



EUROPEAN PATENT APPLICATION

(43) Date of publication:
04.09.2024 Bulletin 2024/36

(51) International Patent Classification (IPC):
H01Q 15/14 (2006.01)

(21) Application number: **23461529.2**

(52) Cooperative Patent Classification (CPC):
H01Q 15/147

(22) Date of filing: **03.03.2023**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL
NO PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

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(54) **PARABOLIC REFLECTOR WITH VARIABLE SHAPE**

(57) The subject of the invention is a parabolic reflector with variable shape comprising a dome, characterised in that the dome is made of an elastic material (1), spread on highly flexible bars (3) placed in the form of a mesh created by crossing bars (3); the parabolic reflector with variable shape additionally contains a reference plate (4) with openings, through which pushers (2) connecting the reference plate (4) with the flexible material (1) pass at the points where the bars (3) cross; the pushers (2) are provided at the end connected to the point where the bars (3) cross with elements coupling

with the point where the bars (3) cross; the pushers (2) are at least partially threaded and the threaded parts pass through the reference plate (4) and are provided with nuts (6), placed on the reference plate (4) placed behind the dome; all nuts (6) lie in the same plane, and the number of nut turns (6) translates into the distance between the pusher (2) end and the reference plate (4); wherein the pushers (2) are driven by at least one step motor in order to set the position of the pusher (2) and thus the dome shape, and the dome shape is defined by the pusher (2) position relative to the reference plate (4).

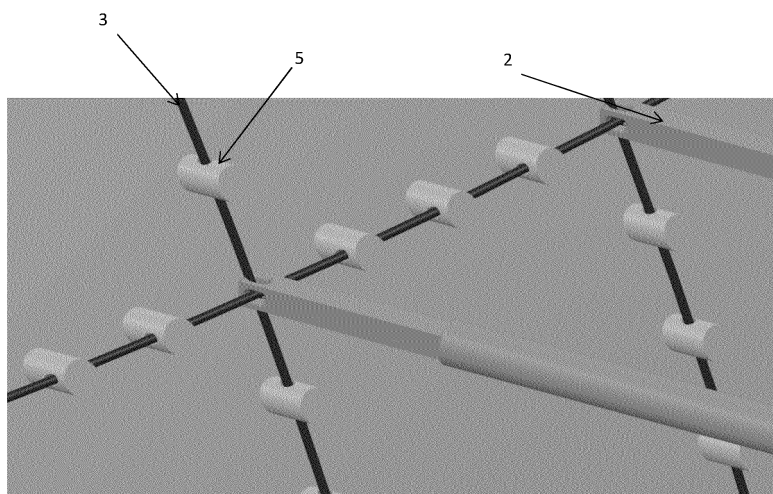


Fig. 5

Description

[0001] The subject of the invention is a parabolic reflector with variable shape.

Background of the invention

[0002] Parabolic reflectors are mainly used as light sources, mirror telescopes and radio telescopes, solar collectors and parabolic antennas.

Prior art

[0003] Known solutions are typically based on a rigid reflector design. The shape determines the parameters of the reflector and the focus position. Although several solutions of parabolic reflectors which may change their shape are known in the art, the shape change applies only to folding and unfolding of the dome, usually for the duration of transport.

[0004] The disclosure of the European patent EP2702448 discloses a folding reflector with screen spokes connected using articulated joints, as a wreath, to a bearing body, which can be used to unfold the reflective screen, in which the actuating device causes a pressure plate to move along the guiding pins, wherein the actuating device has a manually operated or motor-operated lever connected with each of the guiding pins. This solution does not include a flexible dome which enables the shape of the reflector to be changed and enables only the reflector to be folded and unfolded.

[0005] The European patent application EP3480885A1 describes a parabolic antenna spread on ribs, in the shape of a spiral.

[0006] American patent disclosures US4683475A and US4527166A describe an unfolding antenna with radial ribs.

[0007] On the other hand, the Chinese patent application CN104283000A discloses an antenna concept which is flexible before unfolding and becomes rigid after unfolding.

[0008] All cited solutions present foldable antennae with two physical states: unfolded and folded. They cannot change their shape after unfolding, however.

[0009] Thus, there is a need in the art for new designs of antennae/reflectors, which enable shape change during use.

[0010] The objective of this invention is to enable the modification of the "looking" direction of a parabolic antenna and to select the focus without the need to move the entire antenna or a boom with a converter.

[0011] This objective has been achieved with a parabolic reflector with variable shape.

Summary of the invention

[0012] Thus, the subject of the invention is a parabolic reflector with variable shape containing a dome, charac-

terised in that:

- the dome is made of a flexible material (1), which is spread on highly flexible bars (3) placed as a mesh created by crossing bars (3),
- the parabolic reflector with variable shape additionally has a reference plate (4) with openings, through which pushers (2) connecting the reference plate (4) with the flexible material (1) pass at the points where the bars cross (3),
- the pushers (2) are provided at the end connected to the bar (3) crossing point with elements coupling to the bar (3) crossing point,
- the pushers (2) are at least partially threaded and the threaded parts pass through the reference plate (4) and are provided with nuts (6), placed on the reference plate (4) located behind the dome,
- all nuts (6) lie in the same plane, and the number of nut turns (6) translates into the distance between the end of the pusher (2) and the reference plate (4),

wherein the pushers (2) are driven by at least one step motor in order to set the position of the pusher (2) and thus, the shape of the dome, while the shape of the dome is determined by the position of the pushers (2) relative to the reference plate (4).

[0013] The dome has preferably the form of a single sheet of flexible material (1).

[0014] The dome is preferably made of segments made of flexible material (1).

[0015] The front face of the flexible material (1) preferably reflects electromagnetic radiation.

[0016] The flexible material (1) is preferably an elastomer.

[0017] The front face of the elastomer is preferably coated with a material reflecting electromagnetic radiation, such as metal foil, paint containing metal particles, etc.

[0018] The bars (3) are preferably made of spring steel.

[0019] The flexible material (1) is preferably attached removably to the bars (3).

[0020] The flexible material (1) is preferably attached to the bars (3) using at least one protruding element (5) with an opening, through which the bar (3) passes, wherein the protruding element (5) is permanently attached to the flexible material (1), preferably by gluing, thermal welding or welding.

[0021] The pushers (2) are preferably equipped with a clutch uncoupling the pusher (2) drive.

[0022] Each of the pushers (2) is preferably provided with a step motor.

[0023] Each row of the pushers (2) is preferably provided with a step motor.

[0024] All pushers (2) are preferably driven by a single

step motor.

[0025] The bars (3) preferably cross one another at a right angle and the pusher (2) simultaneously shapes the horizontal and vertical bars (2).

Brief description of the figures

[0026]

Fig. 1 presents three example positions of the dome resulting in three "looking" directions of the antenna. Fig. 2 presents changes of the position of the focus resulting from the changing shape of the antenna. Fig. 3 presents the structure of a dome fragment. Fig. 4 presents an enlarged section of the dome structure according to Fig. 3. Fig. 5 presents an even more enlarged section of the dome structure according to Fig. 4. Fig. 6-9 present the translation of pusher positioning onto the dome shape.

Detailed description of the invention

[0027] This solution assumes that the dome can take any shape which can be achieved using the system including pushers and bars made of spring steel. In particular, a shape of the parabolic dome may be achieved, the focus and direction of the symmetry axis of which can be changed within a specific range. This allows the antenna to direct at various satellites without moving the satellite converter installed on a boom, but only by changing the shape of the dome. In addition, the change of the dome shape enables the parabola focus to be selected, which enables several converters to be placed on the antenna and to direct the radio waves reflected from the dome onto the selected converter by changing the dome shape.

[0028] If the dome is large enough, it may be divided and e.g. the left half of the dome can be directed towards one converter and the right half of the dome towards another converter. Thus, it is possible to divide the antenna into areas "looking" towards various satellites.

[0029] The dome of the reflector according to the invention is flexible, which enables programmed change of the shape of the reflector, and thus the direction of the reflector axis and the position of the focus.

[0030] This enables the design of a reflector e.g. in the form of a cuboid box, inside which the flexible dome and the dome shaping system are placed.

[0031] The box can be installed on a building wall. If this is a parabolic antenna reflector, the direction towards which the antenna looks can be changed without changing the position of the box. In particular, the antenna angle can be changed by changing the shape of the flexible dome.

[0032] Fig. 1 shows three positions of the dome. The first (I) at an angle -15° , the second (II) at an angle 0° , and the third (III) at an angle $+30^\circ$. The focus position

remains unchanged. This means that in the case of the antenna, the converter is permanently fixed in a single position. Thus, the antenna box and the arm with the converter remain stationary. Only the flexible dome of the reflector moves.

[0033] The flexible antenna allows for more than just rotation of the antenna dome. The change of the antenna shape allows the focus position to be changed (Fig. 2). This means that several foci can be pre-determined and several stationary converters can be placed in their positions (e.g. for various frequencies).

[0034] Such an antenna may not only change its orientation direction, but also its electric parameters by selecting one of several converters.

[0035] The flexible dome of the reflector and several converter allow, in turn, the dome to be divided into e.g. two parts, with the first part (e.g. the left part) "looks" at a satellite at an angle of e.g. -15° , while the other (e.g. the right part) looks at the satellite at an angle of $+30^\circ$. The first part projects onto a focus located e.g. 250 mm away from the neutral position of the elastomer, while the second part - onto a focus located 500 mm away. It is thus possible to simultaneously receive data from two satellites using a single antenna dome.

Example

[0036] The dome is made of an elastomer (1) spread on bars (3) made of spring steel. In another embodiment, the dome is made of a different flexible material (1). The bars (3) are bent by the pushers (2), achieving the required shape of a parabola. The elastomer (1) is provided "in the rear" with protruding elements (5) with openings, through which the bars (3) made of spring steel pass. Thanks to this, the elastomer (1) has a shape similar to a shape modelled using steel bars.

[0037] The surface of the elastomer (1) may be covered with aluminium foil or paint with high content of metal or another conductor (e.g. graphite), such that it reflects radio waves.

[0038] If the reflector should reflect light, the surface of the elastomer (1) must be coated with a substance providing a mirror effect after polishing.

[0039] The pushers (2) are provided with screws at their ends. These screws are provided with nuts (6) placed in the reference plane passing behind the dome. All nuts (6) are in the same plane. The number of nut turns (6) is translated into the distance between the end of the pusher (2) and the reference plane (4).

[0040] The following versions of pusher (2) drive are considered according to the invention:

1. Each pusher (2) is provided with an individual step motor (this is economically unfavourable, in the case of the solution presented in the Figures this means the use of 81 motors with an antenna positioning time of several seconds).
2. Each row of the pushers (2) is provided with an

individual motor (this is optimal, as in the case of the solution presented in the Figures this means the use of 9 motors with an antenna positioning time of approximately 30 seconds).

3. Only one motor driving all the pushers (2) is used (very slow setting of the dome shape - several minutes).

[0041] Since every pusher (2) may be located at a different distance from the reference plane (4), it is preferable to provide each of the pushers (2) with a clutch uncoupling the pusher (2) drive when it is not being positioned. This allows the position of individual pushers (2) to be set.

[0042] In the case with 9 motors, each of the motors drives the entire row of pushers (2), e.g. through a toothed belt and gears on the pushers. As it is not required to drive all 9 pushers simultaneously, clutches are used (one per pusher). The clutch allows the user to decide if the given pusher is driven at the given time by the pusher row motor. This allows a single pusher or a group of pushers to be controlled.

[0043] Analogously, if only one motor is used, it drives all the pushers through gears with a toothed belt. Individual clutches (e.g. electromagnetic, processor-controlled) enable the control of a single pusher or of a group of pushers.

[0044] A classical gearbox with gears or a chain gearbox can be used instead of the gear with toothed belt, etc.

[0045] Fig. 3 presents the structure of a dome section - elastomer (1), pushers (2), steel bars (3) and the reference plate (4). Fig. 3 shows the dome with dimensions 1000 x 1000 mm, provided with 81 pushers (2) placed in 9 rows and 9 columns.

[0046] In the rear of the elastomer (1) (on the side of the reference plate (4)), protruding elements (5) with openings for steel bars (3) are provided, which ensure shape transfer from the bars (3) onto the elastomer (1). This is shown in Fig. 4.

[0047] Steel bars (3) pass through the end of the pusher (2): horizontal and vertical (Fig. 5).

[0048] The steel bars (3) "model" the shape of the curve (parabola) (Fig. 6-9).

Claims

1. A parabolic reflector with variable shape comprising a dome, **characterised in that**

- the dome is made of a flexible material (1), which is spread on highly flexible bars (3) placed as a mesh created by crossing bars (3),
- the parabolic reflector with variable shape additionally has a reference plate (4) with openings, through which pushers (2) connecting the reference plate (4) with the flexible material (1) pass at the points where the bars cross (3),

- the pushers (2) are provided at the end connected to the bar (3) crossing point with elements coupling to the bar (3) crossing point,
- the pushers (2) are at least partially threaded and the threaded parts pass through the reference plate (4) and are provided with nuts (6), placed on the reference plate (4) located behind the dome,
- all nuts (6) lie in the same plane, and the number of nut turns (6) translates into the distance between the end of the pusher (2) and the reference plate (4),

wherein the pushers (2) are driven by at least one step motor in order to set the position of the pusher (2) and thus, the shape of the dome, while the shape of the dome is determined by the position of the pushers (2) relative to the reference plate (4).

2. A parabolic reflector with variable shape according to Claim 1, **characterised in that** the dome has the form of a single sheet of flexible material (1).
3. A parabolic reflector with variable shape according to Claim 1, **characterised in that** the dome is made of segments made of flexible material (1).
4. A parabolic reflector according to any of the Claims 1-3, **characterised in that** the front face of the flexible material (1) reflects electromagnetic radiation.
5. A parabolic reflector according to any of the Claims 1-4, **characterised in that** the flexible material (1) is an elastomer.
6. A parabolic reflector according to any of the Claims 1-5, **characterised in that** the front face of the elastomer is coated with a material reflecting electromagnetic radiation, such as metal foil, paint containing metal particles, etc.
7. A parabolic reflector according to any of the Claims 1-6, **characterised in that** the bars (3) are made of spring steel.
8. A parabolic reflector according to any of the Claims 1-7, **characterised in that** the flexible material (1) is attached removably to the bars (3).
9. A parabolic reflector according to any of the Claims 1-8, **characterised in that** the flexible material (1) is attached to the bars (3) using at least one protruding element (5) with an opening, through which the bar (3) passes, wherein the protruding element (5) is permanently attached to the flexible material (1), preferably by gluing, thermal welding or welding.
10. A parabolic reflector according to any of the Claims

1-9, **characterised in that** the pushers (2) are equipped with a clutch uncoupling the pusher (2) drive.

11. A parabolic reflector according to any of the Claims 1-10, **characterised in that** each of the pushers (2) is provided with a step motor. 5
12. A parabolic reflector according to any of the Claims 1-10, **characterised in that** each row of the pushers (2) is provided with a step motor. 10
13. A parabolic reflector according to any of the Claims 1-10, **characterised in that** all pushers (2) are driven by a single step motor. 15
14. A parabolic reflector according to any of the Claims 1-13, **characterised in that** the bars (3) cross one another at a right angle and the pusher (2) simultaneously shapes the horizontal and vertical bars (2). 20

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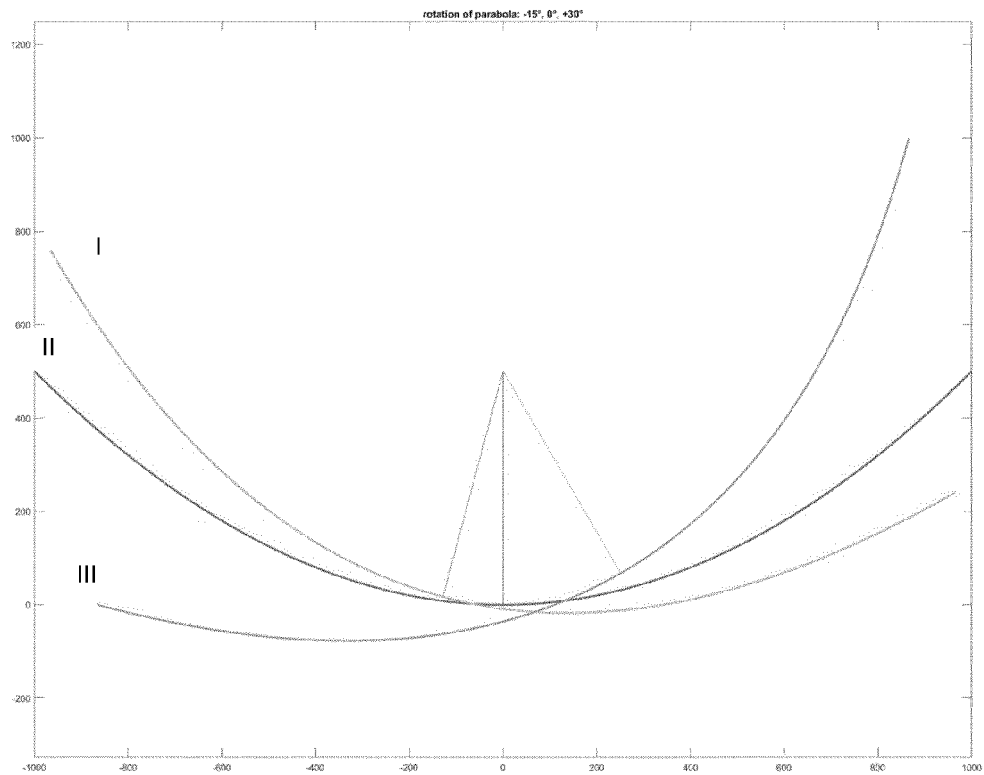


Fig. 1

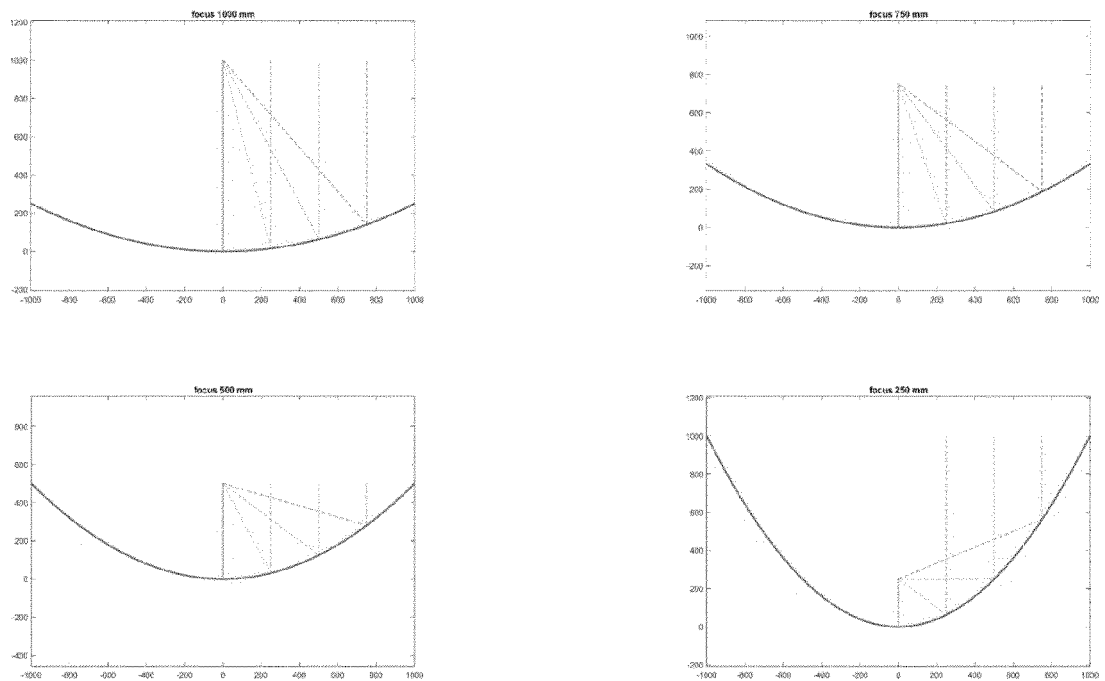


Fig. 2

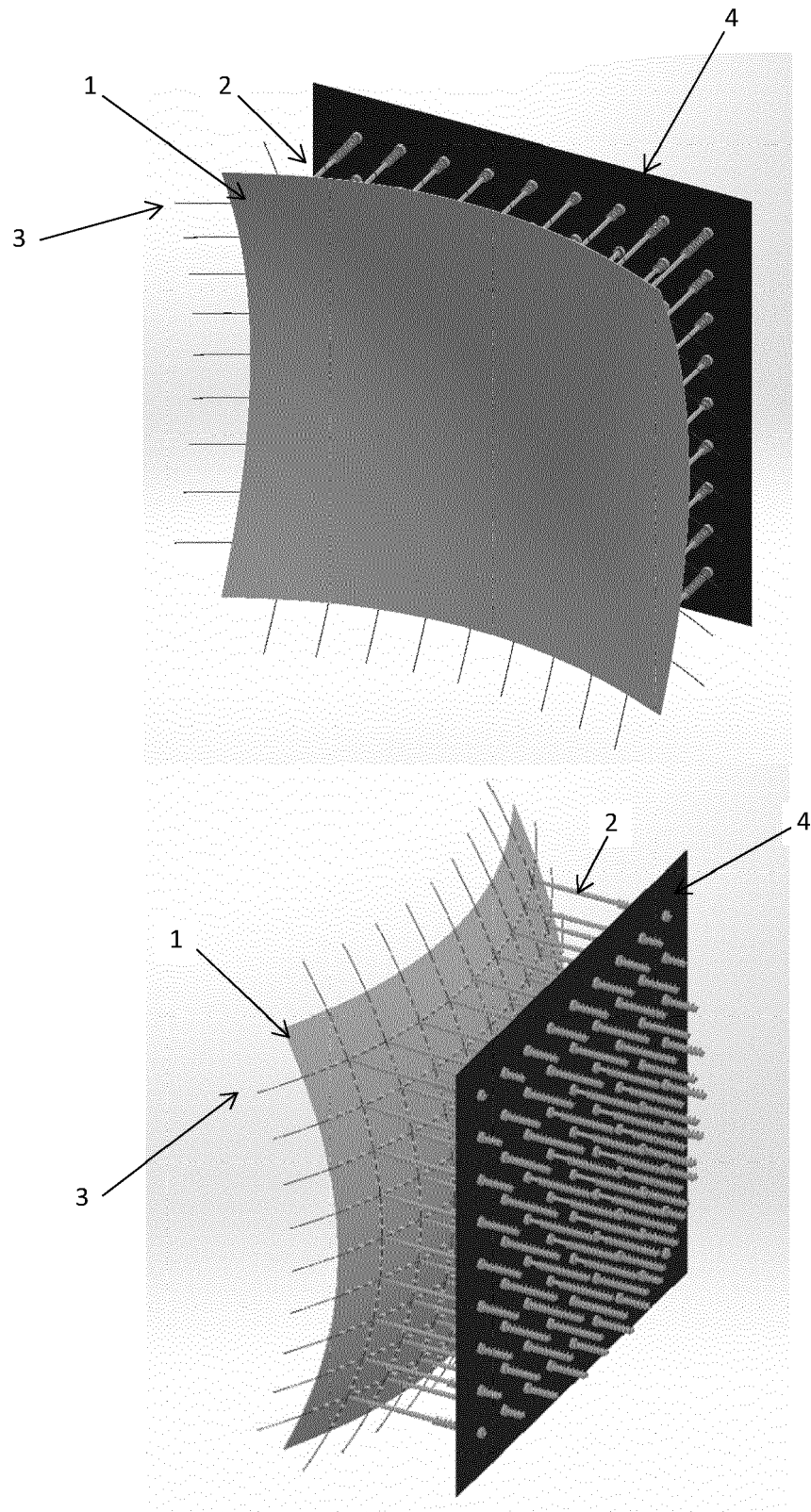


Fig. 3

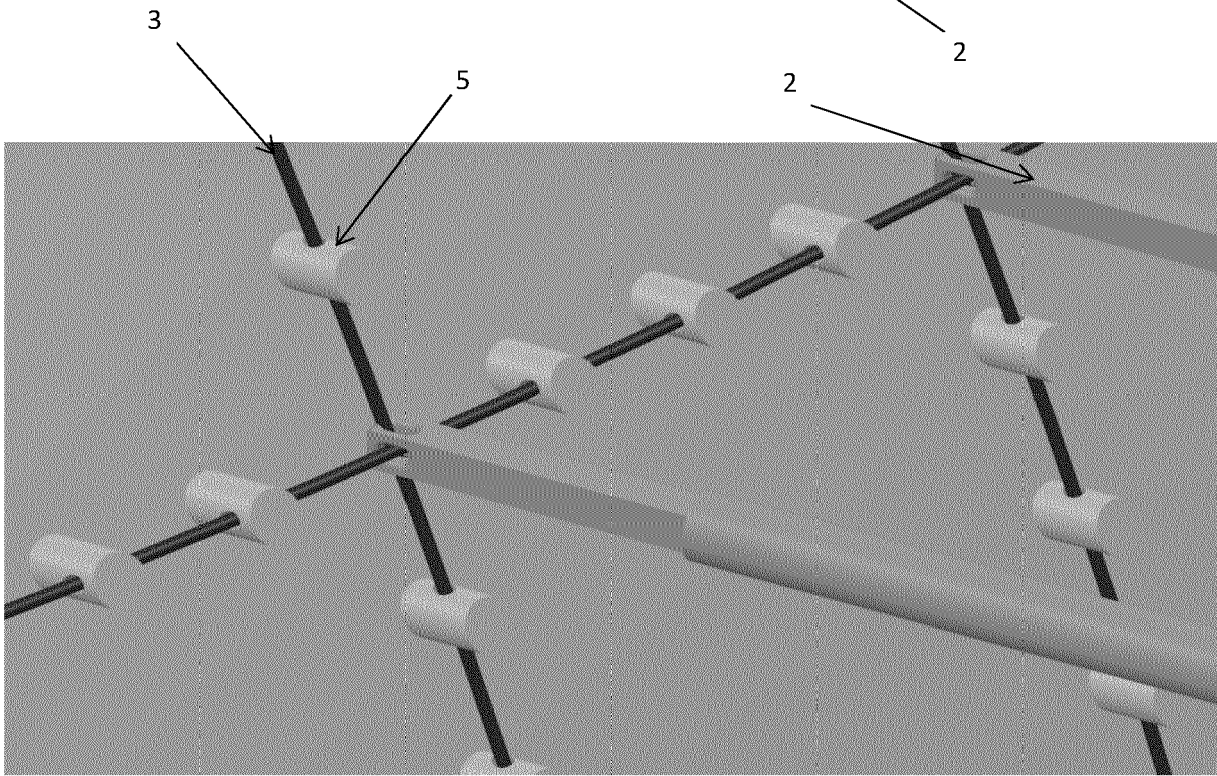
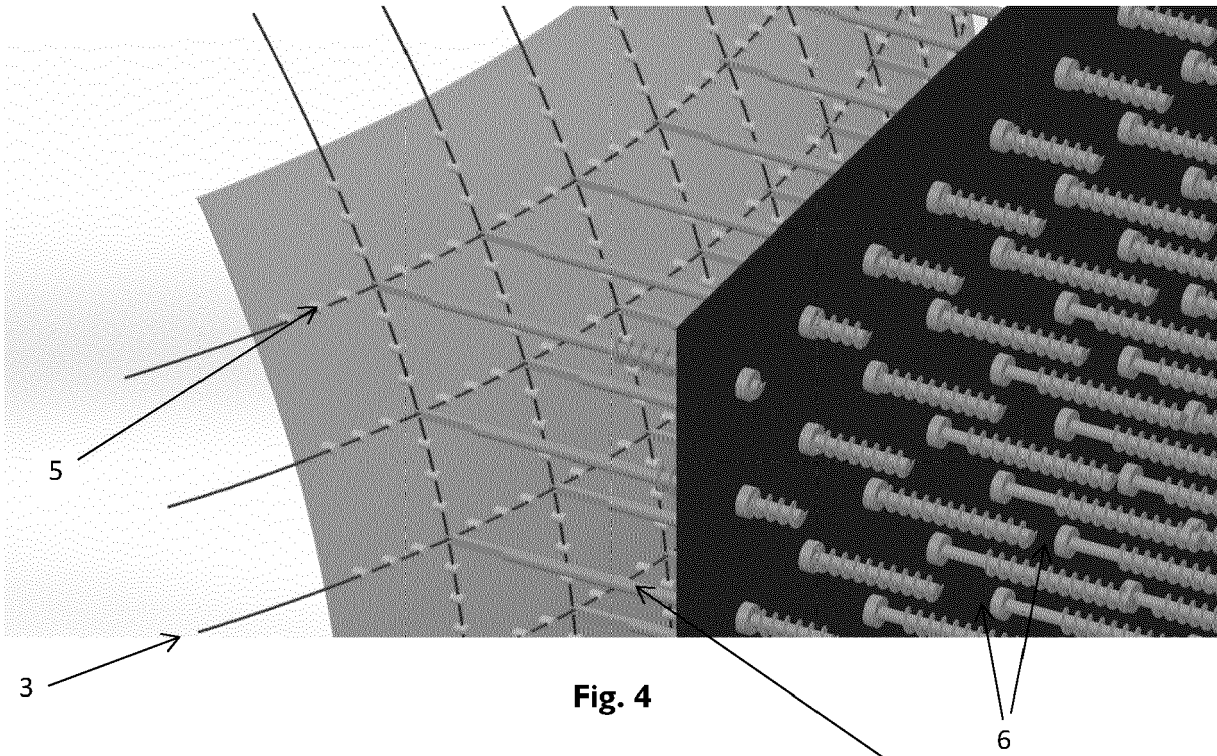


Fig. 5

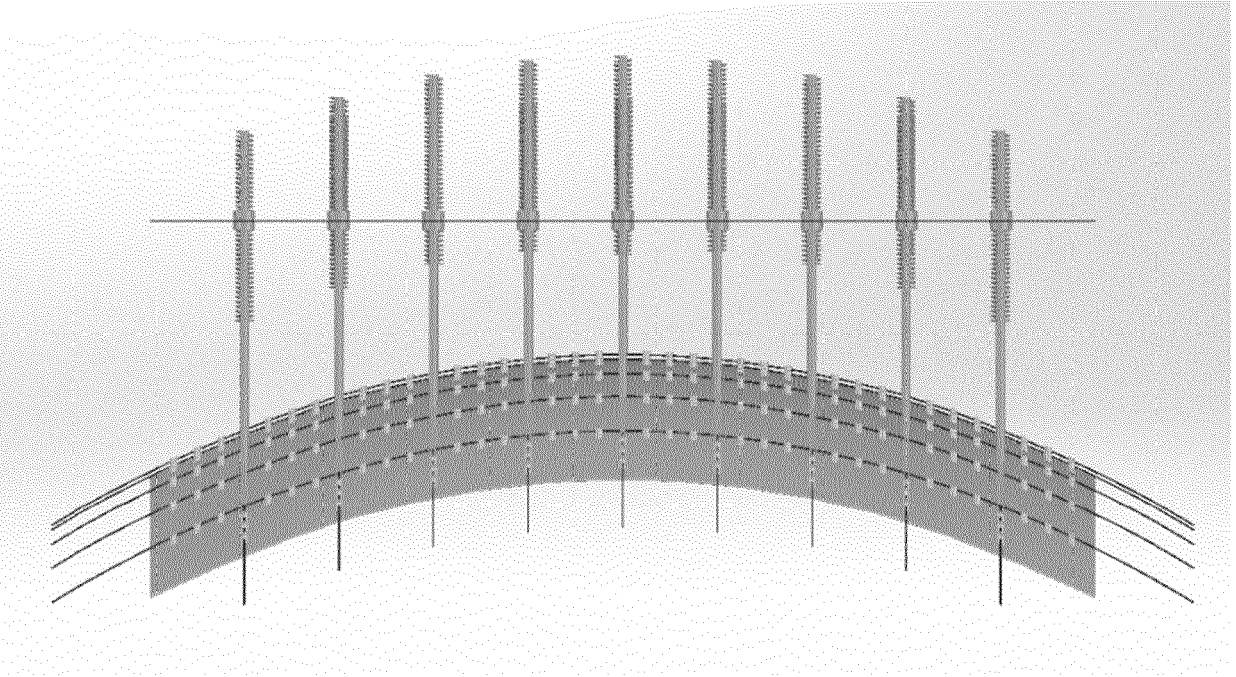


Fig. 6

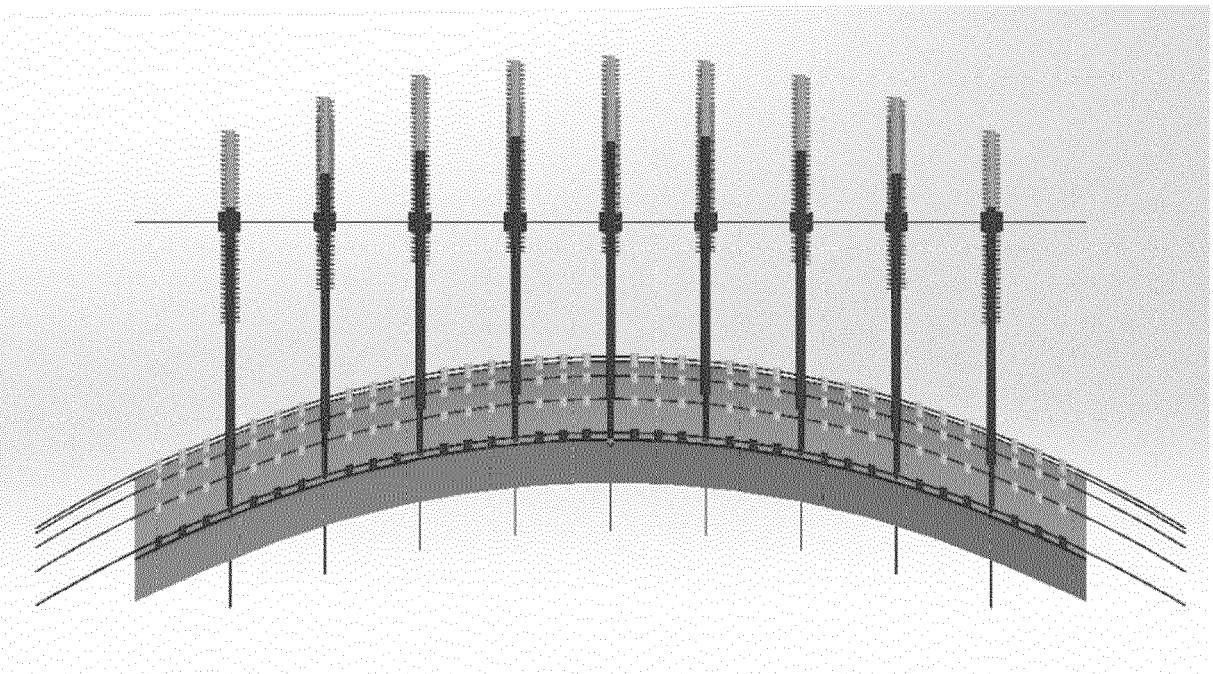


Fig. 7

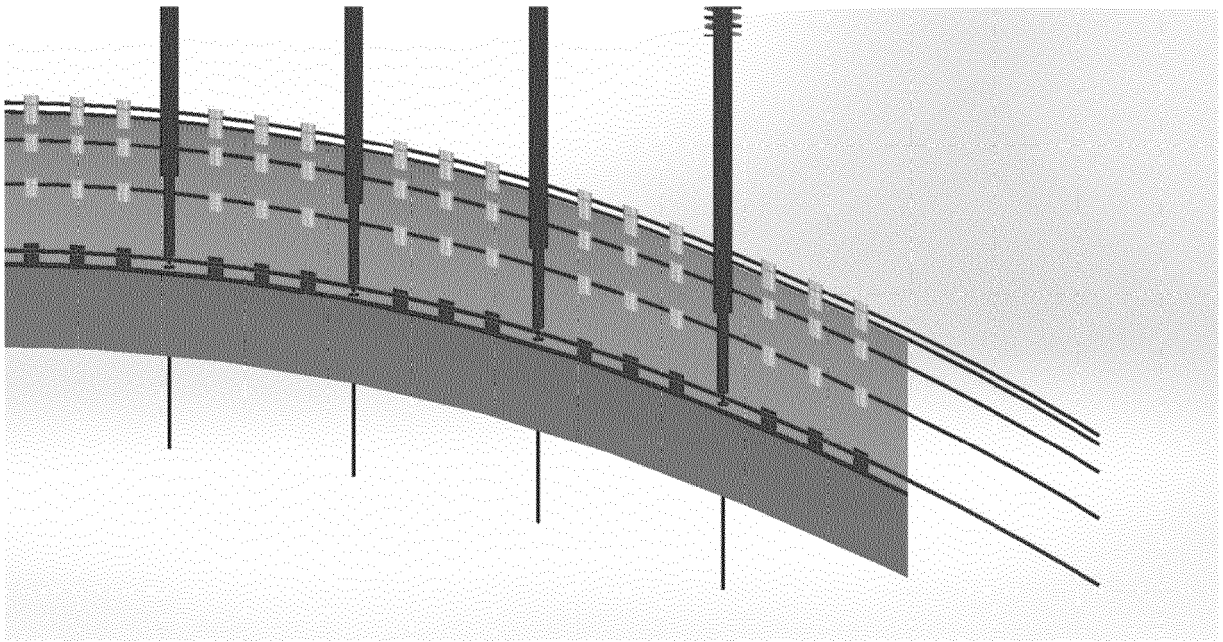


Fig. 8

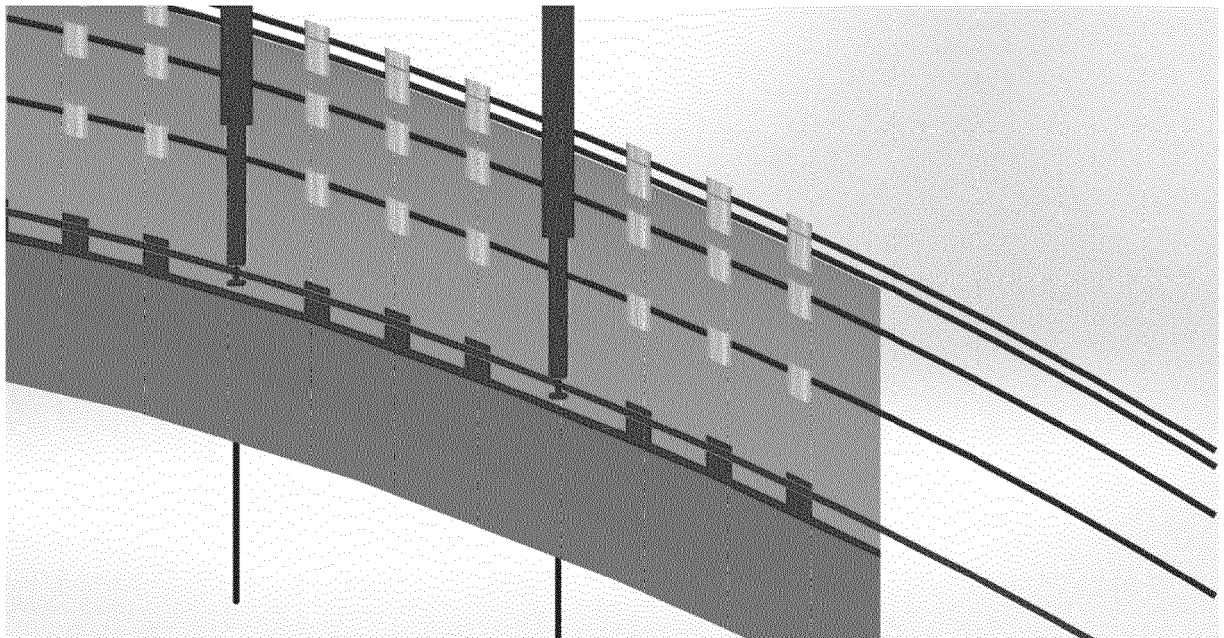


Fig. 9



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Application Number

EP 23 46 1529

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EPO FORM 1503 03.82 (P04C01)

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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 8 August 2023	Examiner Taddei, Ruggero
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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