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(54) **ANCHORAGE DEVICE FOR HEAT-INSULATING TILES OF COMBUSTION CHAMBERS OF GAS TURBINES**

(57) An anchorage device for heat-insulating tiles of combustion chambers of gas turbines includes: an assembly member (27), defined by a metal plate shaped so as to define a pair of diverging side walls (32) coupled by a bottom portion (33); a screw (31); a clamping bracket (28) housed between the side walls (32) and shaped to transmit a clamping force from the screw (31) to the assembly member (27); and a heat shield member (30) protecting the assembly member (27) and the clamping bracket (28).

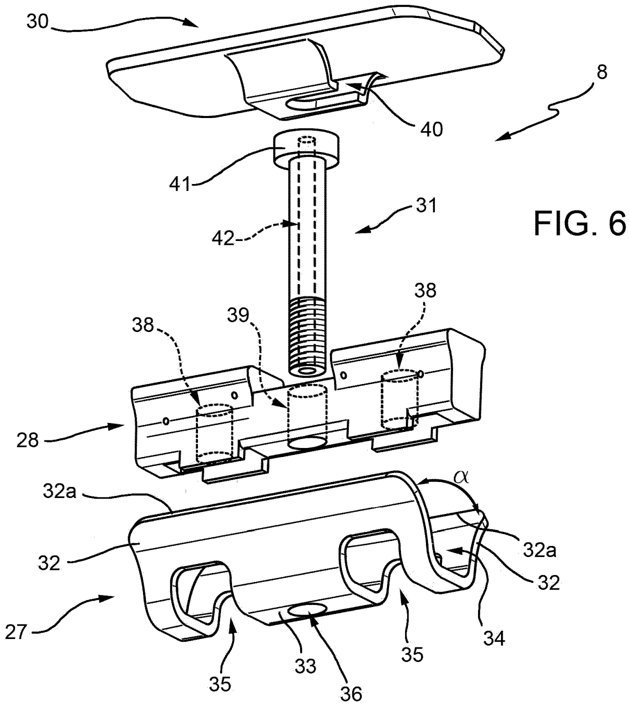

FIG. 6

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Description

[0001] The present invention relates to an anchorage device for heat-insulating tiles of combustion chambers of gas turbines.

[0002] As already known, the combustion chamber of a gas turbine must be internally provided with a heat-insulating coating because of the high temperatures developed by the machine operation. The heat-insulating coating is generally formed by a plurality of tiles arranged in contiguous rows on the inner walls of the combustion chamber casing to define a substantially continuous surface.

[0003] The heat-insulating tiles, where possible, are made of a refractory ceramic material providing a better performance with regard to thermal insulation and average service life if compared to the heat shields made of a metal alloy. Moreover, the tiles made of ceramic material require a modest flow of cooling air or do not require it at all, unlike the heat shields made of a metal alloy. This is advantageous for the efficiency of the machine, because the cooling air is taken at the outlet of the compressor and is therefore subtracted from the flow fed to the burners for combustion and subsequently processed by the expansion turbine.

[0004] The heat-insulating tiles are fastened to the casing of the combustion chamber by anchorage devices, which however have some limits. One type of anchorage, also called "not flame-exposed" is arranged between the respective heat-insulating tile and the casing and engages coupling seats formed on the sides of the tile. This type of anchorage does not need a substantial cooling, but requires a special machining both on the sides of the heat-insulating tile and on the combustion chamber casing. In particular, the machining on the sides of the tiles require a rather high minimum thickness, typically at least 40 mm. However, heat-insulating tiles having such a thickness may be used in large-sized combustion chambers of gas turbines, which generally provide power around 150 MW and above. In gas turbines of smaller size, e.g. providing power around 70 MW or lower, the volume of the combustion chamber does not allow to use heat-insulating tiles having a thickness sufficient to the coupling with not flame-exposed anchorages. Moreover, even the machining, in particular thinning, to be performed on the combustion chamber casing is not compatible with the size of medium-small sized gas turbines.

[0005] Other anchorages of the so-called "flame-exposed" type do not impose specific thickness limits, but require abundant cooling. As already mentioned, however, the air tapping needed for cooling causes a reduced produced thermal power and, ultimately, a lower overall efficiency of the machine. The object of the present invention is therefore to provide an anchorage device for heat-insulating tiles of gas turbines that can overcome or at least mitigate the aforesaid limitations.

[0006] The present invention provides an anchorage device for heat-insulating tiles of gas turbines as defined in claim 1.

[0007] The present invention will now be described with reference to the accompanying drawings showing a non-limiting embodiment, in which:

- Figure 1 is a perspective view, partially sectioned and with parts removed for clarity's sake, of an annular combustion chamber of a gas turbine according to an embodiment of the present invention;
- Figure 2 is a perspective front view of a heat-insulating tile;
- Figure 3 is a three-quarter perspective view from above of the heat-insulating tile of Figure 2, sectioned along the plane III-III of Figure 2;
- Figure 4 is a three-quarter perspective view from below of the heat-insulating tile of Figure 2;
- Figure 5 shows a pair of heat-insulating tiles juxtaposed in the assembly position;
- Figure 6 is an exploded perspective view of an anchorage device according to an embodiment of the present invention; and
- Figure 7 is a perspective view of the assembled anchorage device of Figure 6.

[0008] Figure 1 shows a combustion chamber 1 of a gas turbine (not shown in full). The combustion chamber 1 comprises an annular casing 2 extending about an axis and is provided with a heat-insulating coating 3, which internally coats the casing 2 and delimits a combustion volume 4. Figure 1 also shows burner housings 6, which are not described for the sake of simplicity.

[0009] The heat-insulating coating 3 comprises a plurality of heat-insulating tiles 5 made of refractory material, arranged in adjacent rows along circumferences around the axis of the combustion chamber 1. Optionally, the heat-insulating coating 3 may also include rows of metallic heat-insulating shields 7, in particular in the less hot portions of the combustion chamber adjacent to the outlet. The heat-insulating tiles 5 are fastened to the casing 2 by anchorage devices 8. Each anchorage device 8 engages a respective pair of adjacent heat-insulating tiles 5.

[0010] One of the heat-insulating tiles 5 of a specific row of the heat-insulating coating 3 is shown in detail in Figures 2-6. What described below, unless otherwise stated, applies in general not only to all the heat-insulating tiles 5 in the same row, which are identical, but also to the heat-insulating tiles 5 of other rows of the heat-insulating coating 3.

[0011] The heat-insulating tile 5 has a substantially quadrangular shape. More in detail, the heat-insulating tile 5 has a first face or hot face 10 (Figures 2 and 3), exposed to the combustion volume 4, and a second face or cold face 11 (Figures 3 and 4) opposite to the hot face 10 and oriented towards the casing 2. The hot face 10 and the cold face 11 may be slightly curved, respectively concave and convex, according to the distance from the axis of the combustion chamber 1. The heat-insulating tile 5 also has a first side 12 arranged upstream with respect to a gas flow direction in the combustion chamber 1 and a second side 13 arranged downstream with respect to the first side 12. Sides 15 extend between the hot face 10 and the cold face 11 and between the first side 12 and the second side 13. The sides 15 are slightly converging from the first side 12 to the second side 13, so that the heat-insulating tiles 5 in the same row internally and externally define substantially truncated-conical surfaces. The heat-insulating tile 5 is substantially symmetrical with respect to a middle longitudinal axis A (Figure 2), longitudinal being here understood to indicate the direction that perpendicularly goes from the first side 12 to the second side 13.

[0012] The heat-insulating tile 5 (Figures 2-4) has an anchorage seat 17 on each side 15 for its coupling with respective anchorage devices 8. The anchorage seats 17 are defined by respective recesses, open on the hot face 10 and on the respective side 15. The anchorage seats 17 are delimited at the bottom by the coupling surfaces 18 sloping with respect to the hot face 10 of the heat-insulating tile 5. In one embodiment, the coupling surfaces 18 are substantially flat and sloping from the hot face 10 to the respective side 15 with a constant inclination comprised e.g. between 30° and 60° with respect to the hot face 10. Moreover, the sides 15 have recesses at the respective anchorage seats 17, so that two contiguous tiles in the same row define between them a gap 20 open at the bottom and allowing the passage of a respective anchorage device 8 (in this regard see Figure 5). Because of the slope and of the recesses, the coupling surfaces 18 intercept the respective sides 15 at an intermediate height between the hot face 10 and the cold face 11 (Figure 3).

[0013] With reference to Figures 3 and 4, the cold face 11 of the heat-insulating tile 5 has a recessed portion 21, which is surrounded by a raised portion 22 along the perimeter of the heat-insulating tile 5. An insulating layer 25, for example made of woven heat-insulating fibres, is shaped to correspond to the raised portion 22 of the cold face 11 and is applied on it by glue points (not shown). The contact surface between the heat-insulating tile 5 and the casing 2 of the combustion chamber 1 is limited to the insulating layer 25 along the raised portion 22, while the recessed portion 21 is separated from the casing 2. Moreover, the material forming the insulating layer 25 also dampens the transmission of mechanical vibration from the casing 2 to the heat-insulating tiles 5.

[0014] Figures 6 and 7 show in detail one of the anchorage devices 8, which are structurally identical and may possibly include some size differences to allow the coupling to heat-insulating tiles 5 of different rows. In one embodiment, the anchorage devices 8 of a same row of heat-insulating tiles 5 are identical. Figure 7 shows with dashed lines also portions of a heat-insulating tile 5 coupled to the anchorage device 8 and of the casing 2 of the combustion chamber 1.

[0015] The anchorage device 8 comprises an assembly member 27, a clamping bracket 28, a heat shield member 30 and a screw 31.

[0016] In one embodiment, the assembly member 27 comprises a metal sheet folded so as to define a pair of diverging side walls 32, coupled by a bottom portion 33. In one embodiment, a width of the assembly member 27, defined as the maximum distance between the upper edges 32a of the side walls 32, is less than a length, defined in the direction perpendicular to the width and to the direction of insertion of the screw 31. The assembly member 27 is elastically deformable to dampen the vibrations transmitted by the heat-insulating tiles 5. The side walls 32 slope to mate with the coupling surfaces 18 of the heat-insulating tiles 5 and define between them a pocket 34. For example, the side walls 32 form between them an angle α comprised between 60° and 120°. The assembly member 27 is shaped so as to be housed in the gap 20 between two adjacent heat-insulating tiles 5.

[0017] The bottom portion 33 of the assembly member 27 has openings 35 to allow the supply of cooling air to the clamping bracket 28 and an opening 36 for housing the through screw 31.

[0018] In one embodiment, the clamping bracket 28 is defined by a metal bar inserted into the pocket 34 between the side walls 32 of the assembly member 27. The width of the bracket member 28 is such that the bracket member 28 comes first in contact with the bottom portion 33 of the assembly member 27 and then with the side walls 32.

[0019] The clamping bracket 28 has through holes 38 in positions corresponding to the openings 35 of the bottom portion of the assembly member 27. Furthermore, a through seat 39 allows the insertion of the screw 31 through the clamping bracket 28 and the opening 36 in the assembly member 27. The clamping force exerted by the screw 31 is transmitted and distributed by the clamping bracket 28 to the assembly member 27, which is then stably held in its seat. The clamping bracket 28, furthermore, exerts pressure on the bottom portion 33 of the assembly member 27, thus transmitting through the side walls 32 a desired force against the coupling surfaces 18 of the anchorage seats 17 of heat-insulating tiles 5.

[0020] The heat shield member 30 comprises a plate of a metal alloy resistant to high temperatures, possibly covered with a heat-insulating layer (not shown in detail) made of refractory material, for example a ceramic material. The heat shield member 30 covers the assembly member 27 and the clamping bracket 28. The clamping bracket 28 is then trapped in the pocket 34 between the assembly member 27 and the heat shield member 30. The heat shield member 30 extends beyond the edges of the side walls 32 and, in particular, is shaped so as to close the gap 20 housing the anchorage device 8. The heat shield member 30 thus forms a substantially continuous surface with the hot faces 10 of adjacent heat-insulating tiles 5, protecting the assembly member 27 and the clamping bracket 28.

[0021] On the side facing the clamping bracket 28, the heat shield member 30 has a seat 40 to house the head 41 of the screw 31. The walls defining the seat 40 are also shaped so as to press the clamping bracket 28 against the bottom wall 33 of the assembly member 27 thanks to the tightening of the screw 31. The screw 31 is coupled to a seat (not shown) in the casing 2.

[0022] The air possibly required for cooling the heat shield member 30 may be fed through the openings 35 of the assembly member 27 and the through holes 38 in the clamping bracket 28.

[0023] The screw 31, which has an axial through channel 42 for cooling, can be reached with a tool through a hole 43 in the heat shield member 30.

[0024] The described heat-insulating tile 5 advantageously has a reduced thickness if compared to conventional ceramic tiles. In fact, the tile is just as thick as necessary to obtain an effective coupling with the anchorage devices 8, thanks to the shape of the anchorage seats 17, whose sloping coupling surfaces 18 extend to the hot face 10. In turn, the reduced thickness allows using the heat-insulating tile 5 in substitution of metal shields in the combustion chambers of medium-small sized gas turbines. In addition to lower production and maintenance costs, the heat-insulating tile 5 does not require any cooling air, which may only be possibly required for the anchorage devices 8. The air tapping from the compressor is then dramatically reduced, to the advantage of the efficiency of the machine.

[0025] The coupling between the mating sloping surfaces 18 and the elastic side walls 32 of the assembly member 27 of the anchorage device 8 is advantageous because the coupling forces are distributed over a wide area, thus reducing the punctual stresses, particularly close to the chamfered edges.

[0026] Some advantages deriving from the anchorage device 8 are related to the fact that the required cooling air flow rate is limited and comparable with the flow rate required by the known anchorages of the not flame-exposed type, but, at the same time, without the limitations that such anchorages impose on a minimum thickness of the heat-insulating tiles. On the other hand, the known flame-exposed anchorages, that have less stringent limitations on a minimum thickness, require significant amounts of cooling air, thus having an impact on the overall efficiency of the machine.

[0027] The anchorage devices 8 can be frontally coupled and removed with respect to the casing 2 of the combustion chamber 1, thus facilitating the maintenance operations. Moreover, the installation of heat-insulating tiles by the anchorage devices 8 requires only the drilling of the casing 2 for machining the coupling seats (directly or by means of interface plates) of the screws 31. No thinning processing is required which could jeopardise the structural integrity of the combustion chamber 1.

[0028] Finally, it is evident that the described anchorage device may be subject to modifications and variations, without departing from the scope of the present invention, as defined in the appended claims.

Claims

1. An anchorage device for heat-insulating tiles of combustion chambers of gas turbines, comprising:

    an assembly member (27), including a metal plate shaped so as to define a pair of diverging side walls (32) coupled by a bottom portion (33);
    a screw (31);
    a clamping bracket (28), arranged between the side walls (32) and shaped to transmit a clamping force from the screw (31) to the assembly member (27); and
    a heat shield member (30), arranged to protect the assembly member (27) and the clamping bracket (28).

2. The anchorage device according to claim 1, wherein the clamping bracket (28) is arranged between the assembly member (27) and the heat shield member (30) and the screw (31) passes through the clamping bracket (28) and the bottom portion (33) of the assembly member (27).

3. The anchorage device according to claim 2, wherein the side walls (32) of the assembly member (27) define a pocket (34) housing the clamping bracket (28).

4. The anchorage device according to claim 2 or 3, wherein the heat shield member (28) has, on a side facing the clamping bracket 28, a seat (40) for receiving a head (41) of the screw (31).

5. The anchorage device according to any one of the preceding claims, wherein the bottom portion (33) of the assembly member (27) has openings (35) and the clamping bracket (28) has through holes (38) in positions corresponding to the openings (35), the through holes (38) being made so as to convey cooling air fed through the openings (35) to the heat shield member (30).

6. The anchorage device according to any one of the preceding claims, wherein the heat shield member (30) comprises a plate made of a temperature-resistant metallic alloy, extending past the side walls (32) of the clamping bracket (28).

7. The anchorage device according to any one of the preceding claims, wherein the side walls (32) form between them an angle (α) ranging between 60° and 120°.

8. The anchorage device according to any one of the preceding claims, wherein the screw (31) has an axial through channel (42) for cooling.

9. A combustion chamber of a gas turbine comprising

a casing (2), a heat-insulating coating (3) arranged to protect the casing (2) and including a plurality of heat-insulating tiles (5) and a plurality of anchorage devices (8) according to any one of the preceding claims, which connect respective heat-insulating tiles (5) to the casing (2).

10. A combustion chamber according to claim 9, wherein each anchorage device (8) connects two respective adjacent heat-insulating tiles (5) to the casing (2) and each heat-insulating tile (5) is connected to the casing by two respective anchorage devices (8).

11. A combustion chamber according to claim 9 or 10, wherein the heat-insulating tiles (5) are shaped so that side-by-side pairs of heat-insulating tiles (5) define between them a gap (20) for receiving a respective anchorage device (8).

12. A combustion chamber according to claim 11, wherein the heat shield member (30) of each anchorage device (8) is shaped to close the gap (20) housing the anchorage device (8) and to form a substantially continuous surface with the adjacent heat-insulating tiles (5).

13. A combustion chamber according to any one of claims from 9 to 12, wherein the heat-insulating tiles (5) have respective coupling surfaces (18) degrading from the first face (10) to a respective side (15) and the side walls (32) of the anchorage devices (8) slope to mate with the coupling surfaces (18) of the adjacent heat-insulating tiles (5).

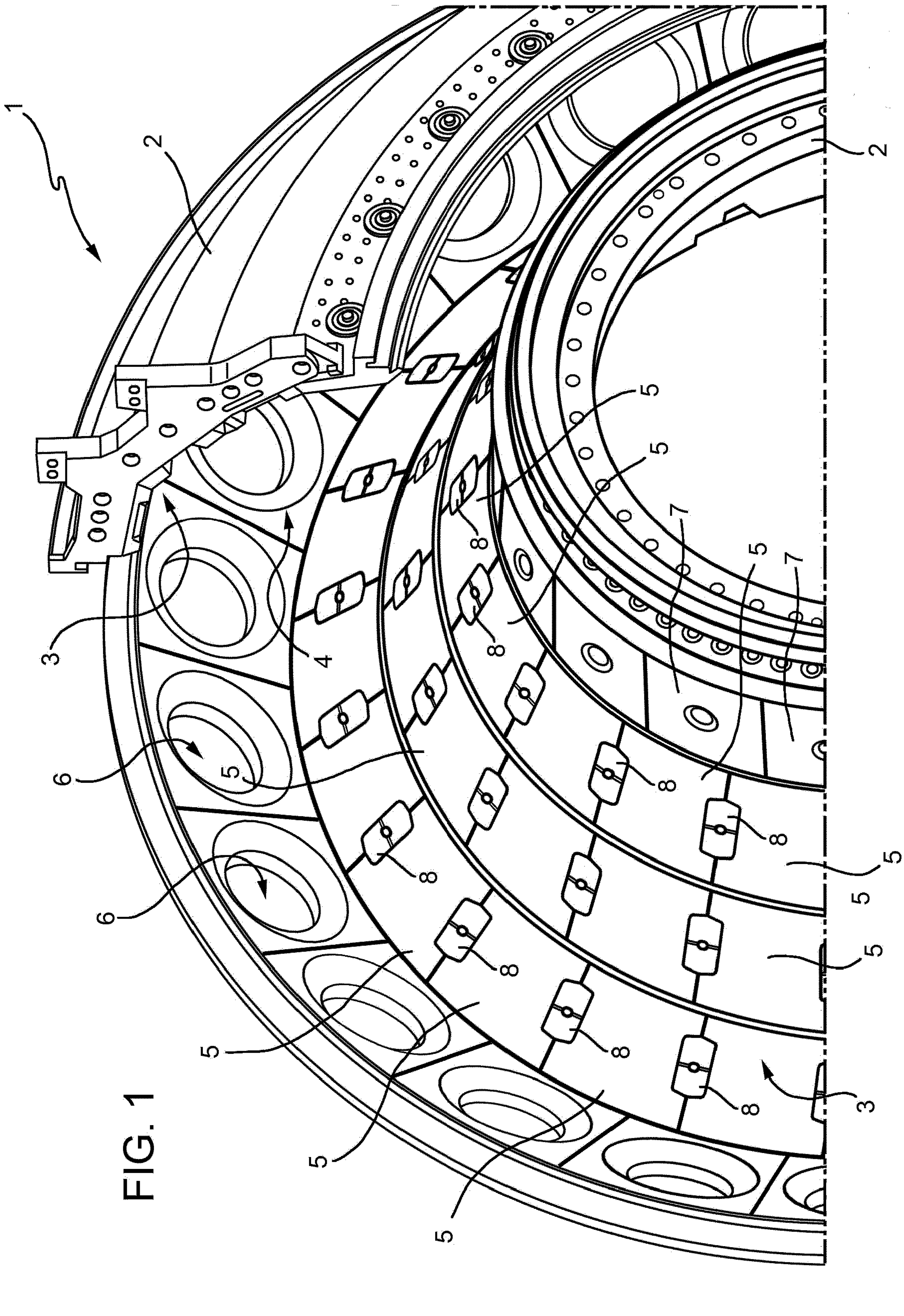

FIG. 1

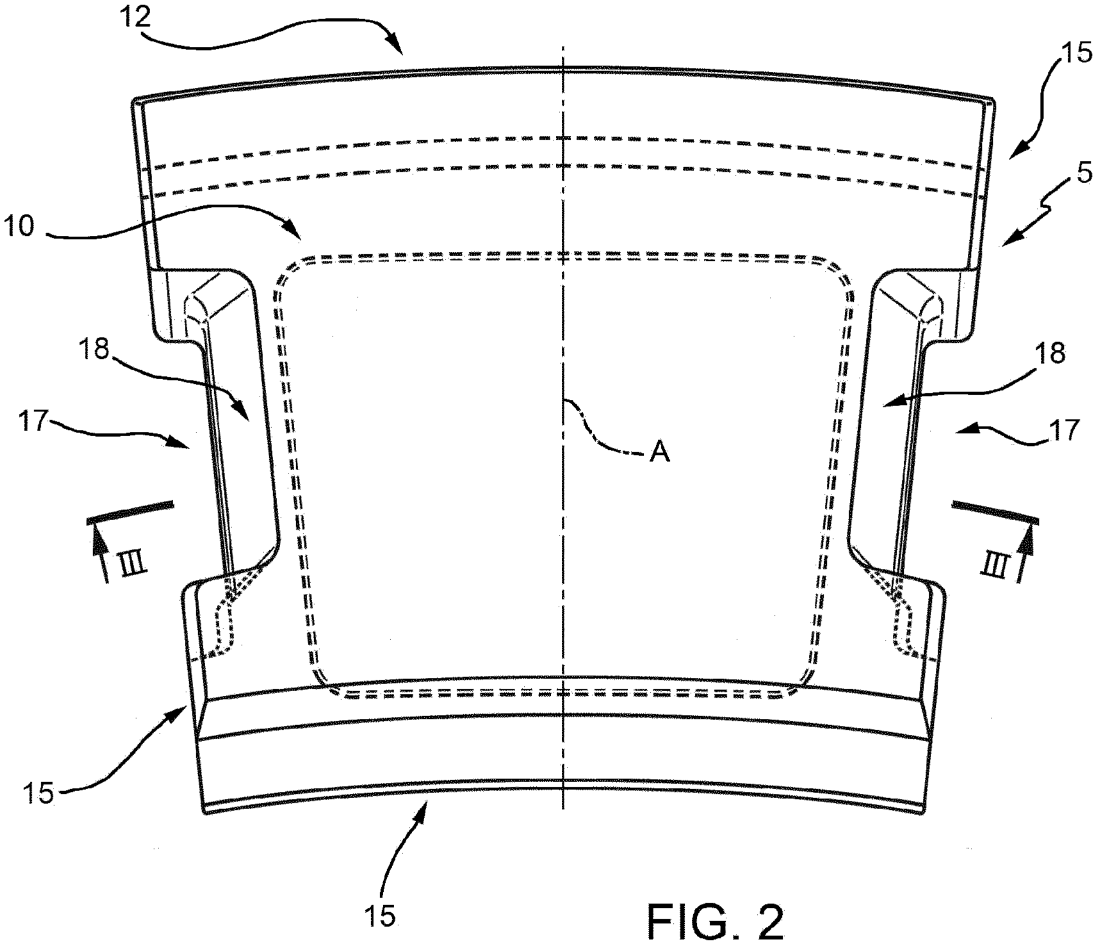
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FIG. 2

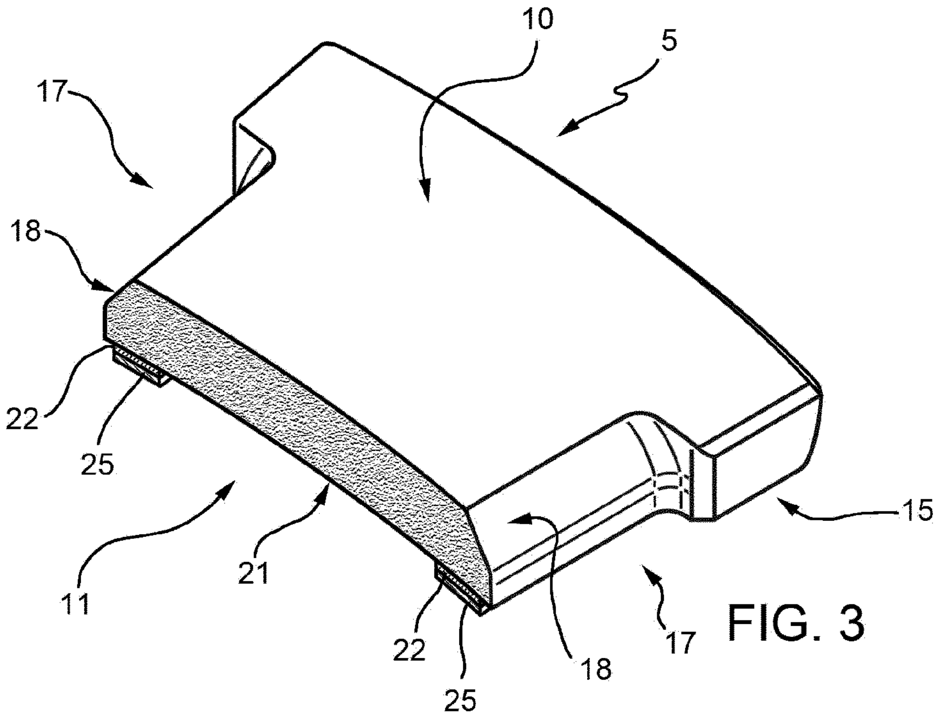
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FIG. 3

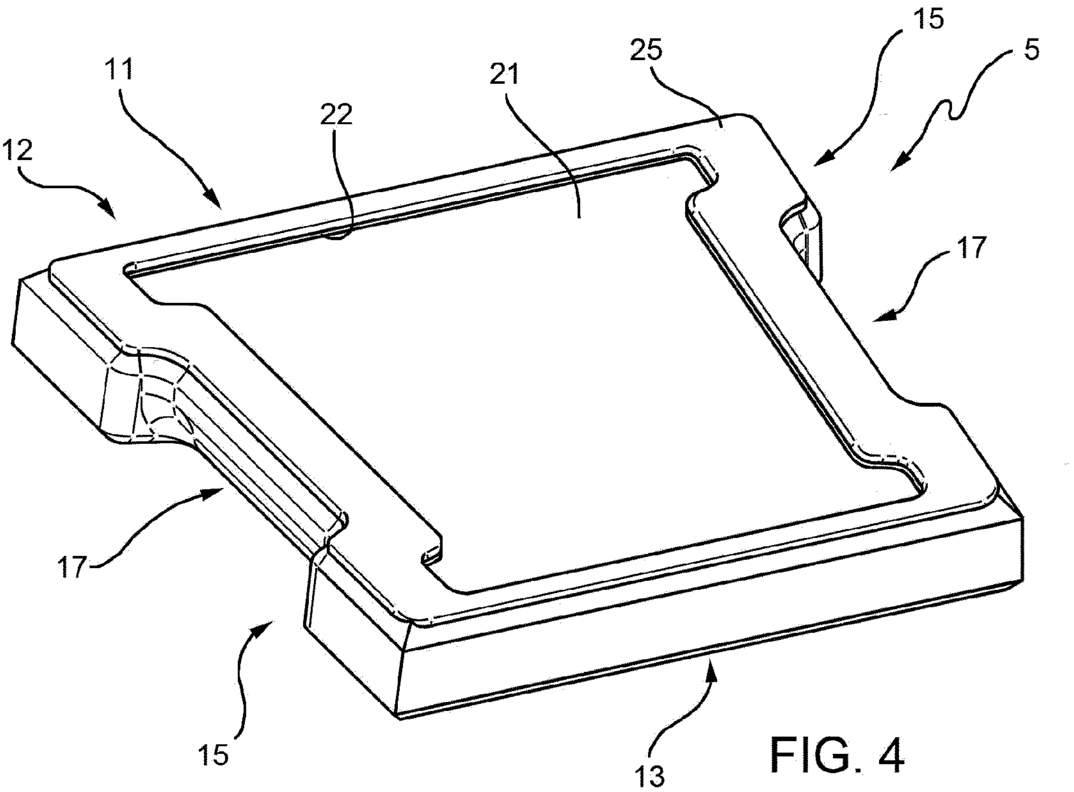

FIG. 4

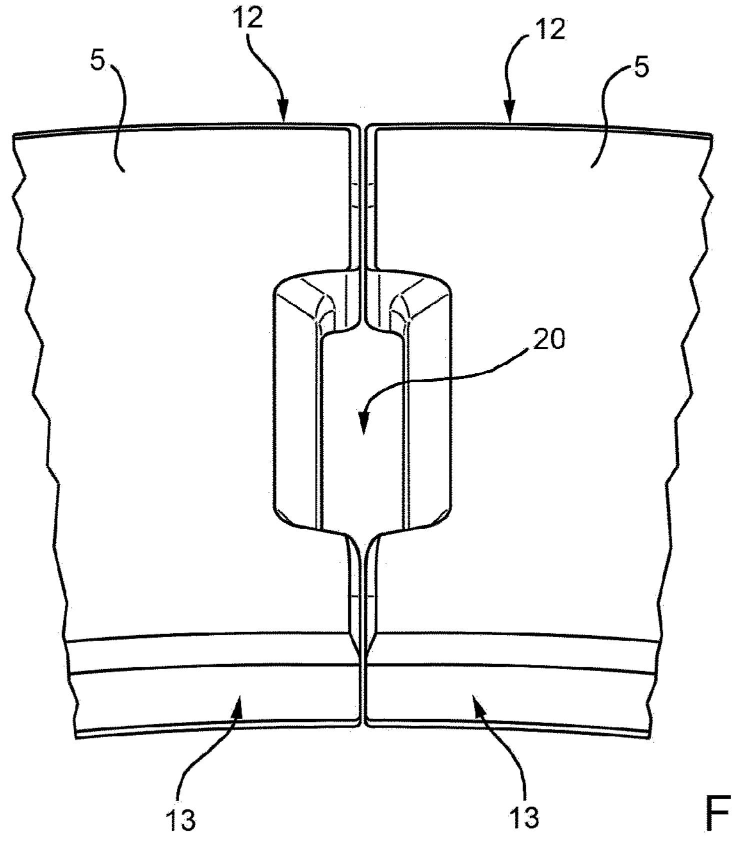

FIG. 5

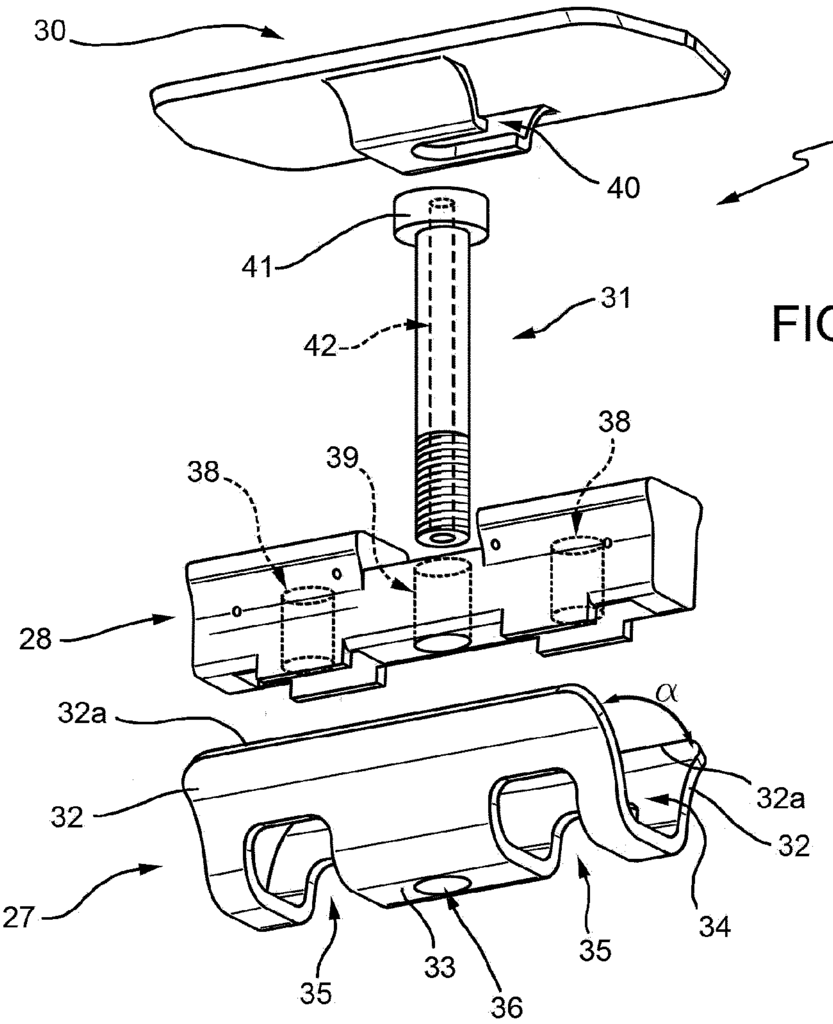
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FIG. 6

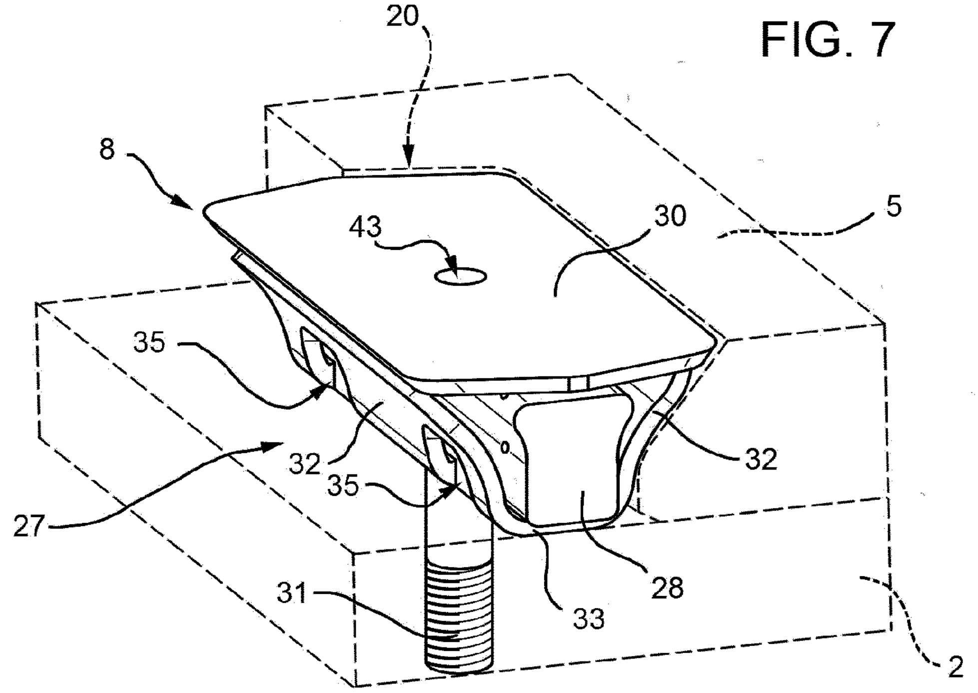
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FIG. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 16 17 3610

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TECHNICAL FIELDS SEARCHED (IPC)

F23R
F23M

The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
Munich	8 July 2016	Rudolf, Andreas

CATEGORY OF CITED DOCUMENTS

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