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(54) Method for manufacturing large metallic tubular piece, and large metallic tubular piece

(57) The present invention relates to metal technology and to manufacture of large metal pieces, and in particular to manufacture of large metallic sleeve pieces, the large metallic sleeve pieces being suitable for various flow applications, such as those in marine technology and process technology, and to manufacturing methods of these large metallic sleeve pieces. The large, metallic sleeve piece of the invention comprises a sleeve structure (13), (15) made of metal plate, the inner surface of the sleeve structure being formed by means of forming rolls (7 to 12) such that the metallic sleeve piece has assumed its inwardly convex shape.

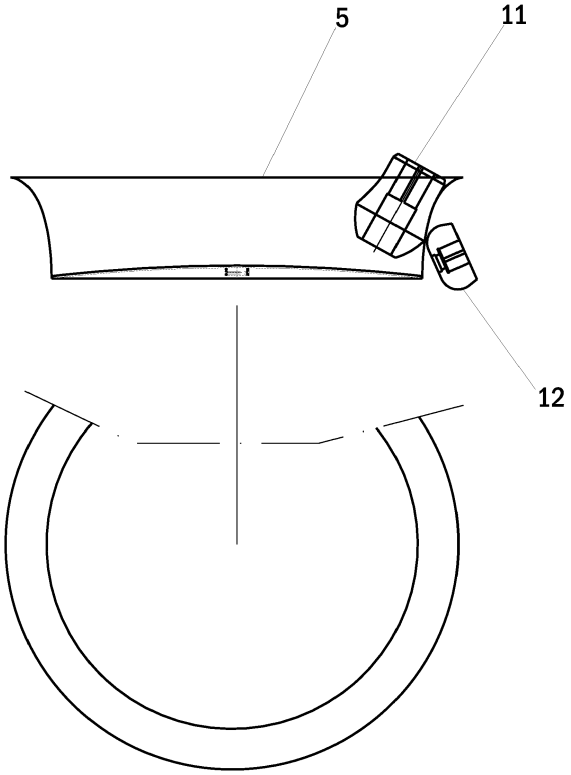

Fig. 7

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Description

Field of the invention

[0001] The invention relates to metal technology and to manufacture of large metal pieces, and in particular to manufacture of large metallic sleeve pieces, the large metallic sleeve pieces being suitable for various flow applications, such as those of marine technology and process technology, and to manufacturing methods of these large metallic sleeve pieces.

Background of the invention

[0002] Flow-controlling, large, metallic sleeve pieces are needed in flow applications used in many fields of technology. For instance, large metallic sleeve pieces are needed in applications of process flow technique, in which the flowing substance may be a liquid or a gas, such as water, air, natural gas or oil. Large, metallic sleeve pieces are also needed, for instance, in marine technology applications, such as in current control of large vessel propellers. Further, in marine technology and off-shore technology, for instance, in oil drilling rigs, there are several flow applications, in which large, metallic sleeve pieces are needed for controlling the flow.

[0003] In particular, in demanding and critically important applications extremely high structural strength is required of large, metallic sleeve pieces. The claimed, large, metallic sleeve pieces are employed, in particular, in applications, in which the flowing substance changes direction and/or flow intensity, which poses additional requirements for the shape of the large, metallic sleeve piece because of flow dynamics. If the direction and/or flow intensity of the substance flowing in the application cannot be changed in a controllable manner, extra flow variations and turbulences will occur, which produce additional stresses and disturbances in the application, load the structures of the application and, in the worst case, may cause faults in the application.

[0004] The large, metallic sleeve pieces, suitable for demanding applications, are 1 to 10 metres in diameter, typically 3 to 6 metres in diameter. A large, metallic sleeve piece of this kind is large in size and because of high structural strength requirements the large, metallic sleeve piece is 4 to 50 mm in thickness, typically 8 to 30 mm in thickness.

[0005] In prior art, large, metallic sleeve pieces suitable for demanding applications, have been manufactured of segments. For one large metallic sleeve there are typically manufactured 8 to 10 press-moulded segment parts, which are interconnected by welding according to prior art. A drawback with the prior art manufacturing method is that the form surface of the sleeve structure is non-uniform. The inner surface, i.e. the form surface, of current, large, metallic sleeve pieces of prior art is not regular, round and annular in shape. In a flow application, non-uniformity of the form surface causes extra flow variations and turbulences which produce additional stresses and disturbances in the application. In addition, in a large, metallic sleeve piece of prior art the seams are subject to stress. A so-called "nut-shaped", large, metallic sleeve piece of prior art is also difficult to manufacture to conform to the strict rotation tolerance requirements of the field. Prior art methods for manufacturing metallic pieces have also been disclosed in patent publications WO 2009/069920 A2, US 3,418,707, US 3,623,349 and SE 356,233 B.

[0006] In many fields of technology, such as marine technology and process technology there is a clear need and demand for large, metallic sleeve pieces of a new type to be used in flow applications, by means of which sleeve pieces it is possible to achieve a sufficient structural strength and a sufficient uniformity of the form surface in the sleeve structure.

Brief description of the invention

[0007] The object of this invention is to provide a novel method for manufacturing a large, metallic sleeve piece of a metal plate, and a novel, large metallic sleeve piece made of a metal plate.

[0008] The method of the invention for manufacturing a large, metallic sleeve piece of a metal plate is characterized by comprising the steps of:

- making a starting preform of the metal plate and
- forming a form surface of the large, metallic sleeve piece from the starting preform by means of forming rolls such that the metallic sleeve piece becomes inwardly convex.

[0009] The large, metallic sleeve piece made of the metal plate in accordance with the invention is characterized in that said metallic sleeve piece comprises:

- a sleeve structure made of metal plate, the inner surface of the sleeve piece being formed by means of forming rolls such that the metallic sleeve piece has assumed its inwardly convex shape.

[0010] There is now developed an improved solution for manufacturing a metallic sleeve piece of a metal plate and an improved solution for a large, metallic sleeve piece made of the metal plate. The solution is characterised by what is stated in the independent claims. Some preferred embodiments of the invention are disclosed in the dependent claims.

[0011] The present invention provides several advantages which will become apparent from the detailed description. By means of the large, metallic sleeve piece of the invention it is possible to achieve very high uniformity in the form surface of the sleeve structure and a regular, round, annular shape, thanks to which it is possible to minimize extra flow variations and turbulences in the application as well as additional stresses and disturbances

resulting therefrom. A frame-steered transportation device of the invention is also structurally strong.

Brief description of the figures

[0012] Some embodiments of the invention will now be described in greater detail by means of some preferred embodiments, with reference to the attached drawings, in which

Figure 1 shows a solution in accordance with a method of the invention how to assemble a starting preform for a large, metallic sleeve piece, made of a metal plate, from a plurality of separate preform blocks or segments.

Figure 2 is a side view, in relation to flow direction, of the starting preform for the large, metallic sleeve piece made of the metal plate in accordance with a method of the invention.

Figure 3 is a view in flow direction of the starting preform for the large, metallic sleeve piece made of the metal plate in accordance with a method of the invention.

Figure 4 is a side view, in relation to flow direction, of a solution to mount a supplementary bending plate for the starting preform of the large, metallic sleeve piece in accordance with a method of the invention.

Figure 5 is a side view, in relation to flow direction, of a solution for preliminary bending of a form surface of the large, metallic sleeve piece in accordance with a method of the invention.

Figure 6 is a side view, in relation to flow direction, of a solution to gauge form an upper part of the form surface of the large, metallic sleeve piece in accordance with a method of the invention.

Figure 7 is a side view, in relation to flow direction, of a solution to gauge form a middle part/lower part of the form surface of the large, metallic sleeve piece in accordance with a method of the invention.

Figure 8 shows a solution, by way of example, how to use the large, metallic sleeve piece of the invention in an application of marine technology.

Figure 9 shows, by way of example, inclination design of the large, metallic sleeve piece of the invention.

Detailed description of an embodiment of the invention

[0013] In the method of the invention for manufacturing a large, metallic sleeve piece, there is first provided a string of preform blocks or segments, of which the large, metallic sleeve piece is to be formed. In the method of the invention, the string of preform blocks or segments made of a metal plate may be assembled from a plurality of separate preform blocks or segments.

[0014] Figure 1 shows a solution in accordance with a method of the invention how to assemble the string of preform blocks or segments for a large, metallic sleeve piece, made of a metal plate, from a plurality of separate preform blocks or segments. In the method of the invention for manufacturing the large, metallic sleeve piece there is typically taken one to sixteen, typically one to six, preform blocks or segments 1 to 4, of which there is first formed a string of preform blocks or segments of a metal plate. The dimensions w_{sa}, h_{sa} and l_{sa} of the preform blocks or segments are appropriately selected in view of the dimensions of a completed, large, metallic sleeve piece. The preform blocks or segments 1 to 4 are interconnected by welding as a sheet. A string of preform blocks or segments, which is welded as the sheet from the preform blocks or segments 1 to 4, may be joined to form a starting preform. The thickness of the metal plate is suitably selected in view of the plate thickness required for the completed, large, metallic sleeve piece. For the large, metallic sleeve piece of the invention the plate thickness may be selected to be 4 to 50 mm, typically the plate thickness is selected to be 8 to 30 mm.

[0015] Figure 2 is a side view, in relation to flow direction, of the starting preform for the large, metallic sleeve piece made of the metal plate in accordance with a method of the invention. In the method of the invention for manufacturing the large, metallic sleeve piece the string of preform blocks or segments, typically consisting of preform blocks or segments 1 to 4, is rolled into the shape of a cylinder or cone and joined into a starting preform 5. The dimensions D_{ak} and d_{ak} of the preform 5 are to a great extent defined by the dimensions w_{sa}, h_{sa} and l_{sa} of the preform blocks or segments, which dimensions are suitably selected in view of those of the completed, large, metallic sleeve piece. The string of preform blocks or segments that is rolled into a cylinder or cone may be joined into the starting preform 5 by welding it at the seam.

[0016] Figure 3 shows the starting preform for the large, metallic sleeve piece made of the metal plate in accordance with a method of the invention, seen in the flow direction. In the method of the invention for manufacturing the large, metallic sleeve piece the starting preform, typically consisting of preform blocks or segments 1 to 4, is rolled into the shape of a cylinder or cone and joined into a starting preform 5. The dimensions D_{ak} and d_{ak} of the starting preform 5 are to a great extent defined by the dimensions w_{sa}, h_{sa} and l_{sa} of the preform blocks or segments, which measures are suitably selected in view of those of the completed, large, metallic sleeve piece.

[0017] Figure 4 shows a side view, in relation to flow direction, of a solution in accordance with a method of the invention for mounting a supplementary bending plate for the starting preform of the large, metallic sleeve piece. In the method of the invention on the starting preform 5 provided for manufacturing the large, metallic sleeve piece, there is typically mounted a supplementary bending plate 6 of fabrication phase. The supplementary bending plate 6 is a substantially circular piece made of a metal plate. The supplementary bending plate 6 typi-

cally closes one end of the starting preform 5 of the sleeve piece. By means of the supplementary bending plate it is easier to handle the starting preform 5 of the large, metallic sleeve piece during the manufacturing process. In the figure, the dimensions h_{ak}, w_{ak}, D_{ak} and d_{ak} of the starting preform 5 are to a great extent defined by the dimensions w_{sa}, h_{sa} and l_{sa} of the preform blocks or segments, which dimensions are suitably selected in view of those of the completed, large, metallic sleeve piece. The supplementary bending plate 6 of the starting preform 5 is mounted by welding, for instance. At the joint of the supplementary bending plate 6 it is possible to leave a working allowance d_{work}.

[0018] Next, the starting preform of the metallic sleeve piece is formed into a large, metallic sleeve piece by forming, e.g. cold forming, the inner surface, i.e. the form surface, of the starting preform such that the metallic sleeve piece becomes inwardly convex. The large, metallic sleeve piece of the invention is worked inwardly convex into a so-called "trumpet form". When the large, metallic sleeve piece of the invention is formed, it is possible to perform first a preliminary bending of the form surface of the large, metallic sleeve piece and thereafter the actual gauge forming of the form surface of the large, metallic sleeve piece.

[0019] Figure 5 is a side view, in relation to flow direction, of preliminary bending of the form surface of the large, metallic sleeve piece in accordance with a method of the invention. In the method of the invention for manufacturing a large, metallic sleeve piece, in the preliminary bending of the starting preform 5 of the large, metallic sleeve piece the desired form surface of the large, metallic sleeve piece is formed by means of preliminary bending rolls 7 and 8, which are used as the forming rolls.

[0020] Next, the large, metallic sleeve piece is subjected to the actual gauge forming of the form surface. When the large, metallic sleeve piece of the invention is formed, the actual gauge forming of the form surface of the large, metallic sleeve piece may be performed in two phases. For instance, it is possible to perform the gauge forming of the upper part of the form surface of the metallic sleeve piece, and thereafter, it is possible to perform the gauge forming of the middle/lower part of the form surface of the metallic sleeve piece.

[0021] Figure 6 is a side view, in relation to flow direction, of a solution for gauge forming an upper part of the form surface of the large, metallic sleeve piece in accordance with a method of the invention. In the method of the invention for manufacturing a large, metallic sleeve piece, in the gauge forming of the upper part of the form surface of the metallic sleeve piece, the desired form surface is formed by means of shape rolls 9 and 10, which are used as forming rolls.

[0022] Figure 7 is a side view, in relation to flow direction, of a solution for gauge forming a middle part/lower part of the form surface of the large, metallic sleeve piece in accordance with a method of the invention. In the method of the invention for manufacturing a large, metallic sleeve piece, in the gauge forming of the upper part of the form surface of the metallic sleeve piece, the desired form surface is formed by means of shape rolls 11 and 12, which are used as forming rolls.

[0023] Then, the completely formed, large, metallic sleeve piece is provided with support structures and an optional outer shell. When necessary, a surface finishing and painting may also be performed on the large, metallic sleeve piece.

[0024] Figure 8 shows a solution, by way of example, how to use the large, metallic sleeve piece of the invention in an application of marine technology. The application of marine technology shown in the figure describes, by way of example, a large, metallic sleeve piece 13 of the invention mounted in connection with the Azimuth thruster 14 of an ocean-going vessel.

[0025] Figure 9 shows, by way of example, inclination design of the large, metallic sleeve piece of the invention. The figure shows, by way of example, a large, metallic sleeve piece 15 in accordance with the invention. The overall inclination of the large, metallic sleeve piece 15 is indicated by angle θ. The overall inclination θ of the large, metallic sleeve piece of the invention may be, for instance, within the range of 5° to 75°, typically within the range of 10° to 45°.

[0026] The large, metallic sleeve piece of the invention may also be manufactured modularly by combining a plurality of large, metallic sleeve pieces into one large, metallic sleeve piece.

[0027] The large, metallic sleeve piece of the invention may be used in a variety of process flow technique applications, in which the flowing substance may be a desired liquid or gas, such as water, air, natural gas or oil. The large, metallic sleeve piece of the invention is particularly well suited for use in a variety of marine and offshore technology applications, such as for mounting in connection with large propellers of vessels or current applications of oil drilling rigs.

[0028] By means of the large, metallic sleeve piece of the invention it is possible to achieve extremely high structural strength required by demanding applications. By means of the large, metallic sleeve piece of the invention extra flow variations and turbulences will be avoided. This, in turn, reduces additional stresses and disturbances in the application, reduces the load, to which the structures of the application are subjected, and the resulting faults.

[0029] The large, metallic sleeve piece of the invention is well suited for use in demanding applications. The large, metallic sleeve piece of the invention may be 1 to 10 metres in diameter, typically 3 to 6 metres in diameter. The thickness of the large metallic sleeve piece of the invention may be 4 to 50 mm, typically it may be 8 to 30 mm in thickness.

[0030] The large, metallic sleeve piece of the invention is well suited for various applications, where the required overall inclination of the form surface is within the range of 5° to 75°, typically within the range of 10° to 45°.

[0031] By means of the method of the invention it is possible to provide a large, metallic sleeve piece, which advantageously allows sufficient structural strength and sufficient uniformity of the form surface of the sleeve structure to be achieved.

Claims

1. A method for manufacturing a large, metallic sleeve piece of a metal plate, **characterized in that** the method comprises the steps of:

   - making a starting preform (5) out of the metal plate and
   - forming a form surface of the large, metallic sleeve piece (13), (15) from the starting preform (5) by means of forming rolls (7 to 12) such that the metallic sleeve piece becomes inwardly convex.

2. The method of claim 1, **characterized in that** when the starting preform is fabricated, one to sixteen, typically one to six preform blocks or segments (1 to 4) are combined into the starting preform by welding them to one another.

3. The method of claim 2, **characterized in that** the starting preform is rolled into a cylindrical or conical shape and joined into the starting preform (5).

4. The method of claim 1, 2 or 3, **characterized in that**, when the form surface is rolled, there is first performed preliminary bending of the form surface by means of preliminary bending rolls (7 to 8) and thereafter the actual gauge forming of the form surface by means of shape rolls (9 to 12).

5. The method of claim 4, **characterized in that** in gauge forming of the form surface there is first performed gauge forming of the upper part of the form surface by means of the shape rolls (9 to 10) and thereafter gauge forming of the middle/lower part of the form surface by means of the shape rolls (11 to 12).

6. The method of any one of the preceding claims 1 to 5, **characterized in that** the large, metallic sleeve piece is manufactured modularly by combining a plurality of large, metallic sleeve pieces (13), (15) into one large, metallic sleeve piece.

7. The method of any one of the preceding claims 1 to 6, **characterized in that** support structures and/or an outer shell is mounted on the large, metallic sleeve piece (13), (15).

8. The method of any one of the preceding claims 1 to 7, **characterized in that** a surface finishing and/or painting is performed on the large, metallic sleeve piece (13), (15).

9. The method of any one of the preceding claims 1 to 8, **characterized in that** the manufacturing of the metallic sleeve piece (13), (15) employs a substantially circular, supplementary bending plate (6) of fabrication phase, made of metal plate.

10. A large, metallic sleeve piece, made of metal plate, **characterized in that** the metallic sleeve piece comprises:

    - a sleeve structure (13), (15) made of metal plate, the inner surface of the sleeve structure being formed by means of forming rolls (7 to 12) such that the metallic sleeve piece has assumed its inwardly convex shape.

11. The large, metallic sleeve piece of claim 10, **characterized in that** the large, metallic sleeve piece is manufactured modularly by combining a plurality of large, metallic sleeve pieces (13), (15) into one large, metallic sleeve piece.

12. The large, metallic sleeve piece of claim 10 or 11, **characterized in that** the large, metallic sleeve piece also comprises support structures and/or an outer shell for the metallic sleeve piece (13).

13. The large, metallic sleeve piece of any one of the preceding claims 10 to 12, **characterized in that** the metallic sleeve piece (13), (15) is provided with surface finishing and/or painting.

14. The large, metallic sleeve piece of any one of the preceding claims 10 to 13, **characterized in that** the metallic sleeve piece (13), (15) is 1 to 10 metres in diameter.

15. The large, metallic sleeve piece of any one of the preceding claims 10 to 13, **characterized in that** the metallic sleeve piece (13), (15) is 3 to 6 metres in diameter.

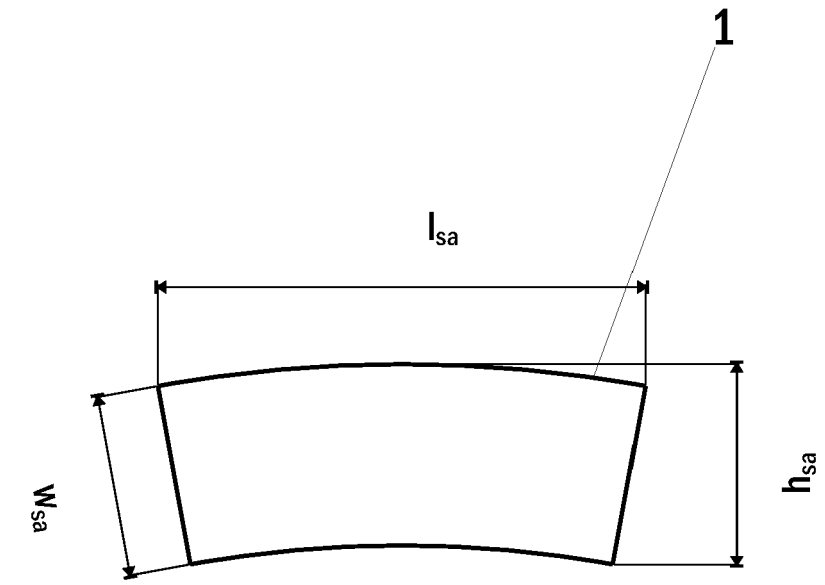
16. The large, metallic sleeve piece of any one of the preceding claims 10 to 15, **characterized in that** the metallic sleeve piece (13), (15) is 4 to 50 millimetres in thickness.

17. The large, metallic sleeve piece of any one of the preceding claims 10 to 15, **characterized in that** the metallic sleeve piece (13), (15) is 8 to 30 millimetres in thickness.

18. The large, metallic sleeve piece of any one of the preceding claims 10 to 17, **characterized in that**

the overall inclination of the metallic sleeve piece (13), (15) is within the range of 5° to 75°.

19. The large, metallic sleeve piece of any one of the preceding claims 10 to 17, **characterized in that** the overall inclination of the metallic sleeve piece (13), (15) is within the range of 10° to 45°.



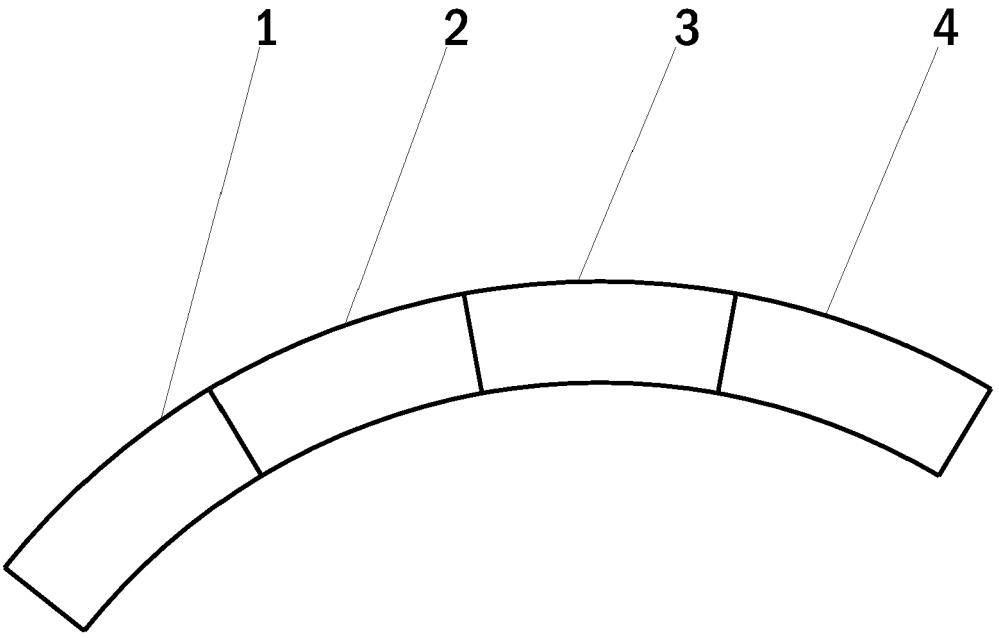


Fig. 1

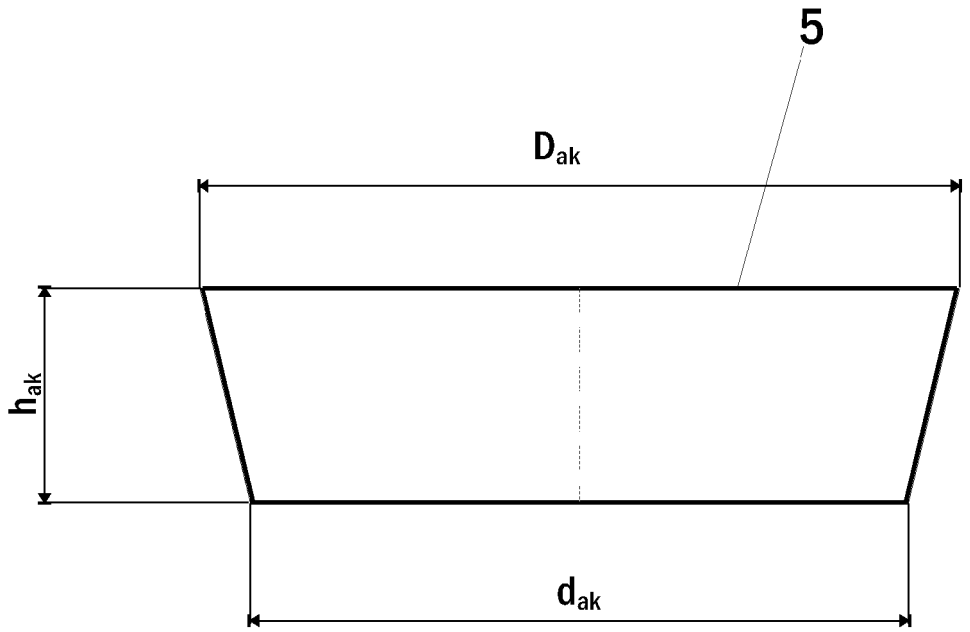


Fig. 2

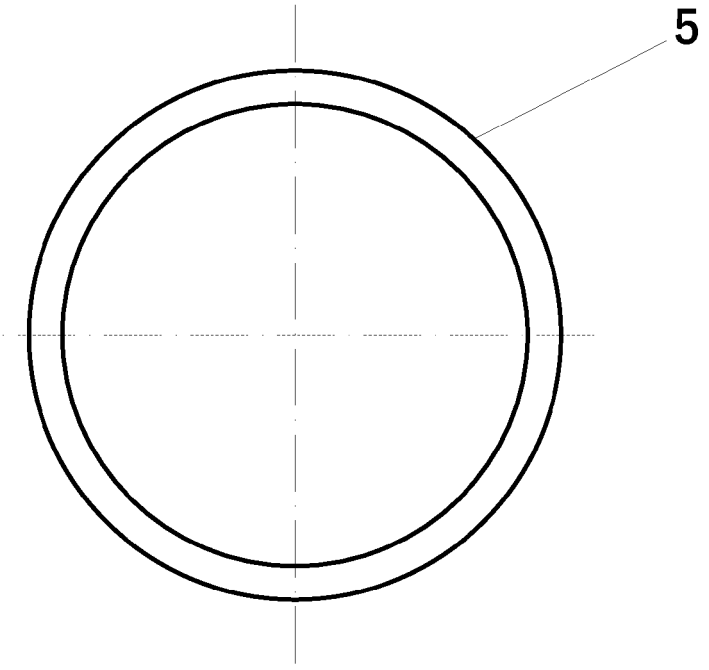


Fig. 3

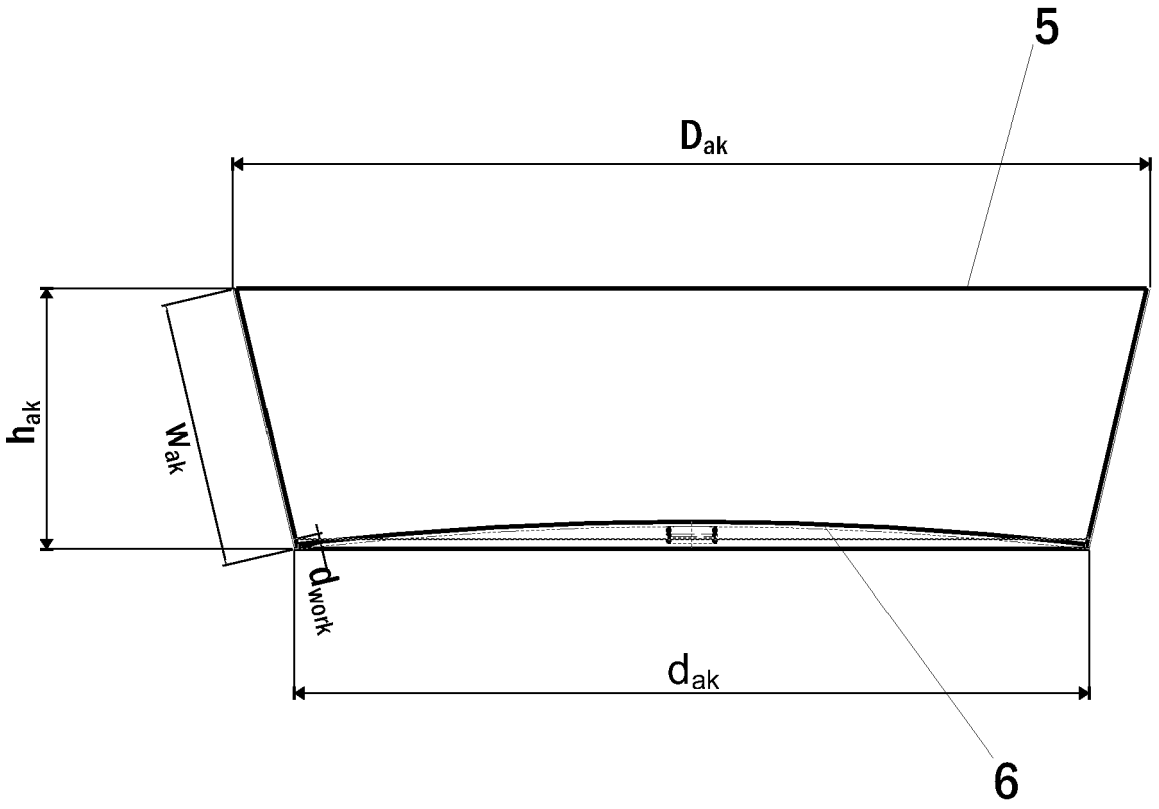


Fig. 4

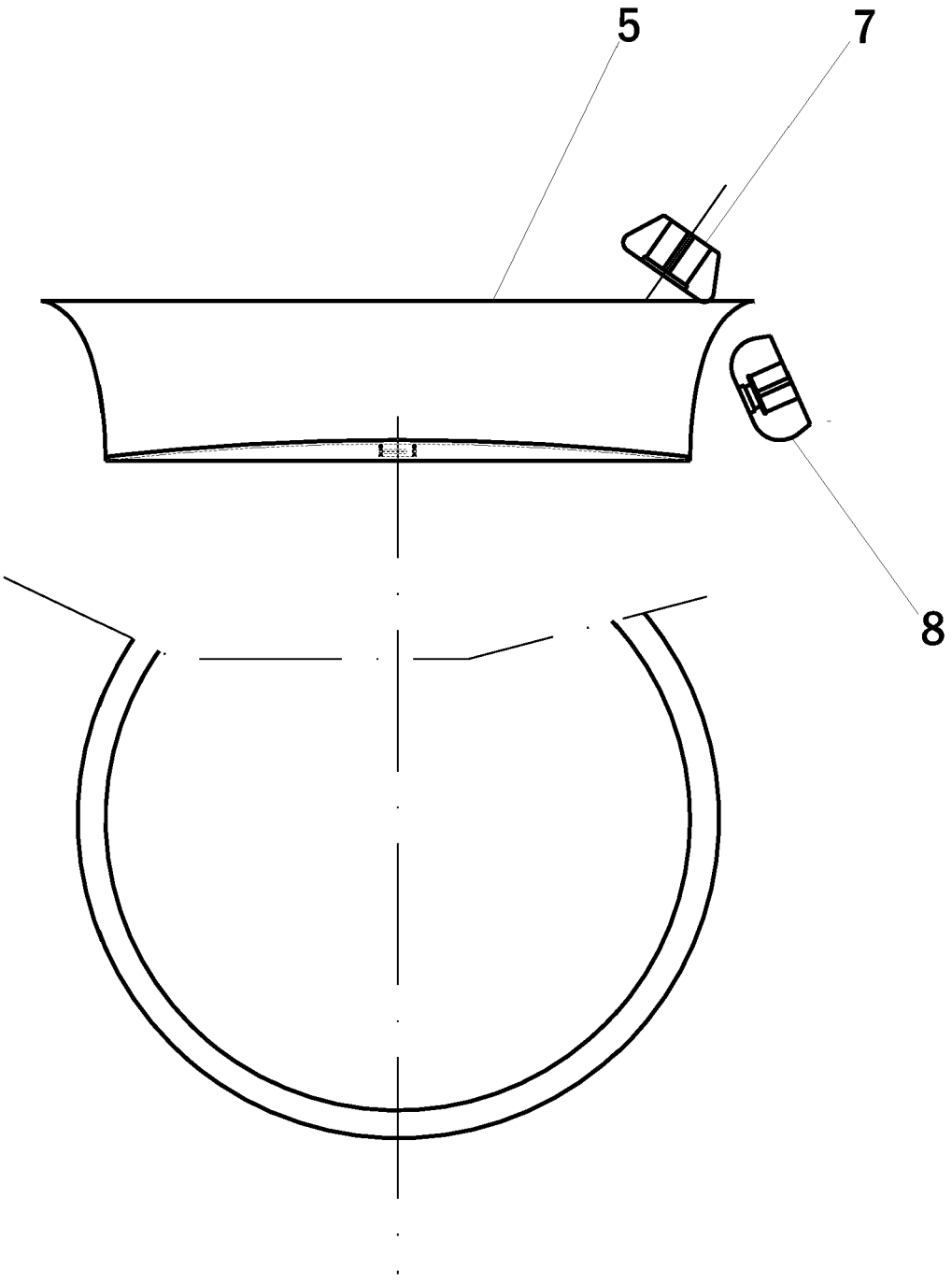


Fig. 5

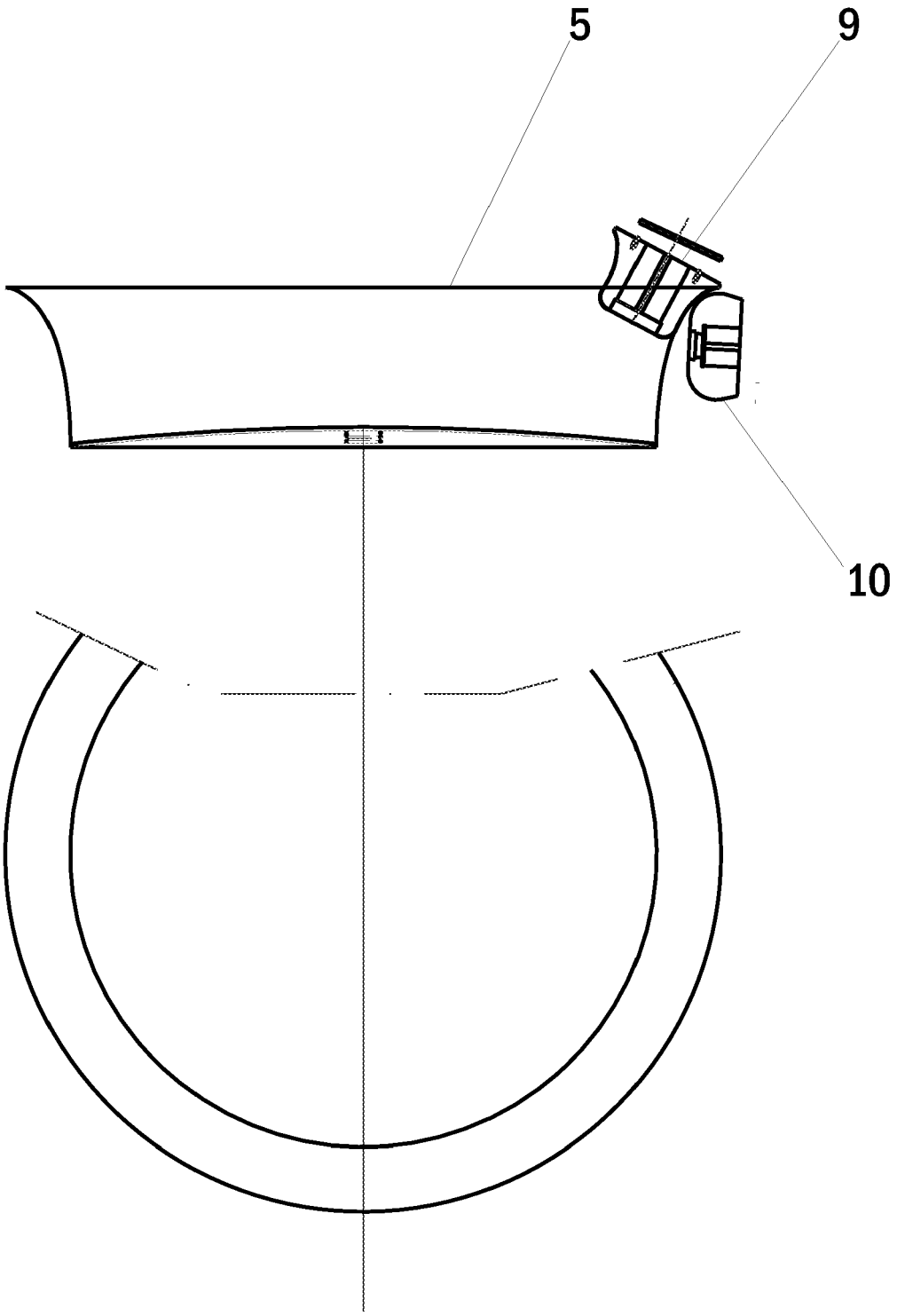


Fig. 6

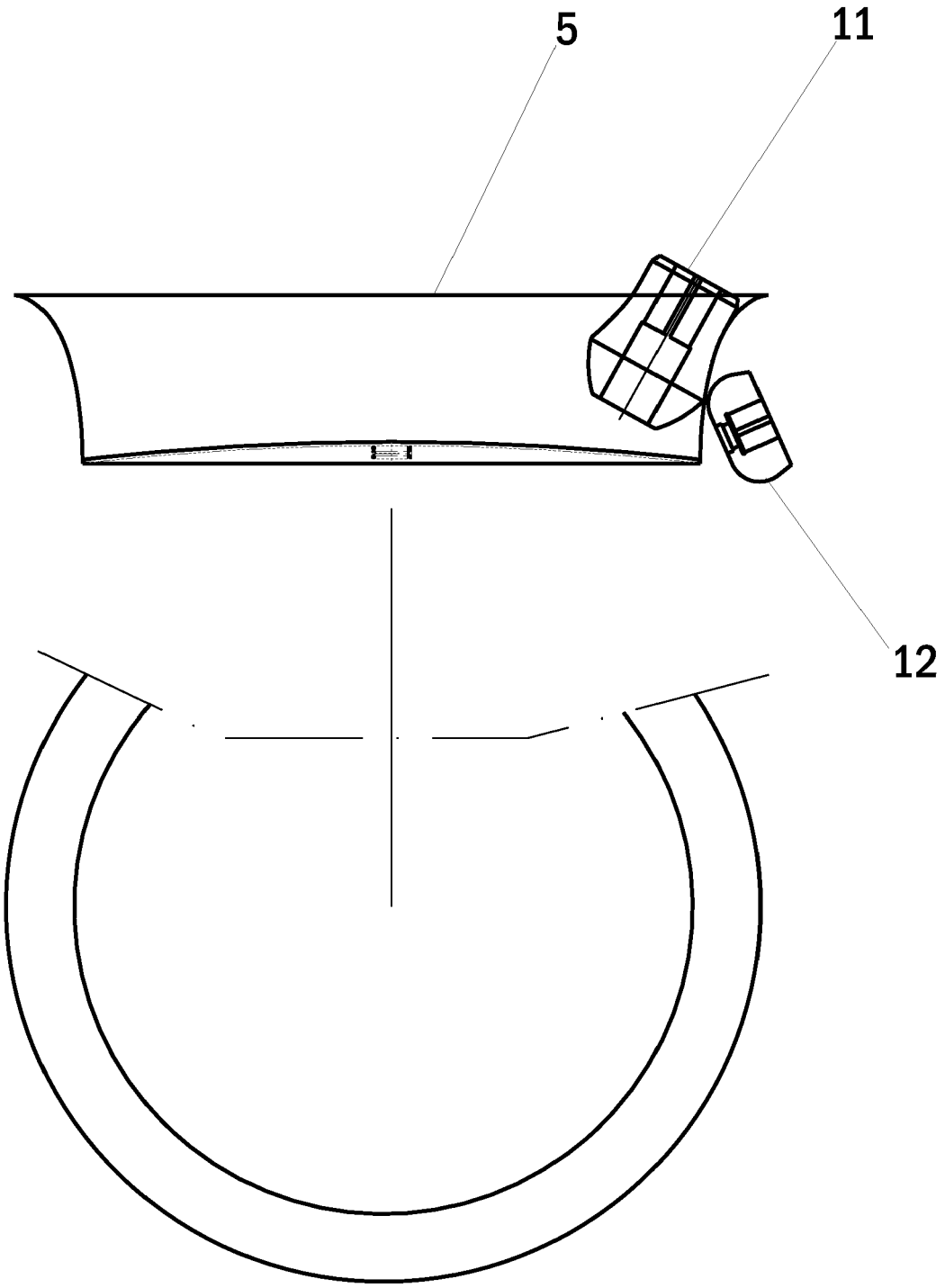


Fig. 7

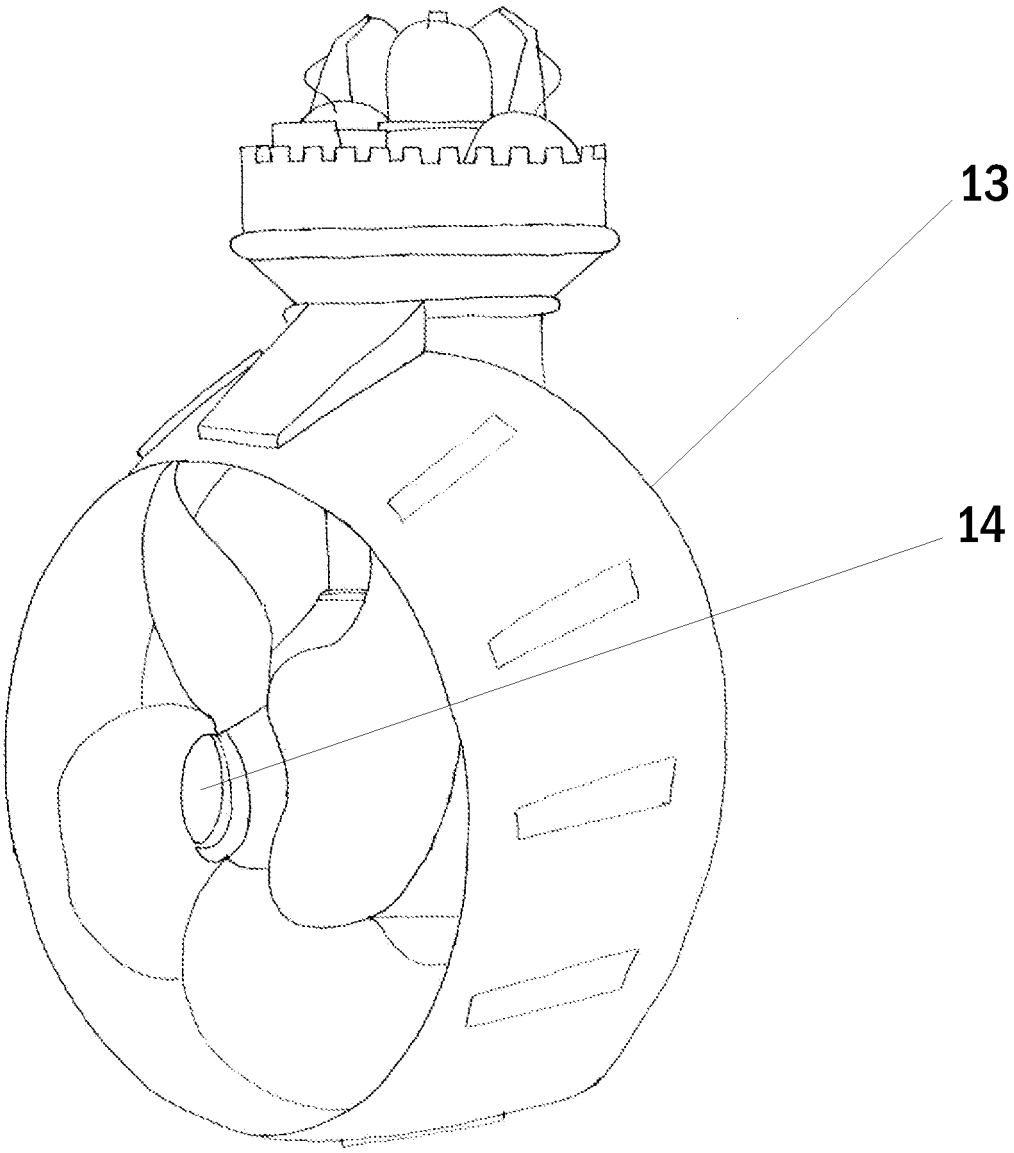


Fig. 8

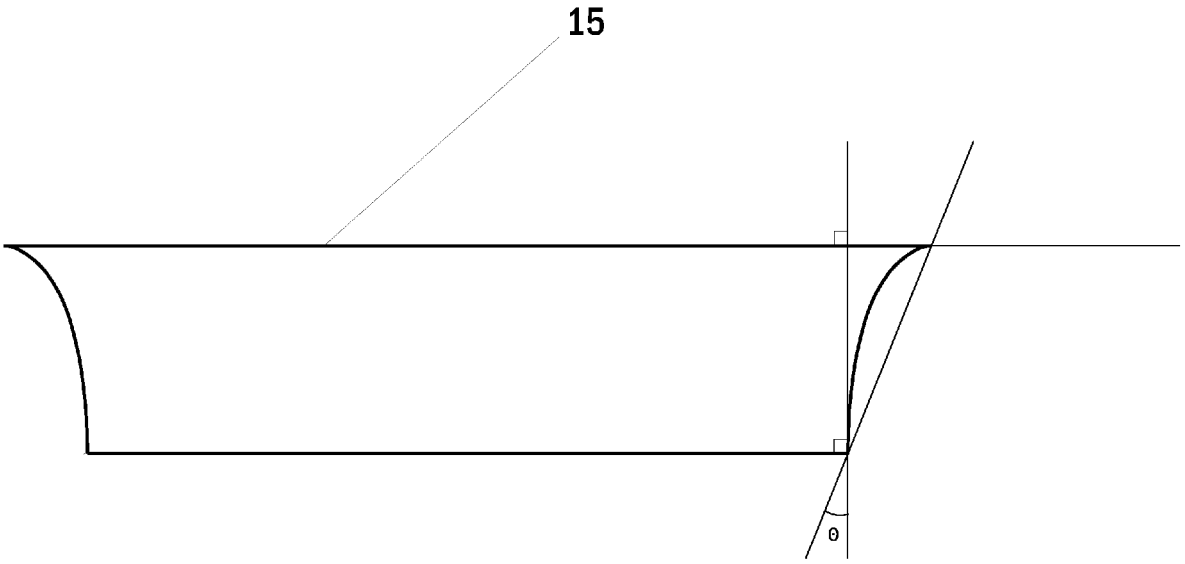


Fig. 9

REFERENCES CITED IN THE DESCRIPTION

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