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Denk et al.(10) **Pub. No.: US 2011/0232635 A1**(43) **Pub. Date: Sep. 29, 2011**(54) **CONCENTRATED SOLAR RADIATION
ASSEMBLY**(22) Filed: **Mar. 29, 2010****Publication Classification**(75) Inventors: **Thorsten Denk**, Provincia de
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F24J 2/02 (2006.01)(52) **U.S. Cl.** **126/680**(73) Assignees: **INTEVEP, S.A.**, Caracas (VE);
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(Swiss Federal Institute of
Technology), Zurich (CH)(57) **ABSTRACT**

A concentrated solar radiation assembly comprising a housing divided into segments by housing trusses; window blocks positioned within the segments supported by the housing trusses; and, internal trusses positioned on top of the window blocks and within the segments. The assembly may be hermetically sealed, large-scale and refrigerated by water flow within the trusses.

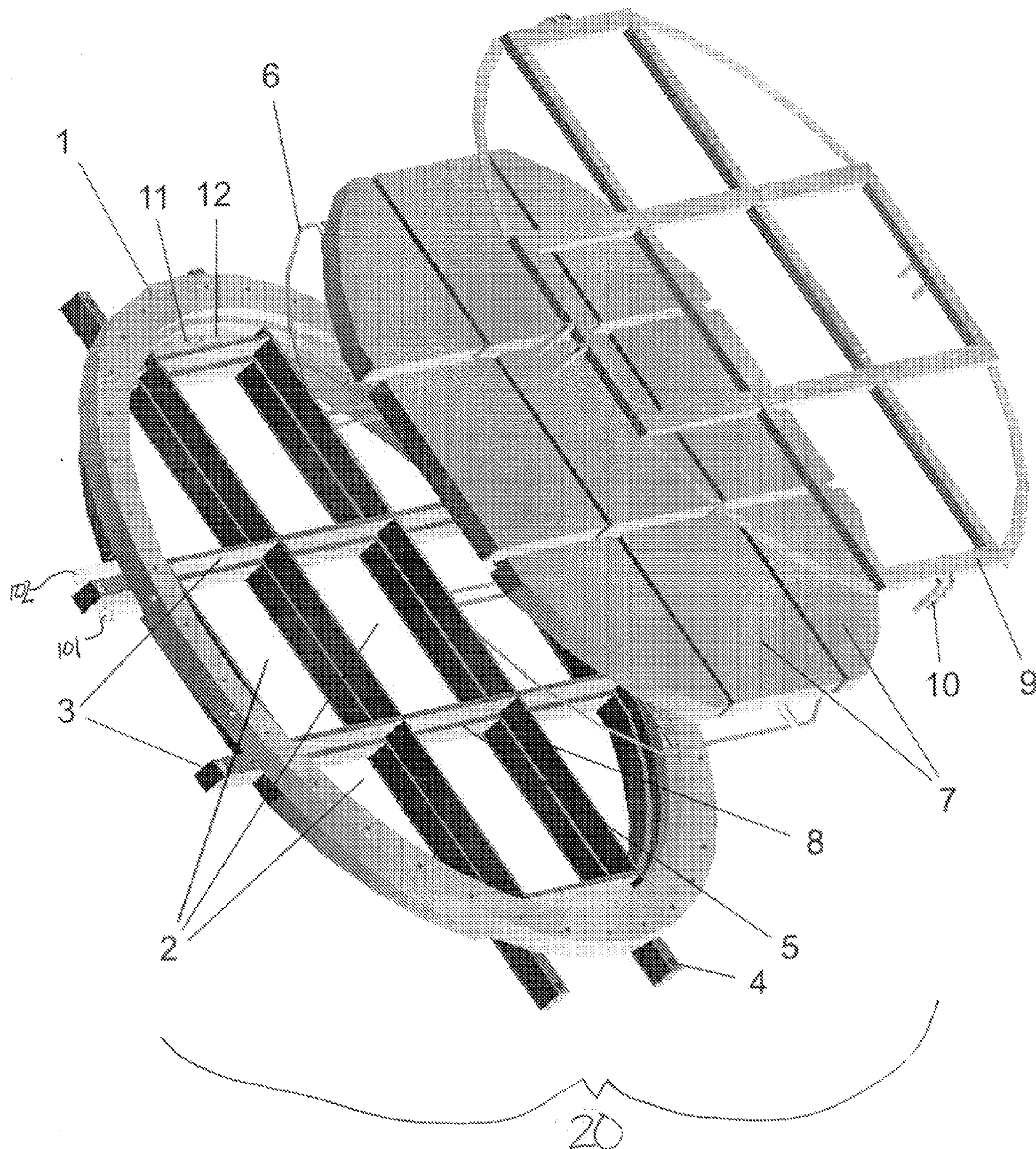
(21) Appl. No.: **12/748,660**

FIGURE 2

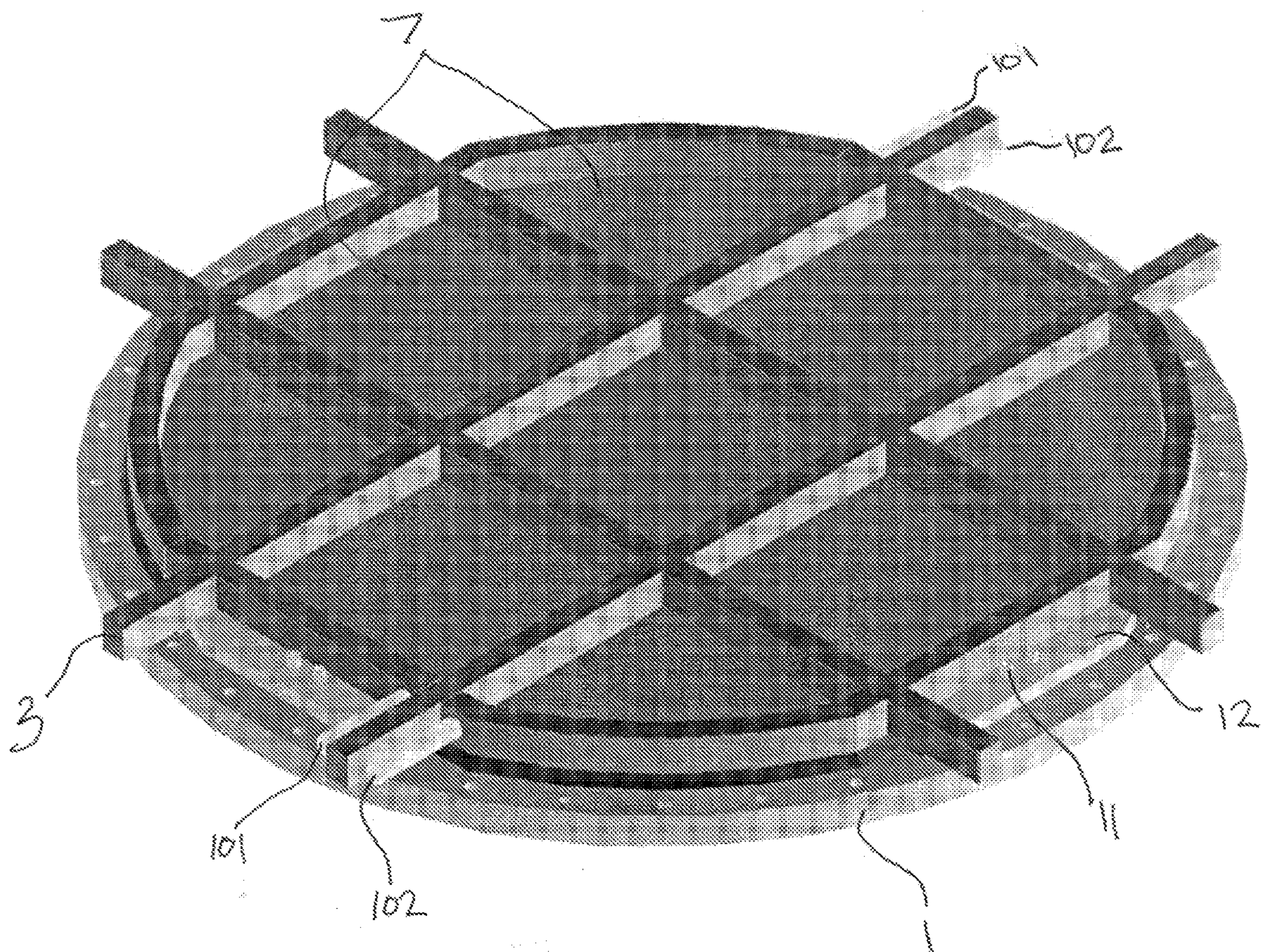


FIGURE 3

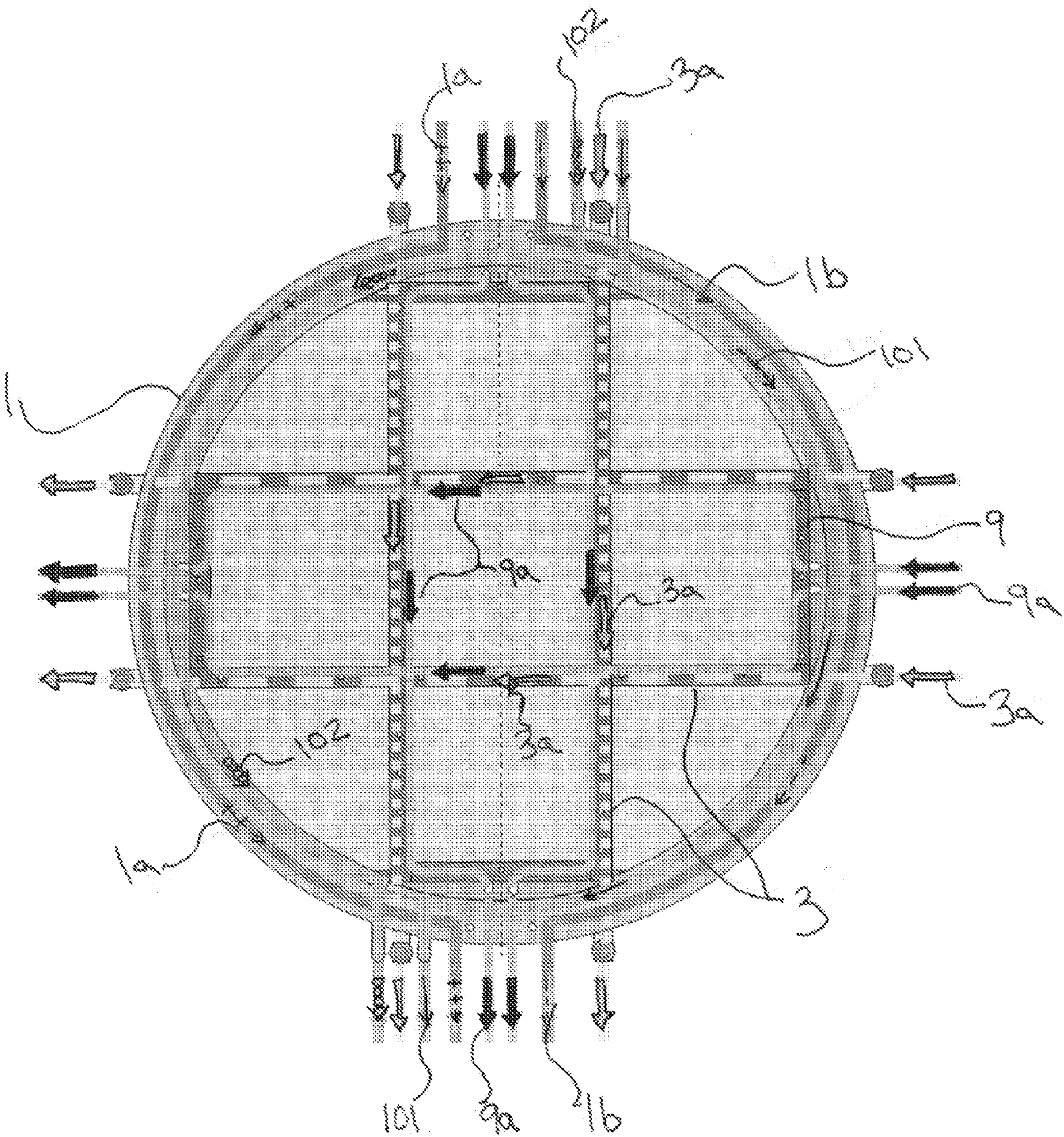


FIGURE 4

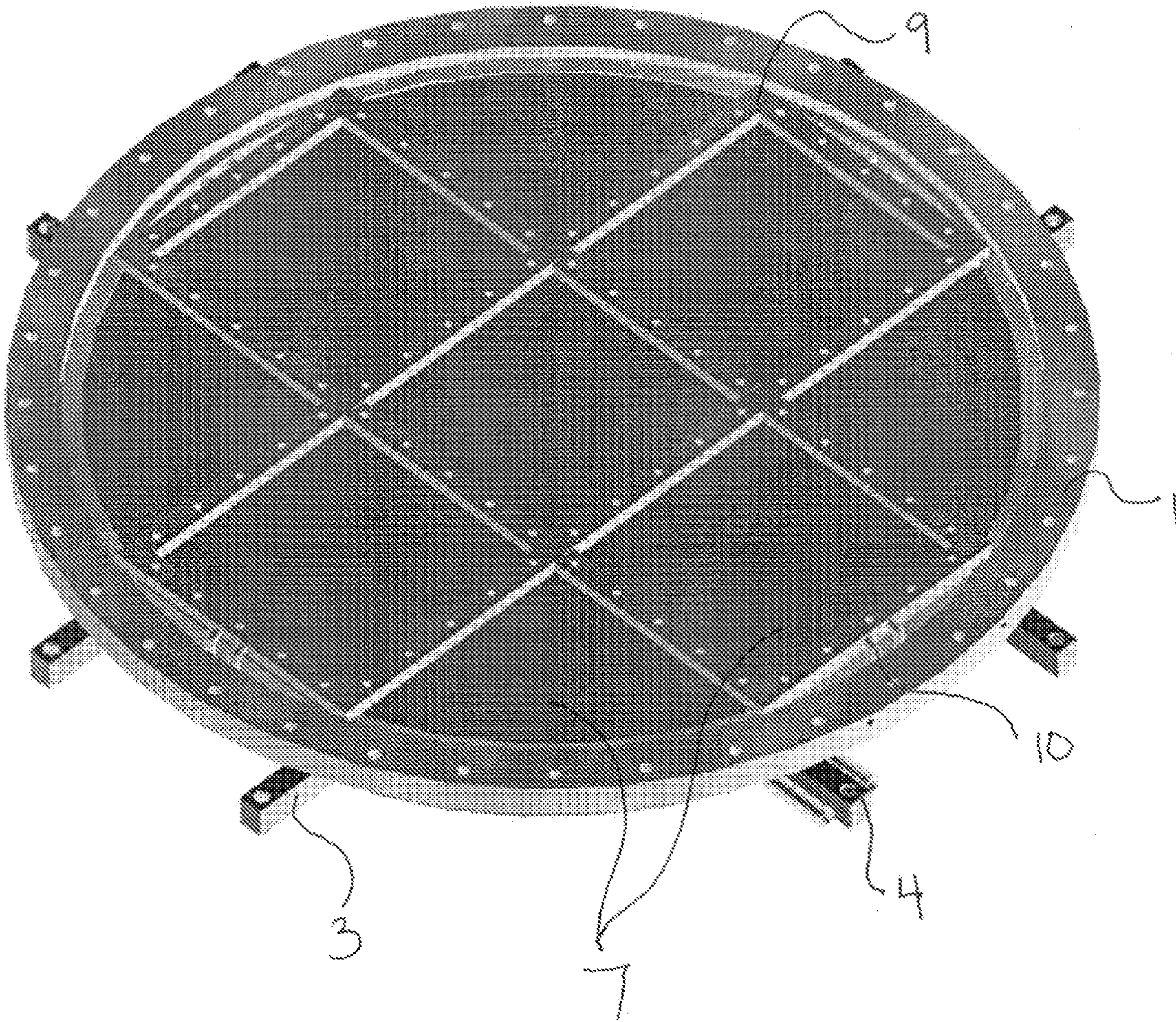
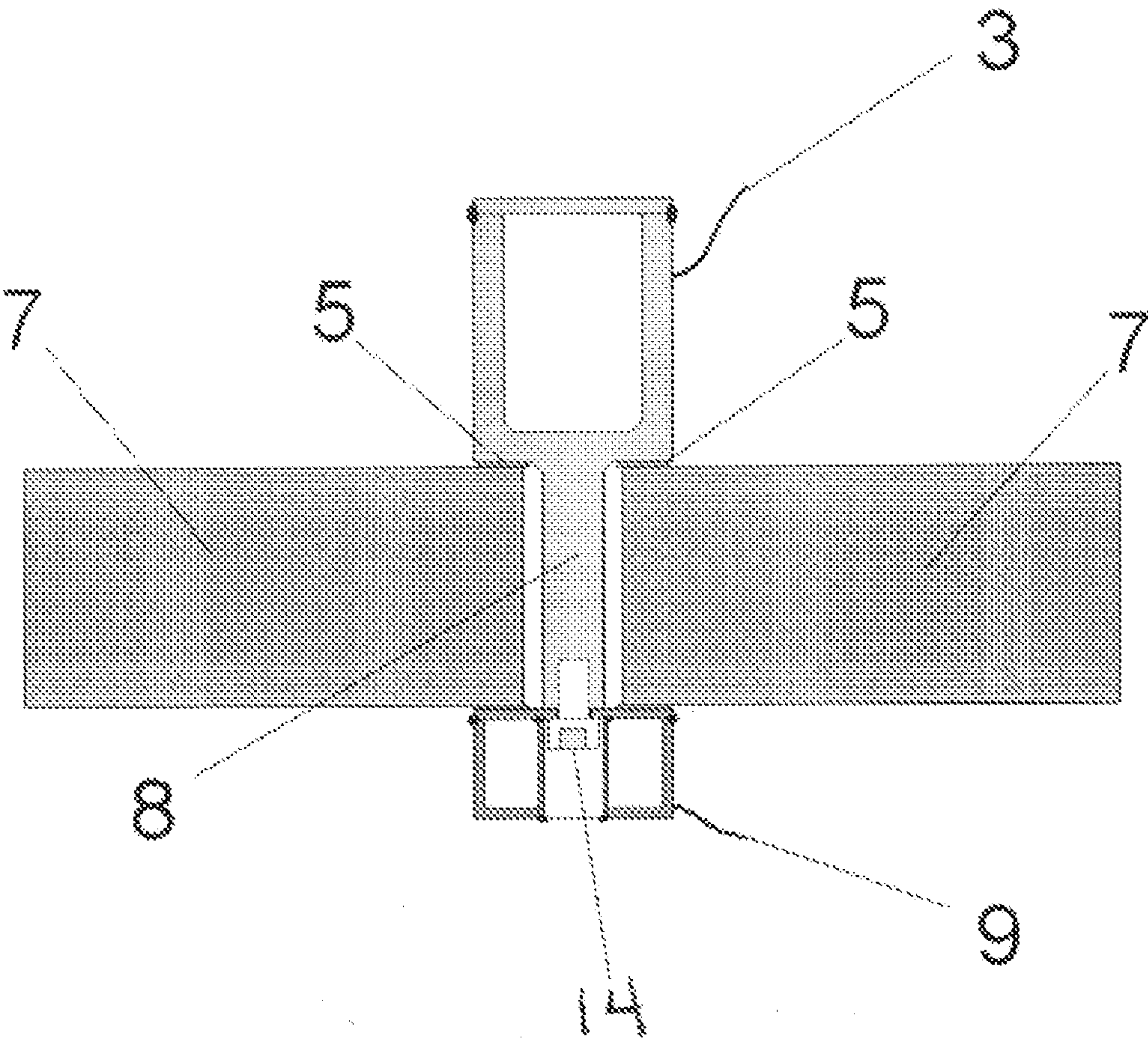


FIGURE 5



CONCENTRATED SOLAR RADIATION ASSEMBLY

BACKGROUND OF THE INVENTION

[0001] This invention relates to a solar energy concentrating and collecting assembly, that is to closed central assembly systems for concentrated solar radiation, even more particularly, to a refrigerated window for a large-scale concentrated solar radiation assembly or structure.

[0002] Concentrated solar power systems focus direct solar radiation through optical devices onto an area where a assembly is located. The assembly transforms the radiation into heat. Since concentrated solar power systems produce both heat and electricity, they can replace all or part of the energy requirements in some industrial applications. On the small scale, they also have durability and low operating costs.

[0003] Various solar energy collection arrangements are known. Many utilize an assembly with a receiver located at the focus. The receiver or central solar radiation assembly absorbs concentrated sunlight at high temperatures, commonly about 700°-1500° C. and transfers the heat generated by the solar absorber to a working fluid, which either serves as a heat carrier fluid or is designed to perform a thermochemical process. In one known kind of central solar assembly, a so-called tubular assembly, the working fluid flows inside tubes located usually near the inner periphery of the solar assembly housing. In such a assembly, solar radiation is absorbed at the outer surface of the tubes and is transmitted as heat to the working fluid, which is thus heated. The overall resistance to heat transfer and the ensuing heat loss in such tubular central solar assemblies is relatively high.

[0004] High temperature closed solar assemblies generally have a cylindrical housing. Closed solar assemblies are closed at one side by a transparent window to form a sealed recipient capable of holding a working fluid or a chemical reaction mixture in direct contact with the absorber while avoiding physical contact between the working fluid and the ambient air. The sealed recipient also protects against temperature loss. In operation, the working fluid or reaction mixture is forced to flow across the assembly chamber whereby heat is transferred from the absorber to the fluid and is utilized for the chemical reaction or is transported outside the assembly.

[0005] The transparent window that shields the absorber in a solar assembly must be capable of sustaining the extreme conditions of high solar flux, high temperature and in some applications pressure associated with the conditions of operation. Solar assemblies designed for large-scale solar energy conversion systems need large transparent windows. These windows with the necessary dimensions and the required optical/thermo mechanical qualities are not readily available. Since large pieces must be made to order and the requirements concerning mechanical stability increase with size, these windows are extremely expensive or even impossible to manufacture. As a result, there is a need for improved large-scale solar assembly windows and large-scale concentrated solar power systems.

SUMMARY OF THE INVENTION

[0006] The primary object of the present invention is the creation of an improved solar assembly window for a central solar assembly that fulfills the requirements of a large central assembly in terms of efficiency, thermal and mechanical loads.

[0007] It is a further object of the present invention to provide a concentrated solar radiation assembly.

[0008] In accordance with the present invention, a large-scale concentrated solar radiation assembly is disclosed. The concentrated solar radiation assembly comprises a housing divided into segments by housing trusses; window blocks positioned within the segments supported by the housing trusses; and, internal trusses positioned on top of the window blocks and within the segments. The housing trusses and internal trusses are hollow and define cooling channels for flow of cooling liquid, such as water or the like.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] A detailed description of preferred embodiments of the present invention follows, with reference to the attached drawings, wherein:

[0010] FIG. 1 illustratively depicts a non-limiting example of the individual components of the concentrated solar radiation assembly as claimed.

[0011] FIG. 2 illustratively depicts a non-limiting example of the outside, solar radiation side, of the assembled concentrated solar radiation assembly as claimed.

[0012] FIG. 3 illustratively depicts a non-limiting example of the inside liquid flow of the concentrated solar radiation assembly as claimed.

[0013] FIG. 4 illustratively depicts a non-limiting example an assembly/structure fluid side, of the assembled concentrated solar radiation assembly as claimed.

[0014] FIG. 5 illustratively depicts a non-limiting example of the hermetic seal of the assembly/structure as claimed.

DETAILED DESCRIPTION

[0015] The invention relates to a refrigerated window for a large-scale concentrated solar radiation assembly or structure. The window is divided into several segments that are shaped to keep the assembly hermetically sealed. The hermetically sealed assembly, including the window, is able to withstand thermal and mechanical loads caused by the highly concentrated solar radiation, very high temperatures, and the pressure difference between the interior and the exterior. Outside trusses define the shape of the window segments. Window segments are held within the segments by a housing and the outside trusses. The outside trusses apply the force needed to hermetically seal the assembly. In addition, the outside trusses are shaped to resist mechanical load and are water cooled to resist thermal load.

[0016] FIG. 1 depicts a non-limiting embodiment of the present invention. FIG. 1 shows an exploded view of a large-scale segmented refrigerated or water-cooled window assembly 20 for highly concentrated solar radiation. Solar radiation enters from the left of assembly 20 and the structure is on the right of assembly 20. The window for a large-scale concentrated solar radiation assembly or structure is divided into several segmented window blocks 7, which can be made of glass, such as quartz glass, or other suitable materials that are well known within the art. Large-scale as used herein may be defined as an assembly having a window where size makes durability of the window assembly an issue, for example, where the window diameter or similar dimension is larger than about 400 mm. In order to withstand the unavoidable mechanical loads and to solve the fabrication problems associated with larger sizes, the window is divided into several segments that are refrigerated by liquid cooled trusses.

[0017] High mechanical load as defined herein is a function of pressure difference and temperature level. Pressure differences of 2 bar, such as from ambient (1 bar) to 3 bar is considered a high mechanical pressure load. Temperature above about 1000° C. is considered high mechanical temperature load. The mechanical pressure and temperature load can be increased up to an unknown limit by reducing the spacing between the trusses and/or increasing the thickness of the trusses and glass-blocks. In theory, the window blocks of the present invention can handle mechanical loads that reach beyond the practical limitations of the window blocks, i.e. window blocks as big as football fields may be manufactured to withstand high mechanical loads; however depending upon their intended use, window blocks of such size may not be practical.

[0018] Continuing on FIG. 1, the window blocks 7 are supported by outer trusses shown here as horizontal and vertical housing trusses 3. The horizontal and vertical orientation of the housing trusses 3 helps to sustain mechanical load possibly caused by the pressurized surface of the windows. An annular liquid-cooled flange 1 is divided into segments 2 by the housing trusses 3. A cooling liquid enters the housing trusses 3 through housing truss liquid inlets 4. The cooling liquid, such as water, may be any liquid that is well known within the art.

[0019] The housing trusses 3 are shaped to include a support surface 5. The support surface 5 supports the window gaskets 6, the window blocks 7 and an upstanding rib 8. Upstanding rib 8 provides support for the internal trusses 9 and spacing for the window blocks 7. The internal trusses 9 are connected to the rib 8 of the external trusses 3 with countersunk screws 14. As shown in FIG. 5, the window blocks 7 are captured between support surface 5 of the housing trusses 3 on one side and internal trusses 9 on the other side. The countersunk screw 14 into upstanding rib 8 applies sufficient force between housing truss 3 and internal truss 9 to hermetically seal the window 7. The hermetic seal is also effectuated by a soft ceramic material (not shown) between inner truss 9 and window block 7. The soft ceramic material equalizes the pressure on the window blocks 7 exerted by the support surface 5. The soft ceramic material may be any soft ceramic that is well known within the art, such as ceramic fabric.

[0020] Attached to the internal trusses 9 are liquid inlets 10. The liquid inlets 10 of the internal trusses 9 are connected to liquid inlet holes 11 in flange plate 12. Housing truss liquid inlets 4 and flange plate liquid inlets 11 allow a cooling liquid to flow through the hollow housing trusses 3 and hollow internal trusses 9. The advantageously orientated trusses are thus cooled by liquid flow. The cooled trusses are able to withstand the increased thermal load and temperature caused by the highly concentrated solar radiation.

[0021] The solar radiation assembly of the present invention may incorporate varying geometries. The differing assembly components, including window segments as detailed above, may have differing shapes, sizes and/or orientation. For example, the window segments can be round, square, rectangular and hexagonal. The corresponding internal and external trusses may be orientated around the shape of the window segments. Further, the window segments of the present invention can be used in large-scale systems as described above, and also in small-scale systems. The accompanying figures and detailed disclosure are in no way limiting

to the geometries of the components that, as assembled, complete the solar radiation assembly and/or structure of the present invention.

[0022] FIG. 2 illustratively depicts a non-limiting example of the outside, solar radiation side, of the assembled concentrated solar radiation assembly. This side of the assembly is exposed to solar radiation, i.e. sunlight, which is collected through the window segments 7. As depicted in FIGS. 2 and 3, there are a total of twelve cooling water flows: one (3a) through each of the four outer trusses 3; one (9a) through each of the four inner trusses 9; there are two through the flange 1 wherein one (1a) flows through the upper half of flange 1 and one (1b) flows through the lower half of flange 1; and finally, two (101 & 102) flow through the curved outer trusses welded to flange 1.

[0023] FIG. 4 illustratively depicts a non-limiting example of the inside, assembly/structure fluid side, of the assembled concentrated solar radiation assembly. This side of the assembly is not exposed to direct solar radiation. This side is exposed to heat from the inside of the assembly.

[0024] The segmented refrigerated windows of the present invention may be pieced together into an inexpensive large-scale solar energy conversion system.

[0025] The resultant segmented refrigerated window for large-scale solar assemblies/structures may be installed by any method, which is well known within the art. The solar assemblies/structures of the present invention are designed for large-scale solar energy conversion systems; however, they may also be employed in small-scale solar energy conversion systems. The segmented hermetically sealed refrigerated windows may be created in an unlimited amount of necessary dimensions. The shapes of the components illustrated in FIGS. 1-4 are the preferred embodiments of the present invention; however, regardless of the size or shape, the solar assembly of the present invention is able to withstand the optical load, thermal load and mechanical load needed for large-scale concentrated solar radiation receiver systems.

[0026] The large-scale concentrated solar radiation assembly and/or structure of the present invention may be implemented in other possible applications. The final physical and chemical characteristics of the solar radiation assembly and/or structure of the present invention may be applied to conventional energy technology, renewable energy technology, industrial heat process technology, conventional cementing technology, thermo chemical process technology, and any application that may benefit from the energy or heat generating properties of the present invention.

[0027] It is to be understood that the invention is not limited to the illustrations described and shown herein, which are deemed to be merely illustrative of the best modes of carrying out the invention, and which are susceptible of modification of form, size, arrangement of parts and details of operation. The invention rather is intended to encompass all such modifications, which are within its spirit and scope as defined by the claims.

What is claimed is:

1. A concentrated solar radiation assembly comprising:
 - a housing divided into segments by hollow housing trusses;
 - window blocks positioned within the segments supported by the housing trusses; and,
 - hollow internal trusses positioned on top of the window blocks and inside the segments, wherein the hollow

housing trusses and internal trusses define cooling flow paths for cooling the structure.

2. The concentrated solar radiation assembly of claim 1, wherein the assembly is hermetically sealed.

3. The concentrated solar radiation assembly of claim 1, wherein the housing comprises an outer annular flange for mounting to the solar radiation assembly.

4. The concentrated solar radiation assembly of claim 1, wherein the housing trusses extend across the housing and intersect each other.

5. The concentrated solar radiation assembly of claim 1, wherein the shape of the housing trusses withstands high mechanical load.

6. The concentrated solar radiation assembly of claim 1, wherein the housing trusses are shaped to support the internal trusses and fix the internal trusses in place.

7. The concentrated solar radiation assembly of claim 1, wherein the shape of the window segments is selected from the group consisting of round, square, rectangular, hexagonal or combinations thereof.

8. The concentrated solar radiation assembly of claim 1, wherein the flow paths are in a longitudinal direction.

9. The concentrated solar radiation assembly of claim 1, further comprising gaskets supported by the housing trusses positioned between the housing trusses and the window blocks.

10. The concentrated solar radiation assembly of claim 1, further comprising soft ceramic material supported by the inner trusses positioned between the inner trusses and the window blocks.

11. The concentrated solar radiation assembly of claim 1, wherein the internal trusses are connected to the housing with countersunk connecting screws.

12. The concentrated solar radiation assembly of claim 1, wherein the window has a dimension greater than or equal to 400 mm.

13. The concentrated solar radiation assembly of claim 1, wherein the window blocks are quartz glass.

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