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(54) **Facade panel comprising flexible stud frame connection configuration**

(57) A panel comprising a panel shell (11) having substantially glass-fiber-reinforced concrete material, a stud frame (1) provided to the panel, and flexible connection means providing the stud frame (1) with flexible displacement with respect to the panel shell (11) when necessary, characterized in that said flexible connection means has a connection configuration allowing the flexible connections to displace in at least two dimensions within three-dimensional space.

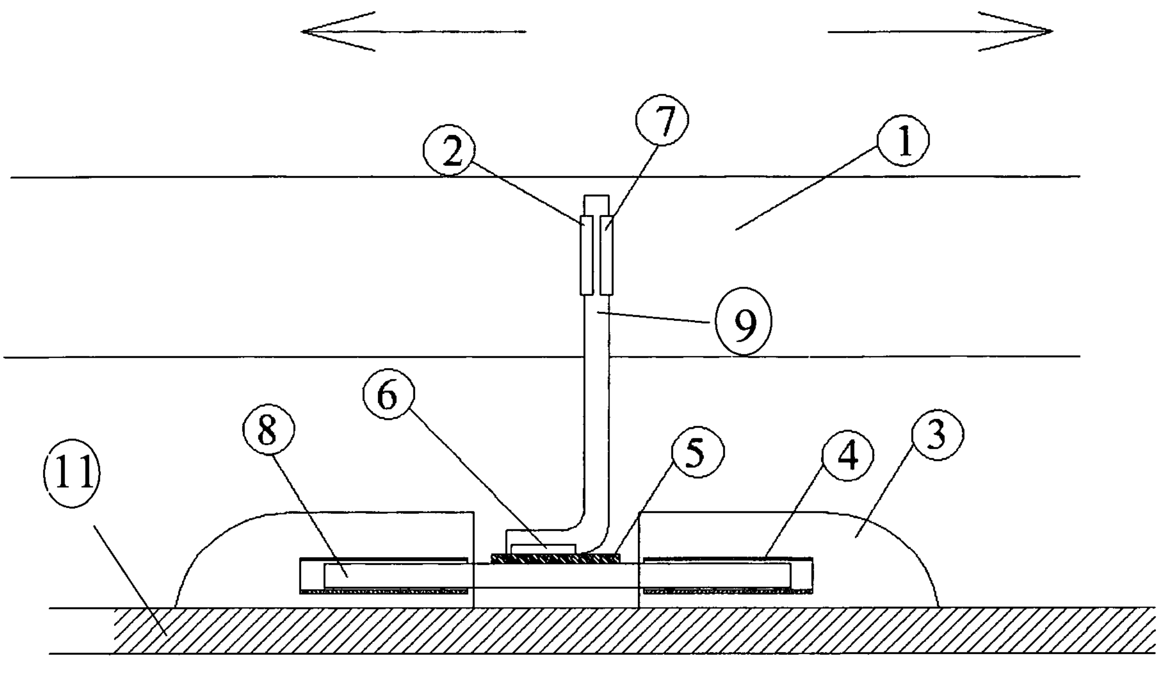

Fig.2

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Description

Technical Field

[0001] The present invention relates to a façade panel connectable to a stud frame arrangement flexibly in a number of directions and reinforced with glass fiber providing heat insulation.

Background of Invention

[0002] Façade panel covering systems have been widely applicable due to the significant advantages they provide in avoiding the condensation processes occurring on external skins of buildings and in enhancing the sound and heat insulation efficiency.

[0003] The efficient provision of said advantages is basically related both to the connective constructions between the façade panels and the building aprons, and to the content of panel material. Indeed, any relative mechanical displacements between the panels and aprons due to seismic movements, for instance, negatively affect the proper placement of such panels on aprons. Additionally, in panels accommodating stud frames within themselves, any stress based on thermal expansion between the panel and the stud frame is capable to cause panel cracking (due to stress differences).

[0004] The content of panel material, on the other hand, is selected from those material compositions having a character ensuring adequate heat insulation. While the material composition of panels is chosen, avoiding any substantial weight increase in the panel becomes a significant criterion with respect both to transport convenience, and to preventing any static overweight to occur on the building carcass.

[0005] Many recommendations put into practice considering the aforesaid matters and deemed to provide solutions have been known by the person skilled in the art. Such recommendations are based on panel constructions ensuring a relatively-flexible displacement tolerance between the panel and the stud frame, and composed of relatively light materials providing heat insulation.

[0006] In US 5,032,340, for instance, the flexion tolerance against any stress to occur between a glass-fiber-reinforced panel and the stud frame is ensured by means of a flexible bar, of which one end is coupled to those pad connections formed on the panel's shell, and the other end fastened to the carcass. Though the flexible connection disclosed in US 5,032,340 provides a partial contribution to the purpose of ensuring a flexible displacement between the panel and carcass, the free displacement capability of this flexibility is applicable on a single dimension, and is dependent only on the elasticity character (elasticity coefficient - Young modulus) of said bar's material. In other words, no constructive flexible displaceability is provided between the panel and carcass in US 5,032,340. This brings a disadvantage leading to coupling stresses of and between the panel and carcass, particularly when the panel sizes are relatively big.

[0007] Another publication of this background art is known from the patent application TR 97/00100. The patent application TR 97/00100 aims to disclose a panel, of which the interior of the panel shell is filled with foam concrete for heat insulation purposes, and which comprises flexible anchoring bars with one end placed into pads provided in the panel shell, and the other end coupled to an omega cross-sectioned carcass. The construction described in TR 97/00100 is functionally identical to the structure disclosed in the aforementioned patent US 5,032,340, and therefore, the disadvantages mentioned above are applicable here as well.

[0008] On the other hand, it is known that many heat insulation materials are being used to improve the heat insulation capabilities of façade panels in use, such materials selected among polyurethane foam, styropor board, light aggregated (pumice, glass beads, slag) concrete, rock wool and cellular concrete, e.g.

[0009] Polyurethane foam applications have some drawbacks in that they are expensive, not resistant against fire and in that their thermal expansions is not well tolerated by the panel shell, and have a short economical life since polyurethane becomes deteriorated in time.

[0010] Furthermore, filling with EPS or XPS boards is a difficultly-applicable method because of the intense involvement of flexible connections coupling the panel to the carrier. Such panels have also poor fire resistance.

[0011] Filling with light aggregated concrete (pumice, glass beads, slag) provides an efficient fire resistance, but since the material density in these filling materials are high, the panel becomes heavy, and no adequate heat insulation is ensured because the heat insulation coefficient of such materials are high.

[0012] In filling work employing cellular concrete, there is a drawback in that the thermal conductivity coefficient of this material becomes relatively higher as the material density is generally kept over 400 kg/m^3 in practice. In order to provide adequate heat insulation, it becomes necessary to enhance the panel thickness, this case increasing the cost and the weight of panel. Besides, cellular concrete has intensive air pores therein. In theory, the heat insulation is ensured by means of stationary air pores it accommodates. The heat insulation is very low on constant temperature and zero relative humidity conditions. Under atmospheric air conditions, however, both the environmental temperature and the relative humidity rate are continuously altering. Since the vapor diffusion resistance value of the cellular concrete is low, the atmospheric humidity permeates into the air blanks within the concrete's structure. As is a known fact, the water molecules within stationary air accelerate the heat transfer. Therefore the heat conductivity coefficient of cellular concrete is increased and the desired heat insulation cannot be provided.

Brief Description of Invention

[0013] One objective of the present invention is to eliminate the potential risk of stress-based (and even crack-based, etc.) panel wastage due to stresses occurring on panel-carcass connections, by providing a flexible connection of façade panels to the stud frame assembly in a multidirectionally displaceable manner.

[0014] Another objective of the present invention is to reduce the weight of façade panels and cost by enhancing heat insulation efficiency of panels.

[0015] In order to achieve these objectives, the present invention provides a panel comprising a panel shell having substantially glass-fiber-reinforced concrete material, a stud frame provided to the panel, and flexible connection means providing the stud frame with flexible displacement with respect to the panel shell when necessary, the subject panel being characterized in that said flexible connection means have a connection configuration allowing the flexible connections to displace in least two dimensions within three-dimensional space.

[0016] In a preferred embodiment according to the present invention, said flexible connection configuration having displacement freedom in three-dimensional space comprises a first bar supported by pad elements fastened to the panel shell and preferably positioned in a mutual fashion, and a second bar fastened substantially perpendicular to said first bar and fixed to the stud frame from one of its ends. Since the bearing of the first bar by the pad elements is ensured by means of silicon or any other similarly-functioning material, it is possible for the first bar, thus the second bar, and therefore the stud frame to perform relative displacement with respect to the horizontal, vertical and in transverse directions.

[0017] In another preferred embodiment of the present invention, the rails on corners, where the panel-to-façade connections are made, are welded to the carcass. Furthermore, the seismic connection elements are fastened to the carcass to provide panel stability against seismic displacements.

[0018] The interior of the panel shell is filled with polystyrene bead concrete composed of a mixture of polystyrene beads, sand, and concrete to ensure the heat insulation of panel.

Brief Description of Figures

[0019] The present invention is to be evaluated together with the annexed figures briefly described hereunder to make clear the subject embodiment and the advantages thereof.

[0020] Figure 1 illustrates a prior art embodiment of a panel, stud frame, and flexible connection elements.

[0021] Figure 2 gives a front view of the subject panel.

[0022] Figure 3 gives a top view of the subject panel.

[0023] Figure 4 gives a perspective view of the connection of a number of flexible connection elements to the carcass according to the subject panel.

[0024] Figure 5 gives a perspective view of the positioning of seismic connection elements within the panel according to the subject embodiment.

[0025] Figure 6 gives a perspective view of the positioning of rails within the panel according to the subject embodiment.

[0026] Figure 7 gives a side view of the final state construction of the panel.

Reference Numbers in Figures

[0027]

1. Carcass
2. Carcass connection piece
3. Pad
4. Bearing housing
5. Bar connection piece
6. Connection piece welding
7. Carcass welding
8. First bar
9. Second bar
10. Seismic connection element
11. Shell
12. Polystyrene bead concrete
13. Net
14. Plaster
15. Panel-to-façade connection rail

Detailed Description of Invention

[0028] Figures 2 and 3, illustrate front and top views of the subject panel respectively. According to these figures, the configuration providing the flexible connection between and of the panel shell (11) and the carcass comprises a first bar (8) extending substantially horizontally with respect to the figure, and a second bar (9) fastened substantially perpendicularly respect to the first bar (8). Said first bar (8) is supported by bearing housings (4) within the pad (3) elements positioned on the inner-upper surface of the shell (11) in a mutual manner so that said bar (8) is enabled to displace in each direction of three-dimensional space. Since the bearing housings (4) in said pads (3) are embodied of a larger size than that of the first bar (8), it is made possible for the first bar (8) to displace a certain distance on the axis of itself, on the axis of the second bar, and on the transversal axis.

[0029] While the ends of the first bar (8) are supported in the pads (3), the supporting/bearing ends, or the surfaces of pads to provide support/bearing are coated by silicon or any other similarly-functioning material so as to create a spring effect. In this manner, the first bar (8) is provided with freedom of displacement on right- and leftward, up- and downward, and on the transverse directions, i.e. in three dimensions.

[0030] In one embodiment of the present invention, displacement of the first bar'(8) in any dimension can be restricted depending on the manner it is supported, and hence, the free displacement capability of said bar can be reduced to two dimensions only, in case needed.

[0031] In another preferred embodiment of the present invention, the first bar (8) is mounted to a second bar (9) substantially extending vertically with respect to the Figure by means of a bar connection piece (5). The second bar (9) is fixed to the carcass (1) by means of a connection piece (2) on a point that is close to the other end of itself (9). The fixation of the second bar (9) to the connection piece (5) is preferably performed by means of welding (6).

[0032] The fixation of the second bar (9) to the carcass (1) is carried out preferably by welding (7) to the carcass connection piece (2). The weld-joining method is preferred in assembling the first bar (8), the bar connection piece (5), and the second bar (9).

[0033] This weld-joining should not be considered as restricting the scope of the present invention, because said parts/pieces can be assembled by means of any other methods known in the art.

[0034] Whereas the configuration (e.g. first bar, second bar, connection piece, etc.) ensuring the flexible displacement according to the present invention, and the connected/related parts thereof can be formed so as to be made of any materials, according to the preferred embodiment of the present invention the materials used are steel.

[0035] In a further preferred embodiment of the present invention, the first bar (8) and the second bar (9) are formed to have a single-piece parts, in this particular embodiment bar connection piece (5) can be excluded.

[0036] Yet in a further embodiment of the present invention, the first bar (8) horizontally extending in Figure 2 can be formed so as to include a group of a plurality of bars (2, 3, etc.) in connection with each other. Similarly, the second bar (9) vertically extending in Figure 2 can also be formed so as to include a group of a plurality of bars (2, 3, etc.) in connection with each other.

[0037] Figure 4 gives a perspective view of the connection of a number of flexible connection elements in the panel to the carcass according to the present invention. The distance between the flexible connection configurations can be adjusted to a value to be predetermined by taking into account the wind loads the panel will be exposed to.

[0038] Particularly for enhancing the panel's stability against seismic movements, preferably one more of the subject flexible connection configurations is positioned between the panel shell (11) and the carcass (1) to function as a seismic connection element (10). A corresponding representative embodiment is illustrated in Figure 5.

[0039] In order to perform the assembly of the subject panel to a building façade, rails (15) are fixed preferably to four corners of the panel, preferably by means of welding, as shown in Figure 6.

[0040] The interior of the subject panel (i.e. the interior of the panel's shell) is filled with polystyrene bead concrete material (12). Polystyrene bead concrete (12) is preferably composed of a mixture of polystyrene beads (10-15 kg/m^3 density), cement, and sand. In a preferred embodiment of the present invention, this mixture is formulated so as to have a dry density preferably of 120 to 500 kg/m^3 in line with targeted heat insulation values (0.050 - 0.30 lambda value), and is prepared after being mixed in a concrete mixer.

[0041] The polystyrene beads in the polystyrene bead aggregated concrete (PBAC) filled in the panel shell have closed air pores, the stationary air trapped in such enclosed air pores providing a quite efficient heat insulation. By making use of this feature of polystyrene beads, these beads are mixed with a type of concrete of proper formulation so that a filling material is obtained, which has a high heat insulation capability and which can respire as the polystyrene beads are bound within/to the concrete. In this manner, the humidity in the air is avoided from permeating to the stationary air gaps within the beads.

[0042] As seen in Figure 7, after polystyrene bead aggregated concrete (12) is poured into the panel shell (1), a net (13) having a mesh size preferably of 10 x 10 mm and made from glass fiber that is resistant to alkaline conditions is spread, and it is coated up to the upper level of the shell by means of plaster spraying. Said net (13) can alternatively be another type that may be made from plastic material, or Rabitz wire, or from wire mat with relatively larger mesh size. After the façade panel prepared as described above is subjected to the curing process, it is made ready for assembly.

[0043] Regarding an alternative embodiment of the present invention, the second bar (9), in place of the first bar (8) that extends horizontally with respect to Figure 2, can be supported by the carcass (1) so as to become displaceable in three directions in three-dimensional space in the configuration ensuring the connection between the panel shell (11) and the carcass (1). According to this alternative embodiment, the first bar (9) extending vertically with respect to Figure 2 is supported by the bearing housing embodied on the carcass preferably by the upper section of said bar (9), and since the size of the bearing gap will be embodied relatively larger than the size of the second bar (9) similarly to the structure employed in the preferred embodiment, it becomes possible to have the second bar (9) displace a certain distance along the axis of itself (9), the axis of the first bar, and in the transversal axis.

[0044] In the aforesaid alternative embodiment, it is also possible to similarly support both bars so that both bars are enabled to displace in three dimensions, in addition to supporting only the second bar (9), as indicated above, so that said bar (9) is made displaceable in three dimensions.

[0045] In another alternative embodiment of the present invention, the panel shell (11) and the carcass (1) can be mutually connected also by means of a bar equipped with a spherical joint on both or one of the ends of itself. In this embodiment, silicon or a similar material can be applied between the spherical joints and the bearings. Thanks to this alternative embodiment, the panel shell (11) is enabled to carry out relative displacement in three directions with respect to the carcass.

Claims

1. A panel comprising a panel shell (11) having substantially glass-fiber-reinforced concrete material, a stud frame (1) provided to the panel, and flexible connection means providing the stud frame (1) with flexible displacement with respect to the panel shell (11) when necessary, **characterized in that** said flexible connection means has a connection configuration allowing the flexible connections to displace in at least two dimensions within three-dimensional space.

2. A panel according to Claim 1, **characterized in that** said connection configuration comprises a first bar (8) supported by the shell (11), and a second bar (9) connected to said first bar (8) substantially perpendicularly.

3. A panel according to anyone of the preceding claims, **characterized by** comprising preferably two pad (3) elements wherein said first bar (9) is supported.

4. A panel according to Claim 3, **characterized in that** the size of the bearing housings (4) formed in said pad (3) elements is larger than the size of the bars, so that said first bar (8) is enabled to displace in three dimensions.

5. A panel according to claims 3 and 4, **characterized by** comprising silicon or any other similarly-functioning material applied between the supported ends of said first bar (8) and the bearing housings (4).

6. A panel according to anyone of the preceding claims, **characterized in that** said first bar (8) is integrated with said second bar (9), or these two bars (8, 9) are connected by means of a connection piece (5).

7. A panel according to anyone of the preceding claims, **characterized by** comprising a connection piece (2) ensuring the connection of said second bar (9) to said carcass (1).

8. A panel according to Claim 1, **characterized in that** said connection configuration comprises a plurality of first bars (8) supported by said panel shell (11), and one or more than one second bars (9) connected to the plurality of first bars (8).

9. A panel according to anyone of the preceding claims, **characterized by** comprising at least one seismic connection element (10) for enhancing the stability of the panel against seismic movements particularly.

10. A panel according to anyone of the preceding claims, **characterized by** comprising rails (15) to be positioned on the four corners of the panel for assembling the panel to the façade.

11. A panel according to anyone of the preceding claims, **characterized by** comprising polystyrene bead aggregated concrete (12) filled into said panel shell (11) to provide heat insulation.

12. A panel according to anyone of the preceding claims, **characterized by** comprising a net (13) made from glass fiber resistant to alkaline conditions.

13. A panel according to anyone of the preceding claims, **characterized by** comprising plaster (14) applied up to the upper level of the shell.

14. A panel according to Claim 1, **characterized in that** the size of the bearing housings formed to support said second bar (9) by said carcass (1) so as to ensure three-dimensional displacement of the second bar (9) is larger than the bar size of the second bar (9).

15. A panel according to Claim 1, **characterized in that** said connection configuration is a bar which is connected to said shell (11) at one end and connected to said carcass (1) at the other end, the bar having spherical joint/s at one or both ends.

16. A panel according to Claim 15, **characterized by** comprising silicon or any other similarly-functioning material applied between said spherical joints and the housings thereof.

17. A panel comprising a panel shell (11) having substantially glass-fiber-reinforced concrete material, a stud frame (1) provided to the panel, and flexible connection means providing the stud frame (1) with flexible displacement with respect to the panel shell (11) when necessary, **characterized by** having a connection configuration comprising a first bar (8) supported by said shell (11), and a second bar (9) connected to this first bar (8) substantially perpendicularly in order to allow said flexible connection means to displace in at least two directions in three-dimensional space; wherein
preferably two pad (3) elements are provided whereby said first bar (8) is supported, and
the size of bearing housings (4) formed in said pad (3) elements is made larger than the sizes of the bars so that said first bar (8) is enabled to displace in three dimensions.

18. A panel comprising a panel shell (11) having substantially glass-fiber-reinforced concrete material, a stud frame (1) provided to the panel, and flexible

connection means providing the stud frame (1) with flexible displacement with respect to the panel shell (11) when necessary, **characterized by** comprising polystyrene bead aggregated concrete (12) filled into said shell (11) to provide heat insulation.

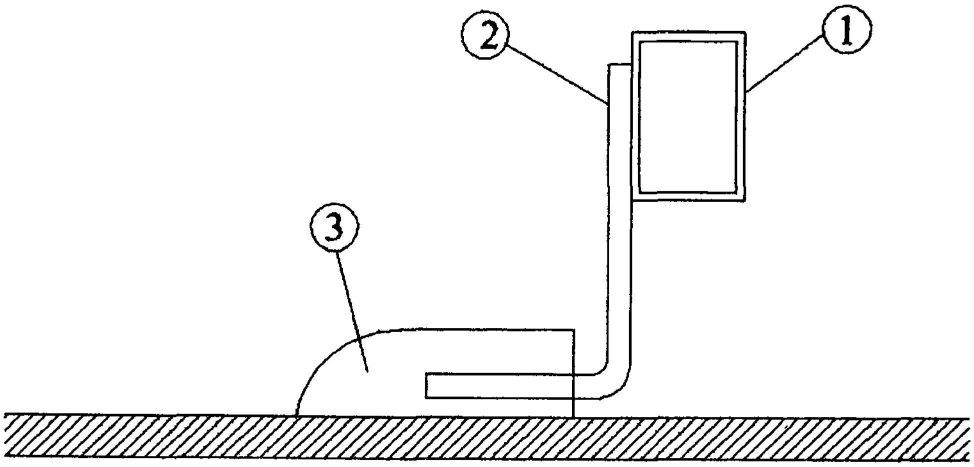

Fig.1

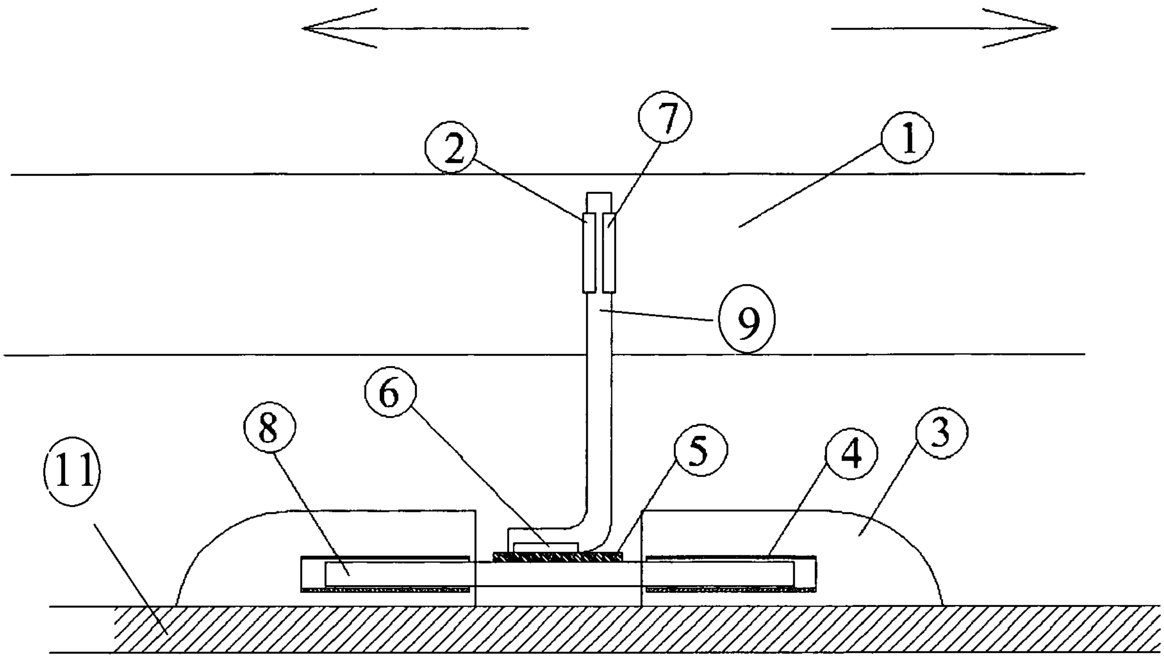

Fig.2

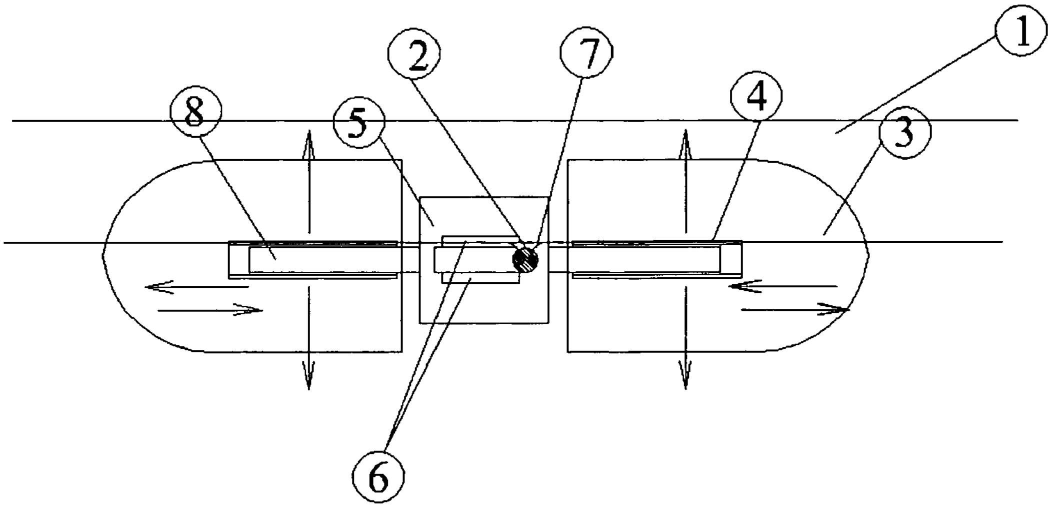

Fig.3

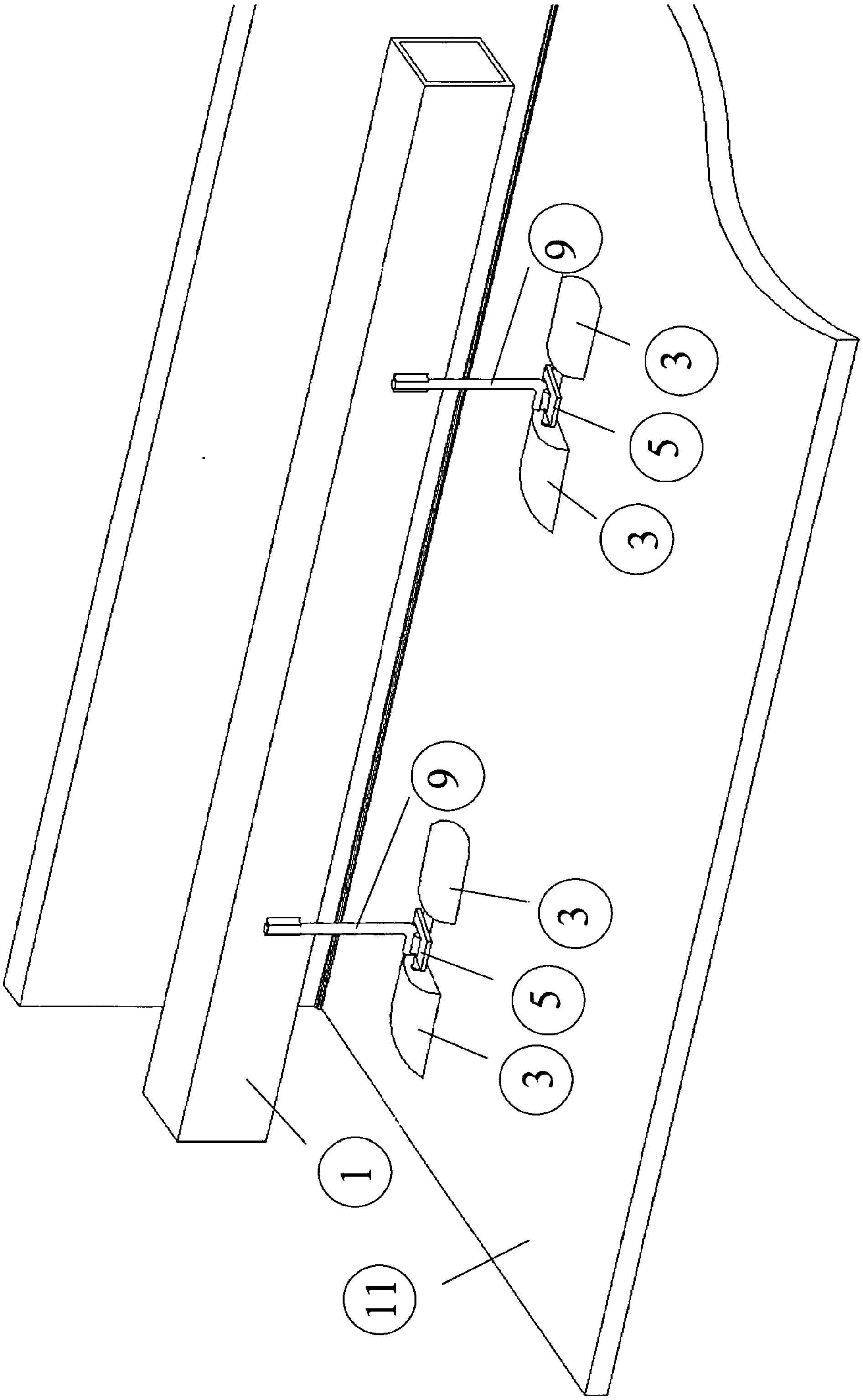

Fig.4

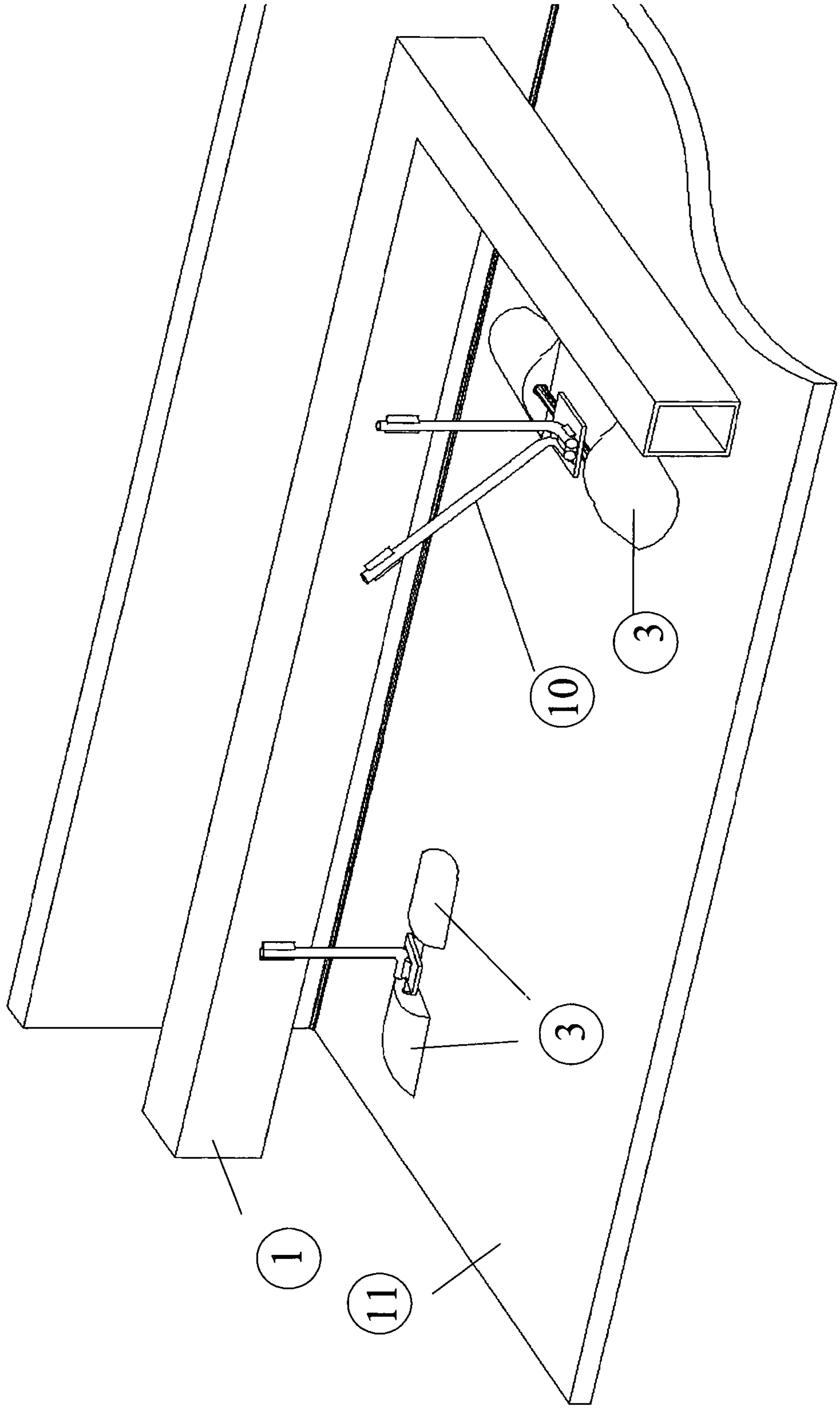

Fig.5

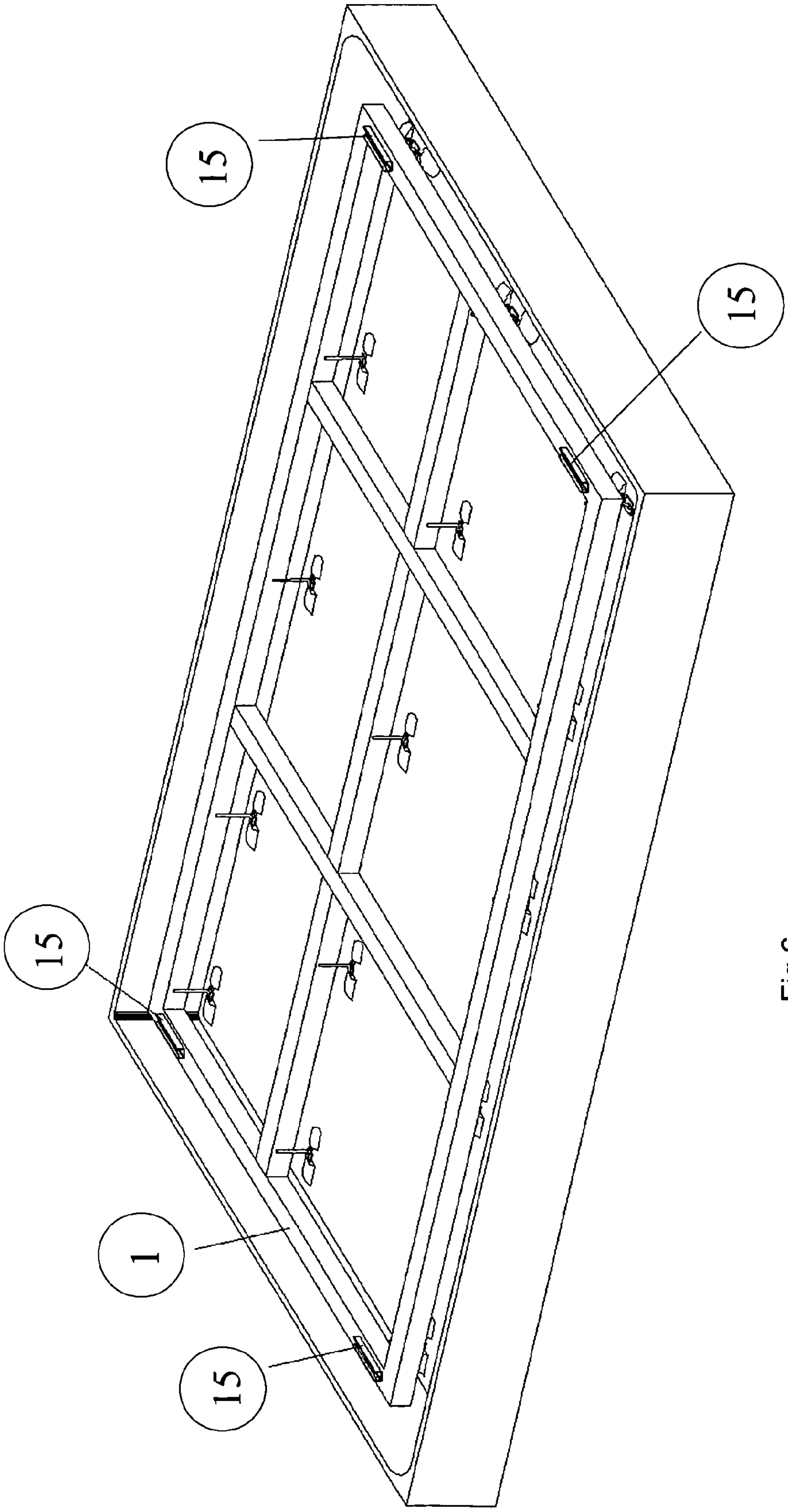

Fig.6

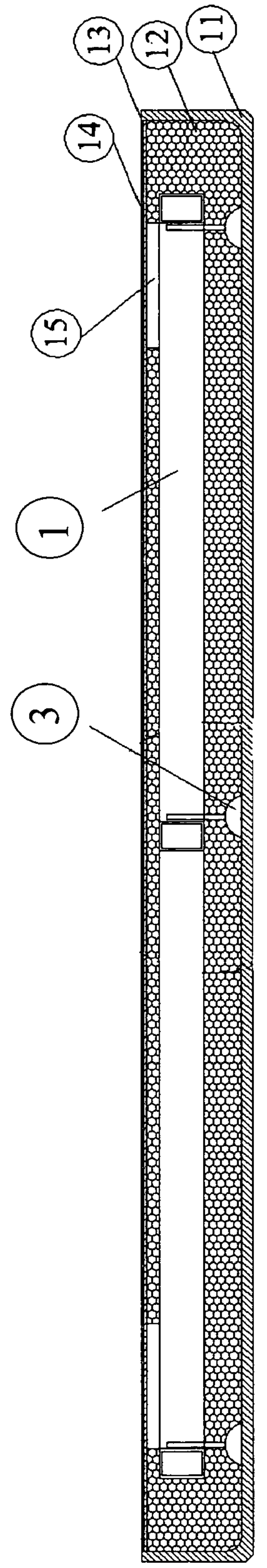

Fig.7

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 5032340 A **[0006] [0006] [0006] [0007]**
- TR 9700100 **[0007] [0007] [0007]**