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(54) Title: WIND TURBINE ROTATING ELECTRIC MACHINE STATOR

(57) Abstract: A wind turbine electric rotating machine stator (1) having a supporting wall (2); an active stator part (6) contacting the supporting wall (2); and a cooling circuit (12) extending partly inside the supporting wall (2) and having a plurality of holes (13) extending inside the supporting wall (2).

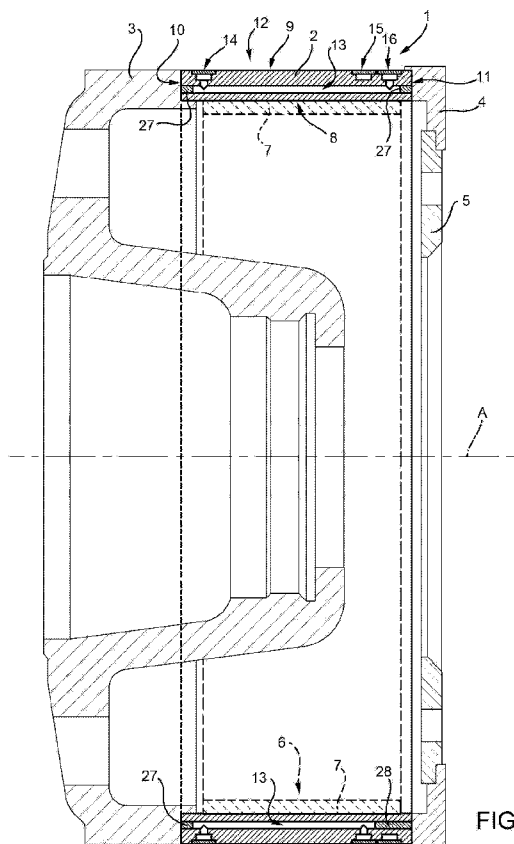


FIG. 1



(84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE,

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WIND TURBINE ROTATING ELECTRIC MACHINE STATOR

TECHNICAL FIELD

The present invention relates to a wind turbine
5 rotating electric machine stator.

BACKGROUND ART

More specifically, the present invention relates to
a stator which forms part of a wind turbine rotating
electric machine for producing electric energy, and
10 comprises a supporting wall, and an active stator part
contacting the supporting wall.

In use, the active stator part produces heat which
must be removed, in that the efficiency of the rotating
electric machine depends on the extent to which it, and
15 in particular its main component parts, such as the
stator and rotor, are cooled.

In this connection, two types of rotating electric
machine cooling systems have been devised : gas,
normally air, systems; and liquid, normally water,
20 systems.

Gas cooling systems are easier to produce but less
effective than liquid types.

Patent Applications WO 2012/040,535, EP 2,395,629,
EP 2,043,233, EP 2,320,540, EP 2,320,080, EP 2,182,570,
25 and WO 99/17422 propose various types of liquid-cooled
electric machine stators, all of which are of varying

degrees of complexity.

DISCLOSURE OF INVENTION

It is an object of the present invention to provide a liquid-cooled stator designed to eliminate the
5 drawbacks of the known art.

According to the present invention, there is provided a wind turbine electric rotating machine stator, the stator comprising a supporting wall; an active stator part contacting the supporting wall; and a
10 cooling circuit extending partly inside the supporting wall and comprising a plurality of holes extending through the supporting wall.

In the present invention, the supporting wall serves to cool the active stator part by circulating
15 cooling liquid inside the holes. The holes are straight and therefore easy to form, and easy to inspect once plugs plugging the ends of the holes are removed.

Preferably, the supporting wall and the active stator part are annular, preferably cylindrical.

20 The active stator part comprises a plurality of side by side stator segments, each facing a given number of respective holes.

Basically, the cooling circuit is designed to select the hole spacing along the supporting wall, and
25 to arrange the holes according to, and so as to optimize cooling of, the stator segments.

Each stator segment comprises a plurality of electric windings, each of which, in use, produces heat. Preferably, the holes are located at an electric winding.

5 The supporting wall has a face designed to contact the active part. Preferably, the holes extend close to said face, so as to more effectively cool the active part.

 The supporting wall has two opposite annular faces.
10 Each hole extends from one annular face to the other, and is in fact a straight through hole. Preferably, the holes are parallel to an axis of symmetry of the stator.

 Preferably, the cooling circuit comprises fittings for connecting adjacent holes.

15 This way, winding paths can be formed.

 In a preferred embodiment of the present invention, each fitting is formed by a recess in the supporting wall, and by a plate for sealing the recess.

 This way, the fitting is fully integrated in the
20 supporting wall.

 Preferably, the cooling circuit comprises two manifolds formed in the supporting wall to drain cooling liquid from the holes and to feed cooling liquid to the holes respectively.

25 Preferably, each manifold is formed by a groove in the supporting wall, and by a plate for sealing the

groove.

The manifolds are also advantageously integrated in the supporting wall.

Preferably, the cooling circuit comprises a plurality of connecting holes, each intersecting a hole;
5 the connecting holes preferably extending radially.

The connecting holes connect the holes to the fittings and manifolds, which are preferably formed at a different radial level from the holes.

10 Preferably, the supporting wall is formed by calendering a flat aluminium plate, or is cast from cast iron.

The supporting wall then undergoes various machining operations, such as drilling the holes and the
15 connecting holes, and milling the recesses and grooves to form the cooling circuit inside the supporting wall.

BRIEF DESCRIPTION OF THE DRAWINGS

A number of non-limiting embodiments of the present invention will be described by way of example with
20 reference to the attached drawings, in which :

Figure 1 shows a longitudinal section, with parts removed for clarity, of a rotating electric machine stator;

Figure 2 shows a smaller-scale exploded view in
25 perspective, with parts removed for clarity, of a portion of the Figure 1 stator;

Figure 3 shows a larger-scale, spread-out view, with parts removed for clarity, of the stator portion in Figure 2;

Figure 4 shows a larger-scale cross section, with
5 parts removed for clarity, of the stator portion in Figure 2;

Figure 5 shows a schematic, spread-out view of a stator with a cooling circuit in accordance with a variation of the present invention.

10 BEST MODE FOR CARRYING OUT THE INVENTION

Number 1 in Figure 1 indicates a wind turbine electric machine stator. More specifically, stator 1 forms part of a supporting structure of the wind turbine, and, in addition to supporting a rotor (not
15 shown) of the electric machine, also serves to support a blade assembly (not shown) connected directly to the electric machine rotor.

In the example shown, stator 1 comprises a supporting wall 2; a frame 3 for connecting supporting
20 wall 2 to the rotor and the blade assembly (not shown); and connectors 4 and 5 located on the opposite side to frame 3 to connect supporting wall 2 to the nacelle (not shown in the attached drawings).

Stator 1 comprises an active stator part 6
25 preferably divided into stator segments 7, each of which is defined by a magnetic circuit (not shown) and at

least one electric winding (not shown). Active stator part 6 is positioned contacting supporting wall 2.

Stator 1 as a whole is annular in shape about an axis of symmetry A. In the example shown, supporting wall 2 and active stator part 6 are annular, preferably cylindrical. Supporting wall 2 comprises two cylindrical faces 8 and 9 and two annular end faces 10 and 11. And active stator part 6 is positioned contacting face 8 of supporting wall 2.

Stator 1 is traversed by a cooling circuit 12 for removing heat generated, in use, by active stator part 6.

Cooling circuit 12 comprises a plurality of holes 13 formed in supporting wall 2.

The size of stator segments 7 and the arrangement of holes 13 allow a given number of holes 13 to be located at a respective stator segment 7.

The preferred configuration is to have one hole 13 at a respective electric winding (not shown in the attached drawings).

Holes 13 extends close to face 8 contacting active stator part 6.

Each hole 13 extends from one annular face 10 to the other annular face 11.

Each hole 13 is preferably parallel to axis A.

Holes 13 are preferably connected to one another at

one end.

In the configuration shown, holes 13 are connected two by two at the ends. In actual fact, cooling circuit 12 comprises a fitting 14 formed in supporting wall 2.

5 Cooling circuit 12 comprises at least two manifolds 15, 16 located close to respective ends of holes 13 and formed in supporting wall 2 to drain cooling liquid from holes 13 and to feed cooling liquid to holes 13 respectively.

10 Construction-wise, and as shown in Figure 2, each fitting is formed by a recess 17 located at the ends of two holes 13 and formed in supporting wall 2, along face 9; and by a plate 18 designed to seal recess 17 and form a compartment communicating with holes 13 by two radial
15 connecting holes 19, as shown more clearly in Figures 3 and 4.

Like fittings 14, manifolds 15 and 16 are formed by respective grooves 20 and 21 located on the opposite side to fittings 14 and formed in supporting wall 2,
20 along cylindrical face 9; and by plates 22 and 23 designed to seal respective grooves 20 and 21 and form two respective compartments communicating with holes 13 by radial connecting holes 19, as shown more clearly in Figures 3 and 4.

25 In the example shown, plates 22 and 23 are divided into two parts and have respective connectors 24 and 25

for connecting manifolds 15 and 16 to a portion (not shown) of circuit 12 outside stator 1.

With reference to Figure 4, plates 18, 22 and 23 are preferably welded to supporting wall 2.

5 Supporting wall 2 has longitudinal grooves 26 for supporting active stator part 6 (Figure 1).

Holes 13 are sealed at the ends. Preferably, holes 13 are closed by plugs 27 and 28 shown in Figure 3.

With reference to Figure 1, frame 3 is positioned
10 resting against annular face 10 of supporting wall 2, so that, using seals not shown, frame 3 acts as a plug in lieu of plugs 27 and 28.

In the same way, connector 4, using seals, is able to act as a plug in lieu of plugs 27 and 28.

15 Supporting wall 2 is preferably formed by calendering a flat aluminium plate.

Alternatively, supporting wall 2 is cast from cast iron.

Holes 13 and connecting holes 19 are drilled, and
20 recesses 17 and grooves 20 and 21 are milled.

Depending on cooling requirements, circuit 12 inside supporting wall 2 may be configured in a plurality of different ways from the one described with reference to Figures 1 to 4.

25 Figure 5 shows a circuit 29 which extends partly inside supporting wall 2, has no fittings, and has two

manifolds 15 and 16 at respective annular faces 10 and 11, and a plurality of holes 13 connecting manifolds 15 and 16. In the Figure 5 configuration, the cooling liquid flows along all of holes 13 in the same
5 direction.

Clearly, changes may be made to the stator according to the present invention without, however, departing from the protective scope of the accompanying Claims.

CLAIMS

1) A wind turbine electric rotating machine stator, the stator (1) comprising a supporting wall (2); an
5 active stator part (6) contacting the supporting wall (2); and a cooling circuit (12; 29) extending partly inside the supporting wall (2) and comprising a plurality of holes (13) extending inside the supporting wall (2).

10 2) A stator as claimed in Claim 1, wherein the supporting wall (2) and the active stator part (6) are annular, preferably cylindrical.

3) A stator as claimed in any one of the foregoing Claims, wherein the active stator part (6) comprises a
15 plurality of side by side stator segments (7); each stator segment (7) facing a given number of respective holes (13).

4) A stator as claimed in Claim 3, wherein each stator segment (7) comprises a plurality of electric
20 windings; each electric winding facing at least one hole (13).

5) A stator as claimed in any one of the foregoing Claims, wherein the supporting wall (2) has a cylindrical face (8) designed to contact the active
25 stator part (6); said holes (13) extending close to said face (8).

6) A stator as claimed in any one of the foregoing Claims, wherein the supporting wall (2) has two annular faces (10, 11); each of said holes (13) extending from one annular face to the other (10, 11).

5 7) A stator as claimed in any one of the foregoing Claims, wherein said holes (13) are parallel to an axis (A) of symmetry of the stator (1).

8) A stator as claimed in any one of the foregoing Claims, wherein the cooling circuit (12; 29) comprises
10 fittings (14) for connecting adjacent holes (13).

9) A stator as claimed in Claim 8, wherein each fitting (14) is formed by a recess (17) in the supporting wall (2), and by a plate (18) for sealing the recess (17).

15 10) A stator as claimed in any one of the foregoing Claims, wherein the cooling circuit (12; 29) comprises two manifolds (15, 16) formed in the supporting wall (2) to drain cooling liquid from the holes (13) and to feed cooling liquid to the holes (13) respectively.

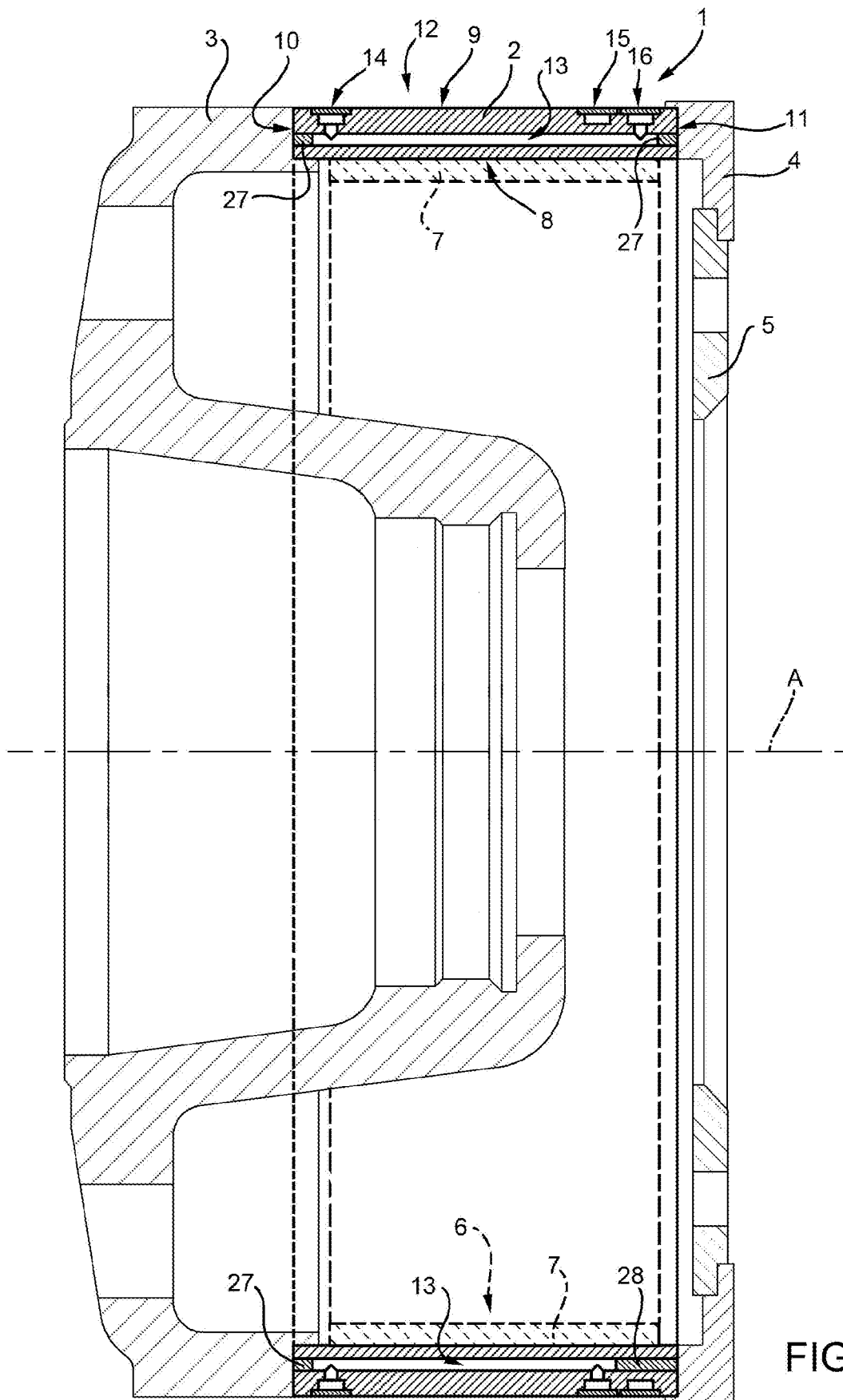
20 11) A stator as claimed in Claim 10, wherein each manifold (15; 16) is formed by a groove (20; 21) in the supporting wall (2), and by a plate (22; 23) for sealing the groove (20; 21).

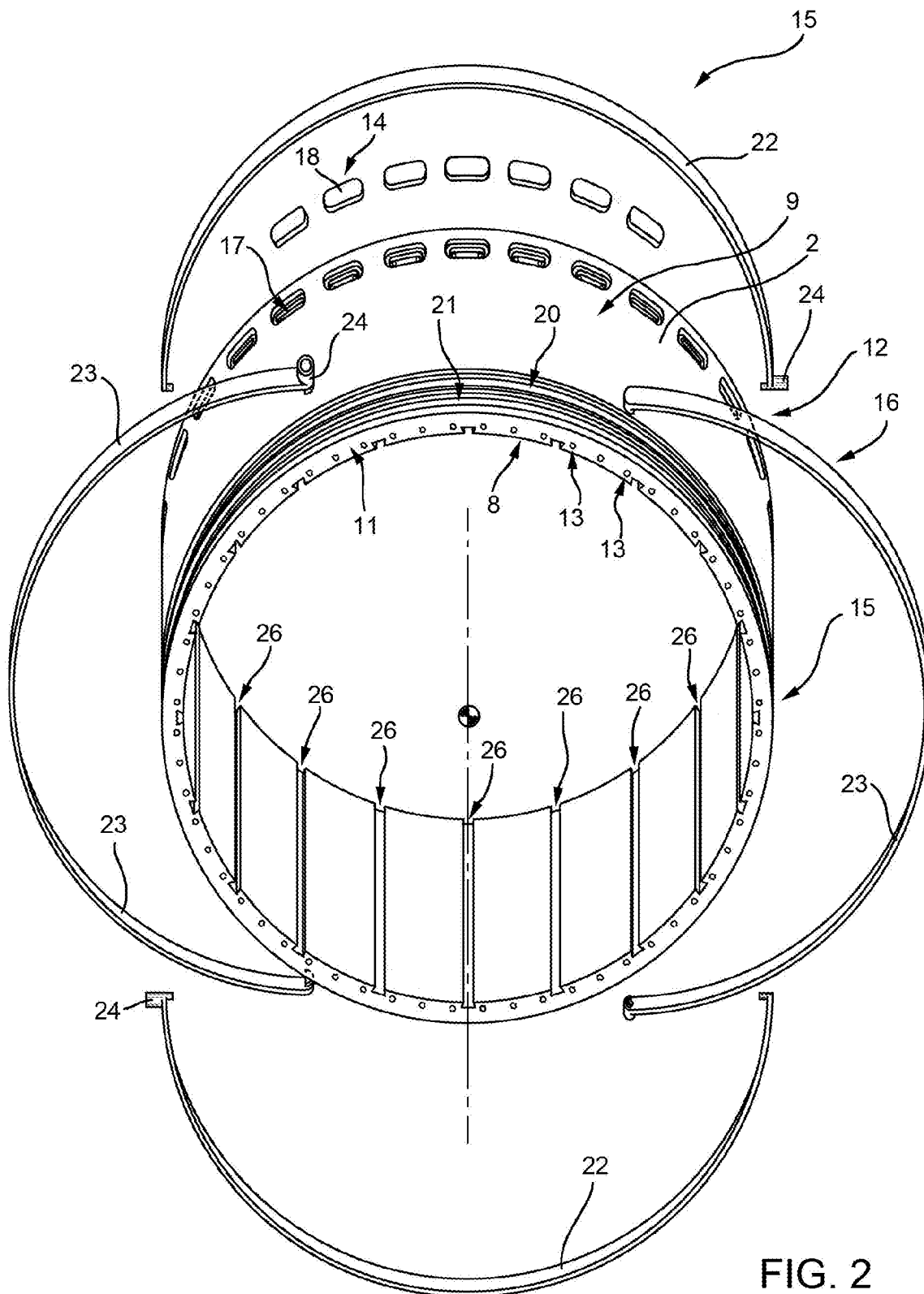
12) A stator as claimed in any one of the foregoing
25 Claims, wherein the cooling circuit (12; 29) comprises a plurality of connecting holes (19), each intersecting a

hole (13); the connecting holes (19) preferably extending radially.

13) A stator as claimed in any one of the foregoing Claims, wherein the supporting wall (2) is formed by
5 calendering a flat aluminium plate.

14) A stator as claimed in any one of Claims 1 to 11, wherein the supporting wall (2) is cast from cast iron.





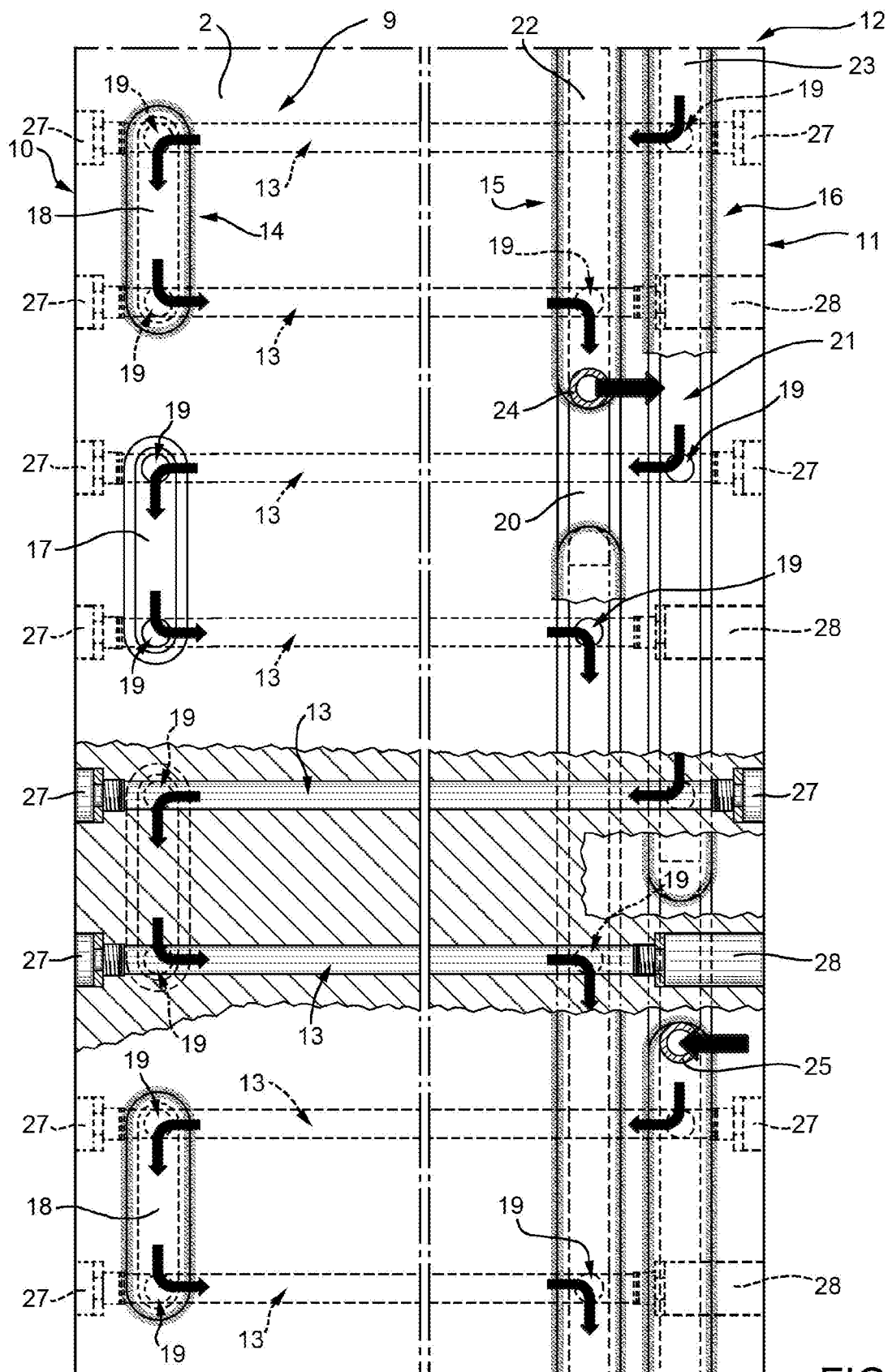


FIG. 3

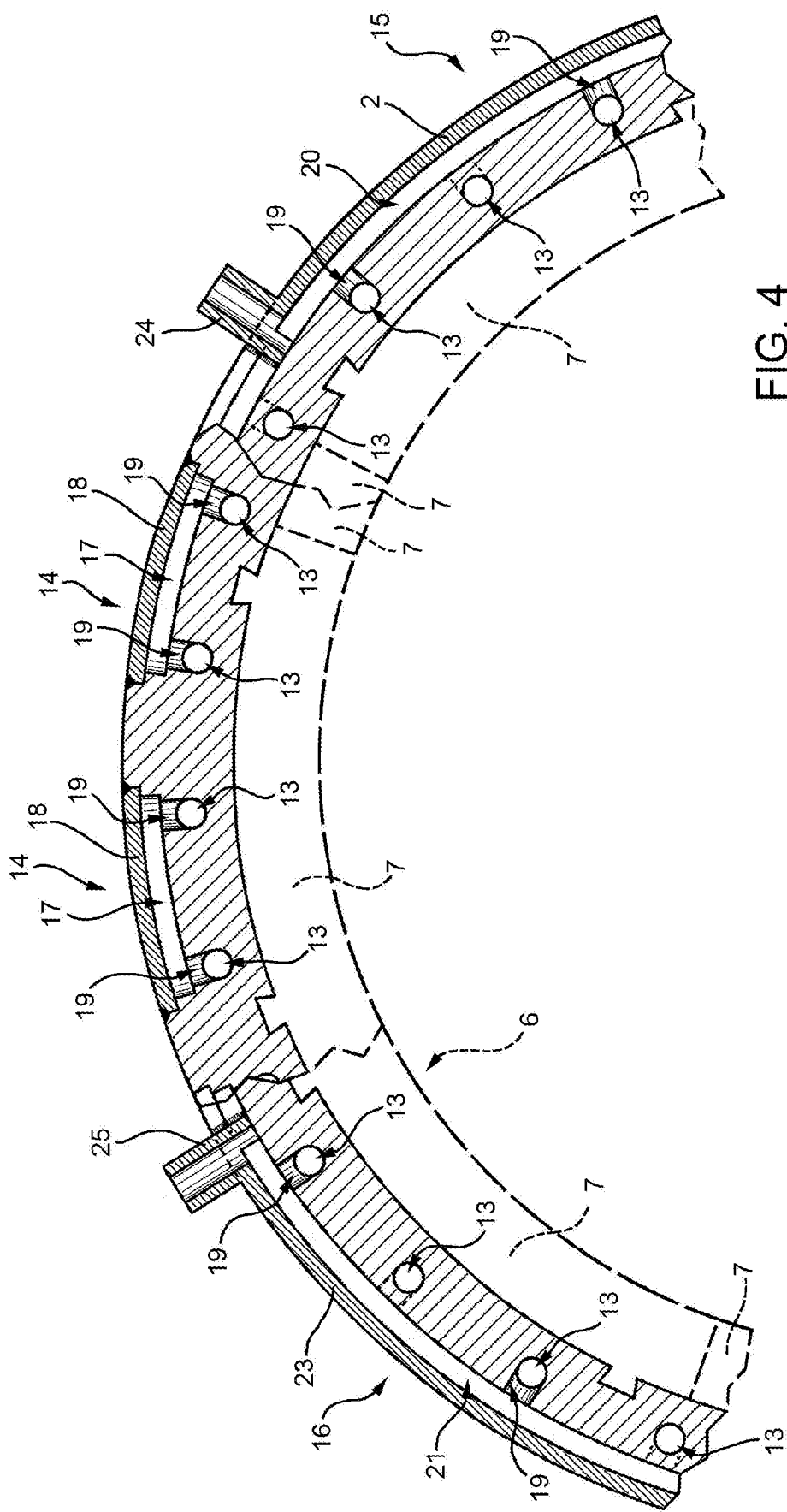


FIG. 4

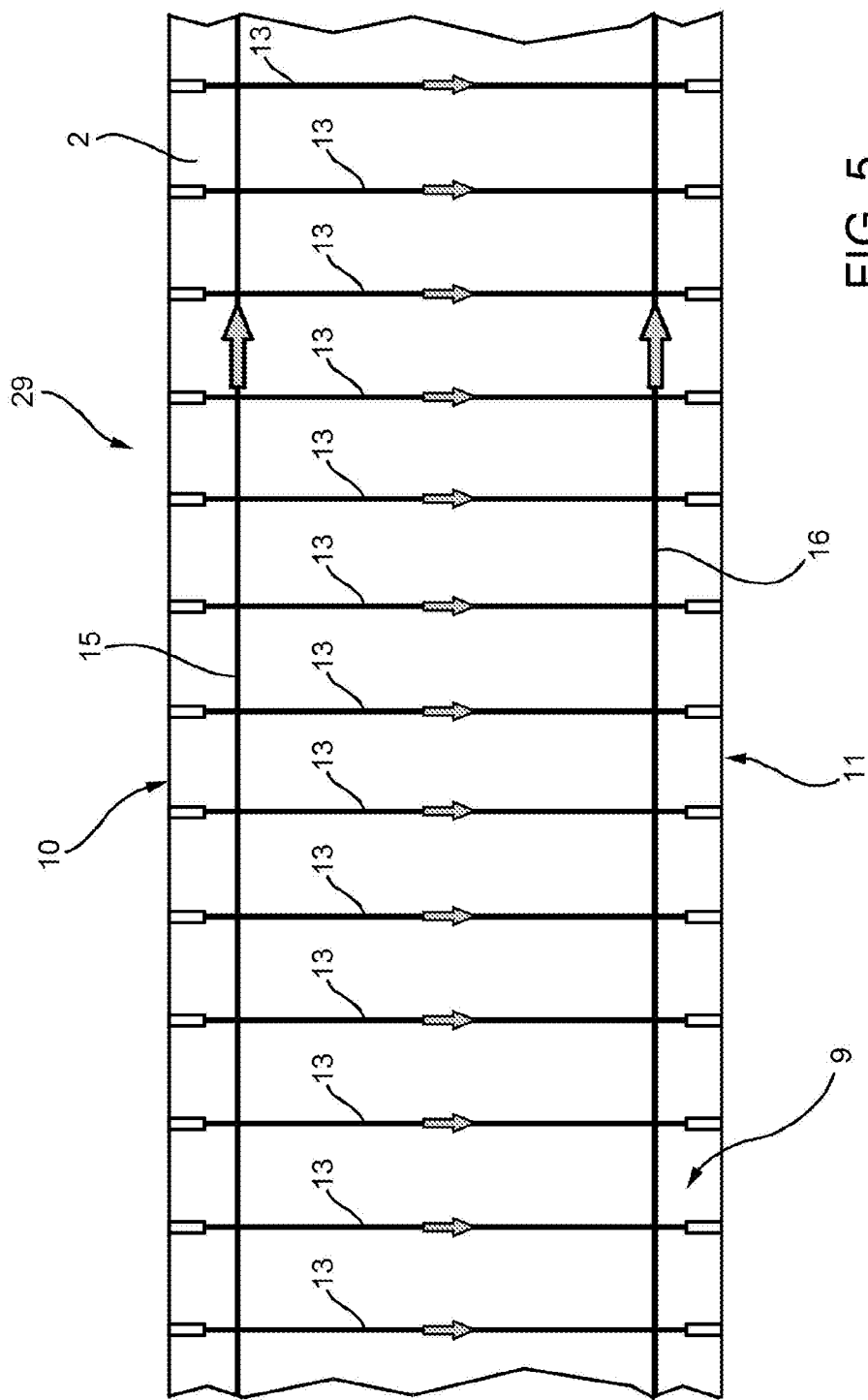


FIG. 5