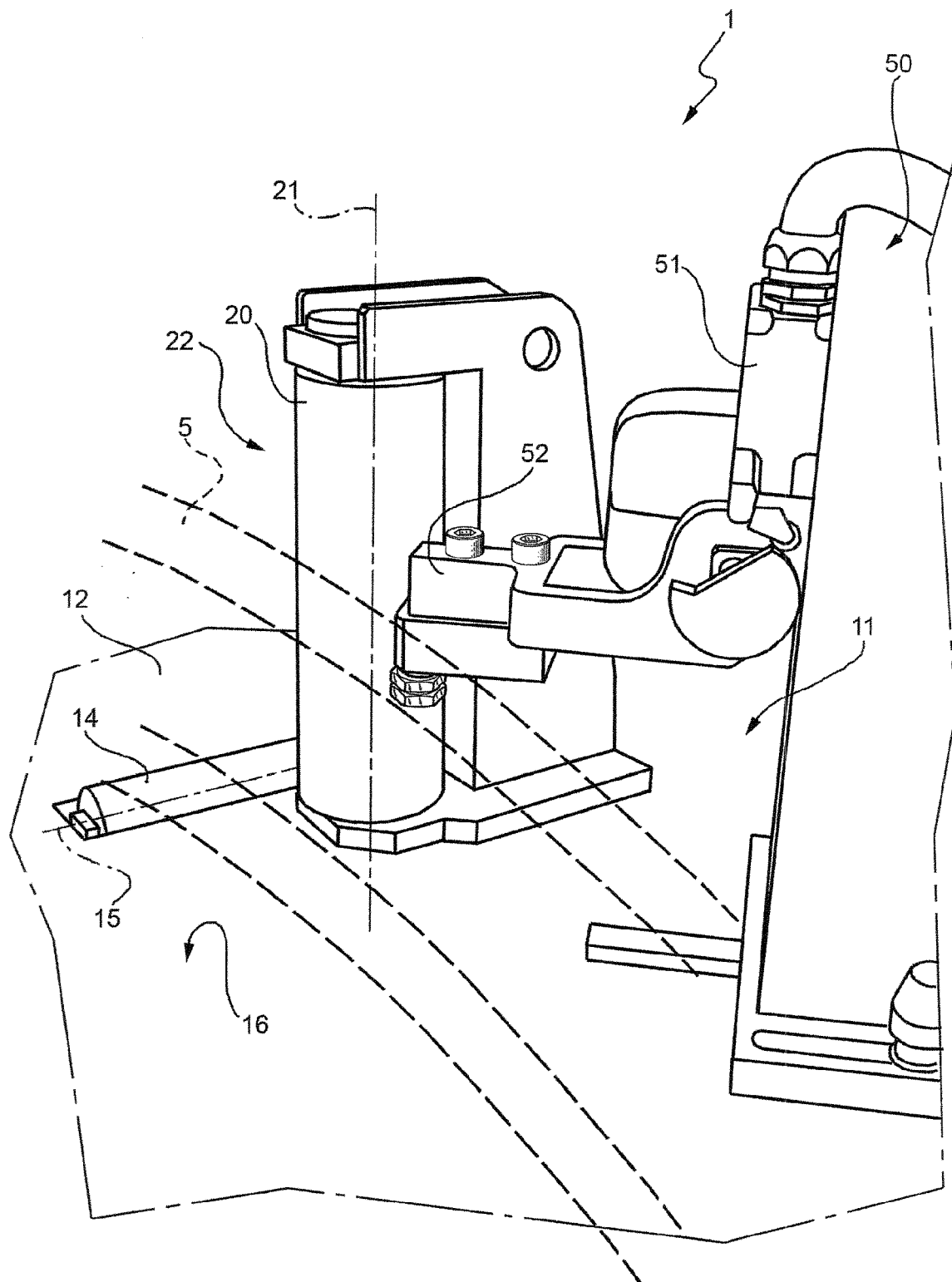
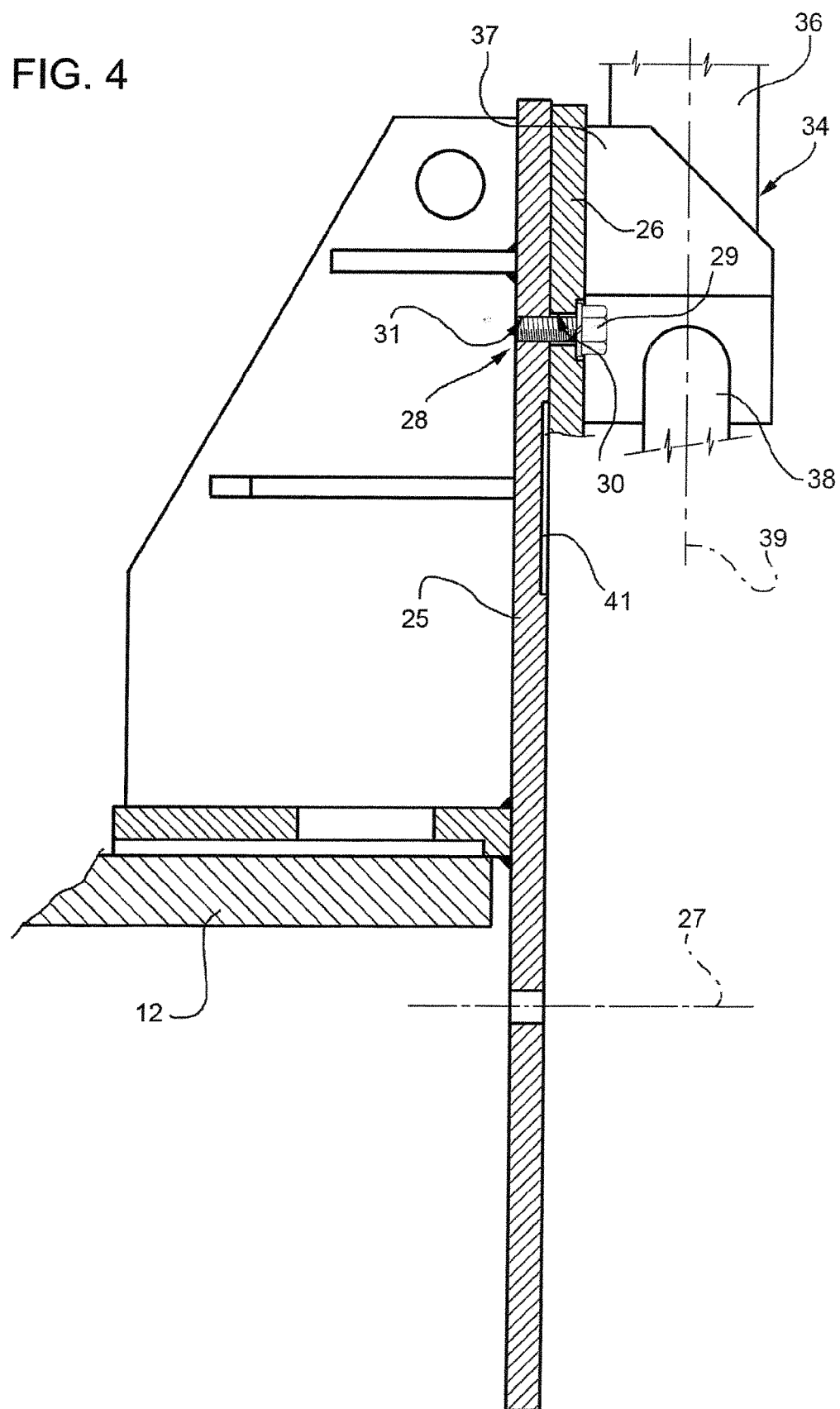


FIG. 4





EUROPEAN SEARCH REPORT

Application Number
EP 09 16 6649

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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			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 09 16 6649

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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