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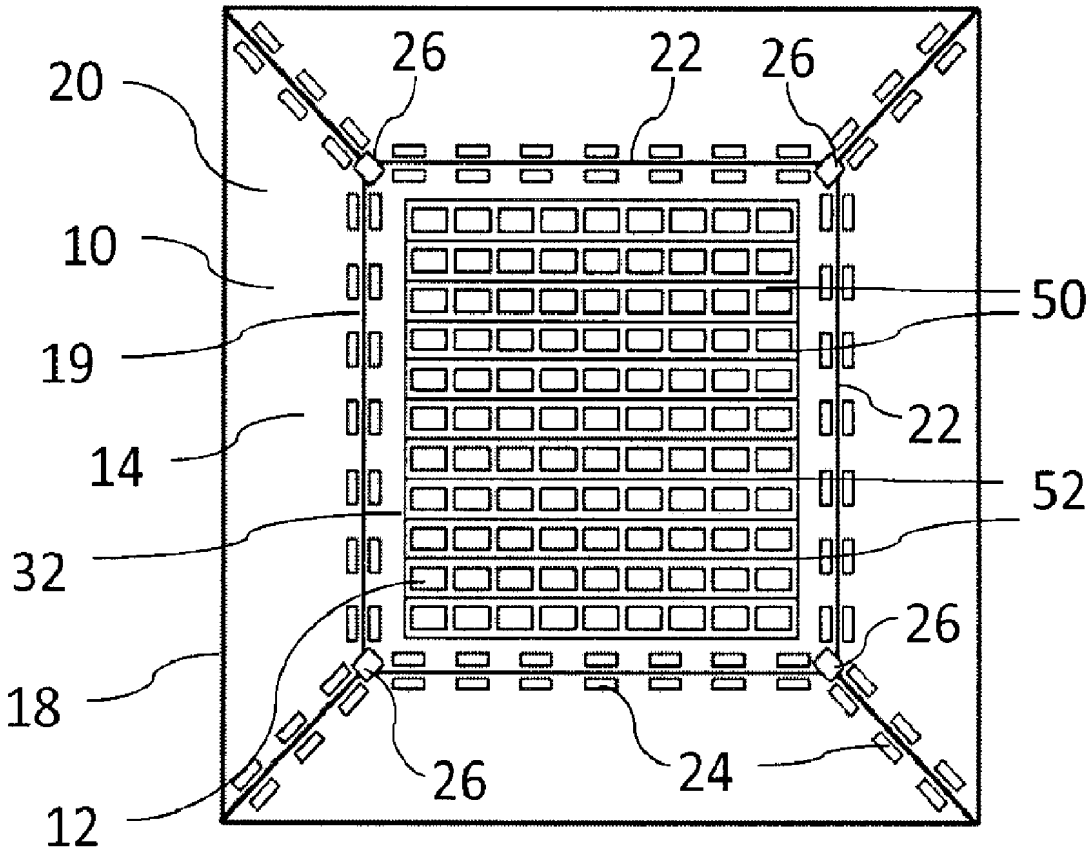
(54) **Titre : REVETEMENT FLOTTANT DOTE DE SUPPORTS STRUCTURELS**
(54) **Title: FLOATING COVER WITH STRUCTURAL SUPPORTS**



(57) **Abrégé/Abstract:**
A floating cover for a body of water has a flexible, impermeable substrate with a bottom face and a top face opposite the bottom face. The substrate is secured laterally across the surface of the body of water while being permitted to move vertically as the level of the body of water changes. A float is affixed to the bottom face of the substrate and a structure is rigidly mounted above the float. The structure extends above the top face of the substrate. The substrate is sealed between the float and the structure. The buoyant force of the float acts against the weight of the structure to maintain the substrate immediately adjacent to the float above the top surface of the body of water so as not to interfere with precipitation drainage.

ABSTRACT OF THE DISCLOSURE

A floating cover for a body of water has a flexible, impermeable substrate with a bottom face and a top face opposite the bottom face. The substrate is secured laterally across the surface of the body of water while being permitted to move vertically as the level of the body of water changes. A float is affixed to the bottom face of the substrate and a structure is rigidly mounted above the float. The structure extends above the top face of the substrate. The substrate is sealed between the float and the structure. The buoyant force of the float acts against the weight of the structure to maintain the substrate immediately adjacent to the float above the top surface of the body of water so as not to interfere with precipitation drainage.

FLOATING COVER WITH STRUCTURAL SUPPORTS

TECHNICAL FIELD

[0001] This relates to floating covers, and in particular, floating covers that support structures on a top surface.

BACKGROUND

[0002] Floating covers are commonly used on bodies of water, such as reservoirs, lagoons, ponds, sloughs, etc. as a cover to prevent evaporation, prevent contamination of the water, to capture gas produced by the water, or to reduce odours. As used herein, the term "water" is used in a broad sense to cover various types of bodies of liquid that may be covered by a floating cover as is known in the art. This may include water or water-based liquids, which may vary from relatively pure sources, such as water that may be used for a municipal water supply, to relatively impure sources, such as effluent or grey-water from a sewage system.

[0003] Typical floating covers are generally held under tension to resist lateral movement, while permitting the cover to move vertically as the level of water changes. In order to address water that may accumulate due to precipitation, floating covers may have a sump that allows water to be drawn off the cover. United States patent no. 3,815,367 (Collins et al.) and 3,815,367 (Collins et al.), each entitled "Floating Reservoir Cover" are early examples of floating covers with tensioners. United States patent no. 3,991900 (Burke et al.) entitled "Reservoir Cover and Canalizing Means" describes a floating cover that is tensioned by weights, that also form a sump. Various devices and designs for floating covers have been used and are known in the art.

SUMMARY

[0004] There is provided an improved tensioned floating cover that supports a structure. The floating cover comprises a flexible, inelastic, impermeable substrate, the substrate having a bottom face and a top face opposite the bottom face, the substrate extending laterally across a surface of a body of water. The floating cover has one or more tensioners that apply tension to a tensioned section of the substrate and bias the tensioned section of the substrate to an installed position on the body of water, the tensioners permitting the substrate to move

vertically on a top surface of the body of water as the volume of water in the body of water changes. The floating cover also has a precipitation drainage system for removing water from the top face of the substrate. The tensioned floating cover is characterized in that there are a plurality of floats affixed to the bottom face of the tensioned section of the substrate, each float having a planar upper profile and a buoyant force in water, wherein each float is spaced from adjacent floats and dimensioned such that in use, the buoyant force maintains the upper profile of the float at a non-disruptive height above the surface of the body of water, the non-disruptive height being a height at which water flow to the precipitation drainage system is not disrupted. One or more structures are rigidly mounted above two or more floats and extend above the top face of the substrate in an upright orientation, the substrate being sealed between the float and the structure, the structure having a weight, wherein the buoyant force of the float acts against the weight of the structure to maintain the substrate immediately adjacent to the float above the surface of the body of water. The one or more tensioners apply sufficient force to maintain the spacing between adjacent floats and to maintain the structures in the upright orientation when acted upon by a predetermined wind load.

[0005] According to another aspect, there is provided a floating cover for a body of water, comprising a flexible, inelastic, impermeable substrate having a bottom face and a top face opposite the bottom face, the substrate being secured laterally across the top surface; one or more tensioners that apply at least 0.5 lb/lineal foot of tension to create a tensioned section of the substrate; a precipitation drainage system for removing water from the top face of the substrate; a plurality of floats having a substantially planar upper profile, the upper profile being affixed to the bottom face of the tensioned section of the substrate, the float having a buoyant force in water; and a structure rigidly mounted above one or more floats, the structure extending above the top face of the substrate, being sealed between the float and the structure and having a weight, wherein the buoyant force of the float acts against the weight of the structure to maintain the substrate immediately adjacent to the float above the top surface of the body of water by 4 inches or less, or 2 inches or less.

[0006] According to an aspect, there is provided an improved tensioned floating cover that supports a structure, the floating cover comprising a flexible, inelastic, impermeable

substrate, the substrate having a bottom face and a top face opposite the bottom face, the substrate extending laterally across a surface of a body of water, the substrate being made from a material that has a tensile strength of at least 100 lb/inch. There are one or more tensioners that apply tension to a tensioned section of the substrate and bias the tensioned section of the substrate to an installed position on the body of water, the tensioners permitting the substrate to move vertically on a top surface of the body of water as the volume of water in the body of water changes. There is a precipitation drainage system for removing water from the top face of the substrate. The tensioned floating cover is characterized in that there are a plurality of floats affixed to the bottom face of the tensioned section of the substrate in a linear or two-dimensional array, each float having a planar upper profile, a buoyant force in water, and a width that is at least 10 times greater than the height, wherein each float is spaced from adjacent floats and dimensioned such that in use, the buoyant force maintains the upper profile of the float at a non-disruptive height above the surface of the body of water, the non-disruptive height being a height at which water flow to the precipitation drainage system is not disrupted. A plurality of structures are rigidly mounted above a plurality of floats distributed about the substrate, the structures extending above the top face of the substrate in an upright orientation, the structure being mounted above the float by a mounting comprising an adhesive mounting, a mechanical mounting, welding, or combination thereof, such that the substrate is sealed between the float and the structure, the structure having a weight, wherein the buoyant force of the float acts against the weight of the structure to maintain the substrate immediately adjacent to the float above the surface of the body of water. The one or more tensioners apply sufficient force to maintain the spacing between adjacent floats and to maintain the structures in the upright orientation when acted upon by a predetermined wind load.

[0007] In other aspects, the floating covers may further comprise one or more of the following features, alone or in combination: the floats may be arranged in a linear or two-dimensional array, the substrate may be made from a material that has a tensile strength of at least 100 lb/inch; the buoyant force may maintain the substrate immediately adjacent to the float above the top surface by 4 inches or less, or 2 inches or less; the float may have a height of less than 6 inches, and a volume extending perpendicular to the height sufficient to provide

the buoyant force; the float may have a width that is at least 10 times greater than the height; the float may comprise a moulded body, a hollow body, a foam filled body, or a laminated structure; the float may comprise ballast that has a density that is greater than or equal to water; the float may be laminated to the bottom face of the substrate; the float may be enclosed within a cavity formed by a second layer of material attached to the bottom face of the impermeable substrate; the structure may be mounted above the float by a mounting comprising an adhesive mounting, a mechanical mounting, welding, or combination thereof; there may be a plurality of structures mounted to a plurality of floats distributed about the substrate; the structure may comprise a body supported above the substrate by a stand; the stand may comprise an assembled frame or a moulded frame, and the body may be supported by a plurality of stands mounted above a plurality of floats; the structure may comprise a support for elongate bodies, a walkway, an access ramp, a working platform, a shelter, a solar module, a decorative element, a shade structure for the body of water, a thermal collector, an aerator, a water cooler, or a pump; the tensioner may comprise length adjustable elements distributed along an outer peripheral edge of the substrate; the tensioner may comprise weights distributed about the top face of the substrate; the substrate may comprise a plurality of substrate sections sealably attached to form the substrate; the floating cover may further comprise stabilizing supports connected between adjacent structures to support the structures against wind pressure; the floating cover may further comprise a plurality of floats and structures, and the stabilizing supports may be connected between adjacent structures; there may be a plurality of floats and structures, and the stabilizing supports may be connected between adjacent floats; the floating cover may further comprise one or more anchors, which may be buoyant or neutrally buoyant in water, affixed to the substrate, and the stabilizing supports may connect between the one or more anchors and the structure or between the one or more anchor and the float; the force applied by the tensioners may permit the substrate to shift under wind loads greater than the predetermined wind load, and return the substrate to the predetermined position relative to the body of water after the wind load is reduced to below the predetermined wind load.

[0008] According to another aspect, there is provided a method of mounting a structure above a floating cover, the method comprising the steps of: providing a floating cover as

described above, having a plurality of substrate sections of a flexible, inelastic, impermeable substrate, the substrate sections with a top face, a bottom face, and parallel side edges separated by a width; affixing a plurality of floats to the bottom face of one or more substrate sections, the floats having a buoyant force in water, the floats being low profile and having a substantially planar upper profile that engages the substrate; rigidly mounting structures to the floats such that the structures extend away from the floats and the top face of the one or more substrate sections; attaching the plurality of substrate sections in edge to edge relation along the parallel side edges to form the substrate, the floats having a height relative to the width of the at least one section that permits adjacent substrate sections to be attached in edge to edge relation without interfering with the attachment between edges to form a sealed surface; installing the substrate on a reservoir and filling the reservoir to form a body of water having a surface; applying tension to the substrate to at least that portion of the substrate to which floats are affixed, the applied tension being sufficient to maintain the spacing between adjacent floats and to maintain the structures in the upright orientation when acted upon by a predetermined wind load.

[0009] According to an aspect, there is provided a method of mounting a structure above a floating cover, the method comprising the steps of: providing a plurality of substrate sections of a flexible, inelastic, impermeable substrate, the substrate sections having a top face, a bottom face, and parallel side edges separated by a width; affixing a plurality of floats to the bottom face of one or more substrate sections, the floats having a buoyant force in water, the floats being low profile and having a substantially planar upper profile that engages the substrate; rigidly mounting structures to the floats such that the structures extend away from the floats and the top face of the one or more substrate sections; attaching the plurality of substrate sections in edge to edge relation along the parallel side edges to form the substrate; installing the substrate on a reservoir and filling the reservoir to form a body of water having a surface, such that the upper profile of the floats is maintained at a non-disruptive height above the surface of the body of water, the non-disruptive height being a height at which water flow to the precipitation drainage system is not disrupted; and applying tension to the substrate to at least that portion of the substrate to which floats are affixed, the applied tension being sufficient to maintain the spacing between adjacent floats, to maintain the structures in the

upright orientation, and maintain the substrate in a predetermined position relative to the body of water when acted upon by a predetermined wind load, the applied tension permitting the substrate to shift under wind loads greater than the predetermined wind load, and returning the substrate to the predetermined position relative to the body of water after the wind load is reduced to below the predetermined wind load.

[0010] According to other aspects of the method described above, the floats may be affixed to the one or more substrate sections with the one or more substrate sections inverted; and the one or more substrate sections to which the floats are affixed may be prepared with the floats and at least a portion of the structures offsite.

[0011] In other aspects, the features described above may be combined together in any reasonable combination as will be recognized by those skilled in the art.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] These and other features will become more apparent from the following description in which reference is made to the appended drawings, the drawings are for the purpose of illustration only and are not intended to be in any way limiting, wherein:

FIG. 1 is a top plan view of a pond.

FIG. 2A is a top plan view of a pond covered by a floating cover tensioned by weights.

FIG. 2B is a top plan view of a pond covered by a floating cover and supporting structures in a two dimensional array.

FIG. 3A is a top plan view of a pond covered by a floating cover tensioned by elongate members attached to a tower.

FIG. 3B is a top plan view of a pond covered by a floating cover and supporting structures in a linear array.

FIG. 4 is a side elevation view of a floating cover with two floats supporting two structures.

FIG. 5 is a side elevation view a floating cover with two floats supporting one structure.

FIG. 6 is a side elevation view of a floating cover with a float supporting a structure and a perimeter anchor that provides a counterbalance.

FIG. 7 is a side elevation view of a floating cover with two floats supporting two structures and connected by a connector.

FIG. 8 is a side elevation view of a floating cover with one float supporting a structure directly on the cover.

FIG. 9 is a side elevation view of a floating cover with the float contained in a pocket of the cover.

FIG. 10 is a side elevation view of a floating cover with a float supporting a structure having a portion that extends below the cover.

FIG. 11 is a side elevation view of a floating cover having a tensioning structure with floats and a weighted sump area.

FIG. 12 is a side elevation view of a floating cover tensioned by an elongate member.

FIG. 13 is a perspective view of a high aspect ratio float.

FIG. 14 is a cross-sectional view of an anchor partially filled with ballast.

FIG. 15 is a side elevation view of a pond having a weight tensioned floating cover.

FIG. 16 is a side elevation view of a pond having a floating cover tensioned by an elongate member.

FIG. 17 is a side elevation view of a section of the floating cover substrate folded over floats.

FIG. 18 is a perspective view of a section of the floating cover, preformed with holes, and being unrolled over the floats.

DETAILED DESCRIPTION

[0013] There will now be described a floating cover, generally identified by reference number 10, that is designed to support a structure 12 above a body of water 16, without affecting the ability of floating cover 10 to operate as such.

[0014] FIG. 1 shows a body of water 16, which may be a pond or other body of water.

Referring to FIG. 2A, 2B, 3A, and 3B, there is shown a floating cover 10 made from a substrate 14 that is used to cover body of water 16. Substrate 14 is made from a material that is flexible, inelastic, and impermeable. An example of a suitable material is CSPE 45 mil, 3ply (chlorosulphonated polyethylene), which has a tensile strength of about 100 lb/inch. Other material may be used with suitable properties as may be selected by a person of ordinary skill. Preferably, the linear tensile strength will be at least 100 lb/inch, or sufficient to support the various loads, including wind loads, etc. without failing. Substrate 14 may be assembled from different materials for different areas, and may be stronger, to account for different load that may be experienced by substrate 14. While there are various degrees of flexibility and elasticity, substrate 14 may be considered flexible if it can be rolled or folded into a package for storage or transport, and may be considered inelastic if there is a negligible amount of stretching across its length under typical wind loads that may be experienced by floating cover 10.

[0015] Substrate 14 is tensioned in order to hold substrate 14 laterally on body of water 16 and allows substrate 14 to move vertically as the volume of water in the body of water 16 changes. Preferably, the tension is applied by a tensioner that is able to adjust, move, or otherwise adapt to movement, such as a length-adjustable spring member or weight, either on substrate 14 or along an outer perimeter 18 of substrate 14. By using adaptable tensioners, substrate 14 is able to adjust by taking in any slack as the level of body of water 16 rises, or allow more slack out as the level goes down. Various types of tensioners as known in the art may be used. For example, referring to FIG. 12, the tensioners are towers 15 with weights on pulleys inside the towers (not shown), positioned around outer perimeter 18 of substrate 14. Alternatively, tensioners may take other designs using elongate members, such as tensioning springs. Referring to FIG. 11, the tensioners may be weights 19 distributed on top surface 20 of substrate 14. As shown, weights 19 take up any slack in substrate 14 by sinking, or deploying slack by moving up. Preferably, weights 19 are installed in a line with floats 24 on the top surface 20 of substrate 14 on either side of weights 19, which keeps substrate 14 that is adjacent to weights 19 on top of body of water 16, rather than sinking with weights 19.

[0016] Substrate 14 is also provided with a precipitation drainage system, such as sump

22 as shown in FIG. 2A and FIG. 2B or drain line 23 as shown in FIG. 3A and 3B, in order to remove water from top face 20 of substrate 14. Generally speaking, the most common type of water that will be found on top of substrate 14 will be from precipitation, although sump 22 will be capable of draining any liquid on the top of substrate 14. As shown, sump 22 includes a pump 26 that is in fluid communication with the depressions caused by weights 19. Weights 19 may be part of the tensioning system as shown in FIG. 2, or may be at a fixed depth, and may be solely for the purpose of creating channels that allow water to flow to sump pump 26, which will be in a depression that is even lower than weights 19, and allow water to be pumped off of substrate 14, either under substrate 14 into body of water 16 or away from body of water 16. While one pump 26 is shown at each of the intersections of the channels, there may be any number of pumps 26, depending on the requirements of the particular floating cover 10. As an alternative to sump 22 or drain line 23, persons of ordinary skill may use other drainage systems as are known in the art.

[0017] The tension and drainage aspects described above are generally known in the art and are commonly used in floating covers installed on bodies of water. As will be described herein, floating cover 10 differs from prior art floating covers in its ability to support a structure above substrate 14 without preventing floating cover 10 from operating as a floating cover 10. In particular, floating cover 10 remains a sealed, impermeable cover, and allows water to be drained off of top face 20 of substrate 14. As described below, floating cover 10 has an area 32 on which the structures are installed, which includes a tensioned section of substrate 14. The characteristics of area 32 may depend on the design of floating cover 10 as well as the characteristics of body of water 16, such as the angle of the sides of body of water 16. As an example, in order to maintain a suitable spacing and position for the structure, area 32 may be defined by weights 19, either as part of sump 22 or as used as a tensioning device, where weights 19 are shown in a square configuration. Other shapes may also be used, or there may be more than one area 32, which may be separated by weights 19. Alternatively, if weights are not used, area 32 may include the entire substrate 14, or at least that area that will remain in contact with water, and not lifted off body of water 16 as the level of body of water 16 changes. The details of how the structures are installed on substrate 14 will be described below.

[0018] Referring to FIG. 2B and 3B, floating cover 10 is provided with a plurality of support floats 30 that are affixed to the bottom face 34 of area 32 in spaced relation, and which are positioned below structures 12 in order to support them above substrate 14. Referring to FIG. 4, each float 30 has a buoyant force in water, with a planar upper profile 36. A suitable shape for float 30 is a rectangular prism, with a height that is significantly less than its width and length. In one example, the height may be less than 1/10 of either the width or the length, and may be 6 inches or less. However, the dimensions of float 30 will depend on the preferences of the user and the characteristics of floating cover 10, including the weight of structure 12 and any tension that may be applied by substrate 14.

[0019] The height of float 30 when installed will depend on the buoyant force of float 30 and the load applied from above. The height must be sufficient to support substrate 14 at or above the surface of body of water 16. If float 30 does not support substrate 14 at or above body of water 16, there is a risk that substrate 14 may have low points which can then accumulate surface water due to precipitation, etc. Preferably, substrate 14 will be supported at least a small amount above body of water 16 to allow for some tolerance for error. However, at the same time, if substrate 14 is lifted above a maximum height above the top surface of body of water 16, floats 30 will disrupt the flow of water toward sump 22 by creating creases or other contours in the inelastic substrate 14. This will also result in water accumulating above substrate 14. Any accumulation of water on substrate 14 is to be avoided as, once water starts to accumulate in an undesired location, a deposit of dust, dirt, etc. will begin to accumulate as the water evaporates. The dust and dirt will increase the weight in that area, such that more water will accumulate in that area, and continue to increase the weight in that area, and will ultimately result in the failure of floating cover 10, either structurally or in its purpose, if corrective action is not taken. In a preferred embodiment, float 30 will extend between 1/8and 4 inches above the surface of body of water 16, or in some cases between 1/8 and 2 inches.

[0020] Floats 30 are spaced from each other, and are preferably in a two dimensional array as shown in FIG. 2B, or a one dimensional array as shown in FIG. 3B, in order to provide a suitable platform on which structures 12 may be mounted. Structure 12 is mounted to floats

30 such that structure 12 extends above the top face 20 of substrate 14 in an upright orientation, and such that substrate 14 is sealed between float 30 and structure 12 to ensure substrate 14 remains sealed and impermeable across body of water 16. The buoyant force of float 30 acts against the weight of structure 12 to maintain substrate 14 that is immediately adjacent to float 16 above the surface of body of water 16. Floats 30 may take various forms as is known in the art, and may be a moulded body, a hollow body, a foam-filled body, a solid body with a low density, a laminated or composite structure, etc. Referring to FIG. 14, float 30 may be a composite structure that includes ballast 37 that is denser or of the same density as water, to reduce the buoyancy of float 30 in water. This may be used to control the height of float 30 in water, to increase the stability of float 30, or to act as an anchor instead of or in addition to a float, as will be described below.

[0021] Float 30 may be mounted to substrate 14 in different ways. Referring to FIG. 4, float 30 and substrate 14 may be laminated together at attachment 38, such as by an adhesive or the application of heat, or may be attached at attachment 38 by using a mechanical attachment, such as a pin connector or other type of attachment that extends through substrate 14, and may attach to structure 12. If mechanical attachment is designed to extend through substrate 14, it should be done in such a way that substrate 14 remains sealed against water passing through in either direction. Referring to FIG. 9, float 30 may also be installed in a cavity 39 that is formed by a second layer of material 14a that is attached to bottom face of substrate 14. Second layer 14a need not be the same material as substrate 14, and may not have the same characteristics. For example, it may not be impermeable.

[0022] As shown, structure 12 extends above substrate 14. In doing so, structure 12 is mounted above float 30, either directly to float 30 or to substrate 14, by various mounting structures, such as by adhesive or heat welding to substrate 14 as shown in FIG. 8, or by mechanical mounting, as shown in FIG. 4. Structure 12 may take various forms, such as a single structure that is supported by multiple floats 30 as shown in FIG. 5, or multiple structures, each of which is supported by one or more floats 30 as shown in FIG. 4. Structure 12 may be a unitary body as shown in FIG. 8, or, referring to FIG. 4, structure 12 may include a stand 40 that supports a body 42 above substrate 14. Stand 40 may be a frame as shown,

which may be an assembled frame, or a moulded frame, or may be a solid or hollow body. The composition of structure 12 will depend on purpose of structure 12, its size and weight, the environmental conditions in which it will be used, etc. In the example shown in FIG.5, there are multiple stands 40 that support an elongate body 42 that extends across the multiple stands 40, such as a pipeline. In other examples, referring to FIG. 7, body 42 may be a walkway for workers, a working platform, an access ramp, a shelter or building, etc. that are either mounted to one or more stands 40, or directly on substrate 14 above floats 30. On other examples, referring to FIG. 8, structure 12 may include a single body 42a mounted above a single float 30, such as solar module, a decorative element, a shade structure for the body of water, a thermal collector, a water cooler, a pump, etc. or may be used to support equipment 54 below substrate 14, such as a pump or aerator. It will be understood that each type of structure 12 described above may be mounted to one float 30, or more than one float 30, and each may be mounted to a stand above float 30, or mounted directly to float 30, depending on various factors, such as the preferences of the user, the construction of structure 12, its size, its weight, etc.

[0023] As noted above, the spacing between floats 30 is maintained at a desired distance, which is at least partly accomplished by properly tensioning substrate 14. The tension is designed to apply sufficient force to maintain the spacing between adjacent floats 30 and to maintain structures 12 in an upright orientation when acted upon by environmental conditions, and in particular, a predetermined wind load. The predetermined wind load may be the wind loads that are typical for the environment in which cover 10 is installed based on average conditions, or somewhat more than the typical wind loads to provide a measure of additional protection against exceptional winds that may be encountered. Alternatively, floating cover 10 may be tensioned sufficiently to withstand the maximum possible wind loads that may be experienced by floating cover 10. For example, in any given year, an area may experience wind gusts of up to 40 mph, but may experience wind gust of up to 70 mph on rare occasions. Floating cover 10 may be tensioned sufficiently to withstand a 40 mph wind gust without moving, and may be designed to allow for some movement in exceptionally high wind conditions, or may be tensioned sufficiently to withstand even an exceptional wind event with wind loads that are higher than normal. In any event, floating

cover 10 will be designed to recover from the maximum level of wind loads that may be applied. This may involve allowing substrate 14 to shift laterally across body of water 16, and to allow some tipping movement of structure 12, but allowing floating cover 10 to return to its original position once the exceptional wind event has ended. Of these consequences, lateral movement of 14 is relatively more acceptable that allowing structure 12 to move too much, as the movement of structure 12 may result in damage to structure 12 or substrate 14.

[0024] In order to enhance the resistance to wind loads in floating cover 10, certain strategies may be used and additional elements installed. As noted above, two main considerations with respect to the reaction of floating cover 10 to wind loads are the lateral movement of substrate 14 in response to wind loads, and the movement of structures 12 in response to wind loads. Preferably, substrate 14 will be sufficiently anchored to prevent lateral movement, or at least limited to extreme weather events. There may be some advantages to allowing substrate 14 to move laterally during extreme weather events, including a reduction in the cost of equipment and installation. Of greater concern is the possible movement of structures 12 relative to substrate 14. Structures 12 must be sufficiently supported by substrate 14 (e.g. via floats 30) such that they remain attached even during extreme weather events. Structures 12 must also be sufficient supported to prevent tipping as a result of wind loads. While it is impossible to prevent all movement in structure 12, any movement that is permitted must be limited to movement that will not cause damage to floating cover 10, e.g. either structure 12 substrate 14, or floats 30.

[0025] If the tension in substrate 14 is insufficient to accomplish the above purposes, floating cover 10 may be provided with various types of stabilizing supports that support structure 12 against wind pressure. Generally speaking, the stabilizing supports act to lower the centre of gravity of structure 12, increase the moment arm required to tip structure 12, transfer loads to an adjacent structure, etc.

[0026] In one example, the stabilizing supports may be connectors 44 that connect between adjacent structures 12 or floats 30. Connectors 44 may extend diagonally from top to bottom of adjacent structures 12 or floats 30, or may connect horizontally between structures

12 or floats 30, either above or below substrate 14. If connectors 44 are above substrate 14, as shown in FIG. 7, care must be taken to avoid weighting substrate 14 in such a way that it will interfere with water flow across substrate 14. As structures 12 begin to tip, one end or edge will go up, and another will go down. As the wind load will generally be in the same direction across all of floating cover 10, or at least within the same localized area, adjacent structures 12 will tilt in the same direction, meaning adjacent edges will move in opposite directions. By connecting adjacent structures 12 or floats 30 with inelastic connectors 44, the connectors 44 will be placed under tension and will resist the tipping movement of structures 12. Connectors 44 are preferably rigid, and may be made from a variety of materials, depending on the preferences of the user. As noted previously, substrate 14 is tensioned, which biases floats 30 into a predetermined array.

[0027] In another example, referring to FIG. 6, anchors 46 may be affixed to substrate 14. Anchors 46 are preferably weighted to resist substrate 14 from being lifted, but may have a sufficiently low overall density to be buoyant in water to prevent pulling down on substrate 14 if not sufficiently supported in other ways. Anchors 46 are preferably positioned beneath substrate 14 and around the perimeter of the array of floats 30 to provide stability to floats 30, substrate 14, and ultimately structures 12. Anchors 46 may be attached in various ways, similar to the manner in which floats 30 are attached to substrate 14. The weight and buoyancy of anchors 46 will be selected such that they do not extend above the surface of body of water 12 in such a way as to interfere with the flow of water across substrate 14. In one example, anchors 46 may be neutrally buoyant, such that they are sufficiently buoyant to have a low profile in water without sinking, and such that their weight is only apparent when anchors 46 are lifted out of water. As they have a low profile above the water level of body of water 16, anchors 46 will have little impact on wind loads and water flow, but will be useful in supporting structures 12. Anchors 46 may be attached by connectors 44 to adjacent structures or floats 30, and provide similar benefits to those described above, although without a corresponding structure 12 above anchor 46. Alternatively, or in addition, there may be mechanical anchors (not shown) that attach between floats 30 or anchors 46 and the bottom of the body of water to assist in anchoring structures 12 and substrate 14.

[0028] Method of Construction

[0029] An example of construction for floating cover 10 will now be described. Referring to FIG. 2, for bodies of water 16 with a large surface area, typical covers are commonly prepared by attaching multiple sections 50 together in edge to edge relation. The edges of sections 50 are generally straight and parallel to allow them to be attached easily, which is generally done by welding in order to seal substrate 14. The ends of sections 50 may also be straight, or may be angled or curved to match the shape of the body of water.

[0030] Before completing the seams 52 between sections 50, floats 30 are attached to the bottom of sections 50. This may be done either on site with sections 50 laid out, in which case floats 30 may be transported separately from sections 50 of substrate 14, which will be transported in a folded or rolled configuration, or may be attached partially or fully by the manufacturer, which will generally require substrate 14 to be folded with floats 30 in each folded section, as shown in FIG. 17. If floats 30 are attached on site, it may be convenient to invert sections 50 to provide access to the bottom surface of substrate 14. Preferably, sections 50 are narrow enough to be moved manually and to provide easy access to floats 30 as they are being installed. In another example, rather than attaching floats 30 off site, substrate sections 50 may be provided with holes 56 offsite, making it easier to align and attach floats 30 as section 50 is unrolled, as shown in FIG. 18. It will be understood that any convenient method of attaching floats 30 to the bottom of sections 50 may be used. Once floats 30 are attached to sections 50, sections 50 are properly aligned and attached together. In order to allow seam 52 between sections 50 to be properly formed, floats 30 are preferably provided with a low height to prevent the material from bunching or pulling away from seam 52, and to ensure substrate 14 does not disrupt the flow of water to sump 22. The rest of substrate 14, including the installation of sump 22, tensioners 14/19, etc. may be accomplished as is known in the art.

[0031] Structure 12 is preferably installed above substrate 14 prior to filling body of water 16 with water, and must be accomplished in such a manner that substrate 14 remains sealed above body of water 16. If used, connectors 44 are also installed at a convenient time. If attached to floats 30, connectors are preferably installed while section 50 is inverted, or prior

to seam 52 being completed. Once structure 12 and floats 30 are installed, and substrate 14 properly positioned above where body of water 16 will be located, body of water 16 may then be filled with water. It may also be possible to install a cover over an existing body of water 16, however this will require a different set of steps.

[0032] In this patent document, the word "comprising" is used in its non-limiting sense to mean that items following the word are included, but items not specifically mentioned are not excluded. A reference to an element by the indefinite article "a" does not exclude the possibility that more than one of the elements is present, unless the context clearly requires that there be one and only one of the elements.

[0033] The scope of the following claims should not be limited by the preferred embodiments set forth in the examples above and in the drawings, but should be given the broadest interpretation consistent with the description as a whole.

What is Claimed is:

1. An improved tensioned floating cover that supports a structure, the floating cover comprising:

a flexible, inelastic, impermeable substrate, the substrate having a bottom face and a top face opposite the bottom face, the substrate extending laterally across a surface of a body of water;

one or more tensioners that apply tension to a tensioned section of the substrate and bias the tensioned section of the substrate to an installed position on the body of water, the tensioners permitting the substrate to move vertically on a top surface of the body of water as the volume of water in the body of water changes; and

a precipitation drainage system for removing water from the top face of the substrate;

the tensioned floating cover being characterized in that:

a plurality of floats are affixed to the bottom face of the tensioned section of the substrate, each float having a planar upper profile and a buoyant force in water, wherein each float is spaced from adjacent floats and dimensioned such that in use, the buoyant force maintains the upper profile of the float at a non-disruptive height above the surface of the body of water, the non-disruptive height being a height at which water flow to the precipitation drainage system is not disrupted;

one or more structures are rigidly mounted above two or more floats and extend above the top face of the substrate in an upright orientation, the substrate being sealed between the float and the structure, the structure having a weight, wherein the buoyant force of the float acts against the weight of the structure to maintain the substrate immediately adjacent to the float above the surface of the body of water; and

the one or more tensioners apply sufficient force to maintain the spacing between adjacent floats and to maintain the structures in the upright orientation when acted upon by a predetermined wind load.

2. The improved tensioned floating cover of claim 1, wherein the floats are arranged in a linear or two-dimensional array.

3. The improved tensioned floating cover of claim 1, wherein the substrate is made from a material that has a tensile strength of at least 100 lb/inch.

4. The improved tensioned floating cover of claim 1, wherein the buoyant force maintains the substrate immediately adjacent to the float above the top surface by 4 inches or less.

5. The floating cover of claim 1, wherein the float has a height of less than 6 inches, and a volume extending perpendicular to the height sufficient to provide the buoyant force.

6. The floating cover of claim 1, wherein the float has a width that is at least 10 times greater than the height.

7. The floating cover of claim 1, wherein the float comprises a moulded body, a hollow body, a foam filled body, or a laminated structure.

8. The floating cover of claim 1, wherein the float comprises ballast having a density that is greater than or equal to water.

9. The floating cover of claim 1, wherein the float is laminated to the bottom face of the substrate.

10. The floating cover of claim 1, wherein the float is affixed by enclosing the float within a cavity formed by a second layer of material attached to the bottom face of the impermeable substrate.

11. The floating cover of claim 1, wherein the structure is mounted above the float by a mounting comprising an adhesive mounting, a mechanical mounting, welding, or combination thereof.

12. The floating cover of claim 1, comprising a plurality of structures mounted to a plurality of floats distributed about the substrate.

13. The floating cover of claim 1, wherein the structure comprises a body supported above the substrate by a stand.

14. The floating cover of claim 13, wherein the stand comprises an assembled frame or a moulded frame.

15. The floating cover of claim 13, wherein the body is supported by a plurality of stands mounted above a plurality of floats.

16. The floating cover of claim 1, wherein the structure comprises a support for elongate bodies, a walkway, an access ramp, a working platform, a shelter, a solar module, a decorative element, a shade structure for the body of water, a thermal collector, an aerator, a water cooler, or a pump.

17. The floating cover of claim 1, wherein the tensioner comprises length adjustable elements distributed along an outer peripheral edge of the substrate.

18. The floating cover of claim 1, wherein the tensioner comprises weights distributed about the top face of the substrate.

19. The floating cover of claim 1, wherein the substrate comprises a plurality of substrate sections sealably attached to form the substrate.

20. The floating cover of claim 1, further comprising stabilizing supports connected between adjacent structures to support the structures against wind pressure.

21. The floating cover of claim 20, comprising a plurality of floats and structures, and wherein the stabilizing supports are connected between adjacent structures.

22. The floating cover of claim 20, comprising a plurality of floats and structures, and wherein the stabilizing supports are connected between adjacent floats.

23. The floating cover of claim 20, further comprising one or more anchors affixed to the substrate.

24. The floating cover of claim 23, wherein the anchors are buoyant or neutrally buoyant in water.

25. The floating cover of claim 1, wherein the force applied by the tensioners permits the substrate to shift under wind loads greater than the predetermined wind load, and returns the substrate to the predetermined position relative to the body of water after the wind load is reduced to below the predetermined wind load.

26. A floating cover for a body of water, comprising:

a flexible, inelastic, impermeable substrate having a bottom face and a top face opposite the bottom face, the substrate being secured laterally across the top surface;

one or more tensioners that apply at least 0.5 lb/lineal foot of tension to create a tensioned section of the substrate;

a precipitation drainage system for removing water from the top face of the substrate;

a plurality of floats having a substantially planar upper profile, the upper profile being affixed to the bottom face of the tensioned section of the substrate, the float having a buoyant force in water; and

a structure rigidly mounted above one or more floats, the structure extending above the top face of the substrate, being sealed between the float and the structure and having a weight, wherein the buoyant force of the float acts against the weight of the structure to maintain the substrate immediately adjacent to the float above the top surface of the body of water by 4 inches or less.

27. A method of mounting a structure above a floating cover, the method comprising the steps of:

providing a plurality of substrate sections of a flexible, inelastic, impermeable substrate, the substrate sections having a top face, a bottom face, and parallel side edges separated by a width;

affixing a plurality of floats to the bottom face of one or more substrate sections, the floats having a buoyant force in water, the floats being low profile and having a substantially planar upper profile that engages the substrate;

rigidly mounting structures to the floats such that the structures extend away from the floats and the top face of the one or more substrate sections;

attaching the plurality of substrate sections in edge to edge relation along the parallel side edges to form the substrate, the floats having a height relative to the width of the at least one section that permits adjacent substrate sections to be attached in edge to edge relation without interfering with the attachment between edges to form a sealed surface;

installing the substrate on a reservoir and filling the reservoir to form a body of water having a surface;

applying tension to the substrate to at least that portion of the substrate to which floats are affixed, the applied tension being sufficient to maintain the spacing between adjacent floats and to maintain the structures in the upright orientation when acted upon by a predetermined wind load.

28. The method of claim 27, wherein the floats are affixed to the one or more substrate sections with the one or more substrate sections inverted.

29. The method of claim 27, wherein the one or more substrate sections to which the floats are affixed to the one or more substrate sections offsite.

30. A method of mounting a structure above a floating cover, the method comprising the steps of:

providing a plurality of substrate sections of a flexible, inelastic, impermeable substrate, the substrate sections having a top face, a bottom face, and parallel side edges separated by a width;

affixing a plurality of floats to the bottom face of one or more substrate sections, the floats having a buoyant force in water, the floats being low profile and having a substantially planar upper profile that engages the substrate;

rigidly mounting structures to the floats such that the structures extend away from the floats and the top face of the one or more substrate sections;

attaching the plurality of substrate sections in edge to edge relation along the parallel side edges to form the substrate;

providing a precipitation drainage system for removing water from the top face of the substrate;

installing the substrate on a reservoir and filling the reservoir to form a body of water having a surface, such that the upper profile of the floats is maintained at a non-disruptive height above the surface of the body of water, the non-disruptive height being a height at which water flow to the precipitation drainage system is not disrupted;

applying tension to the substrate to at least that portion of the substrate to which floats are affixed, the applied tension being sufficient to maintain the spacing between adjacent floats, to maintain the structures in the upright orientation, and maintain the substrate in a predetermined position relative to the body of water when acted upon by a predetermined wind load, the applied tension permitting the substrate to shift under wind loads greater than the predetermined wind load, and returning the substrate to the predetermined position relative to the body of water after the wind load is reduced to below the predetermined wind load.

31. An improved tensioned floating cover that supports a structure, the floating cover comprising:

a flexible, inelastic, impermeable substrate, the substrate having a bottom face and a top face opposite the bottom face, the substrate extending laterally across a surface of a body of water, the substrate being made from a material that has a tensile strength of at least 100 lb/inch;

one or more tensioners that apply tension to a tensioned section of the substrate and bias the tensioned section of the substrate to an installed position on the body of water, the tensioners permitting the substrate to move vertically on a top surface of the body of water as the volume of water in the body of water changes; and

a precipitation drainage system for removing water from the top face of the substrate;

the tensioned floating cover being characterized in that:

a plurality of floats are affixed to the bottom face of the tensioned section of the substrate in a linear or two-dimensional array, each float having a planar upper profile, a buoyant force in water, and a width that is at least 10 times greater than the height, wherein each float is spaced from adjacent floats and dimensioned such that in use, the buoyant force

maintains the upper profile of the float at a non-disruptive height above the surface of the body of water, the non-disruptive height being a height at which water flow to the precipitation drainage system is not disrupted;

a plurality of structures are rigidly mounted above a plurality of floats distributed about the substrate, the structures extending above the top face of the substrate in an upright orientation, the structure being mounted above the float by a mounting comprising an adhesive mounting, a mechanical mounting, welding, or combination thereof, such that the substrate is sealed between the float and the structure, the structure having a weight, wherein the buoyant force of the float acts against the weight of the structure to maintain the substrate immediately adjacent to the float above the surface of the body of water; and

the one or more tensioners apply sufficient force to maintain the spacing between adjacent floats and to maintain the structures in the upright orientation when acted upon by a predetermined wind load.

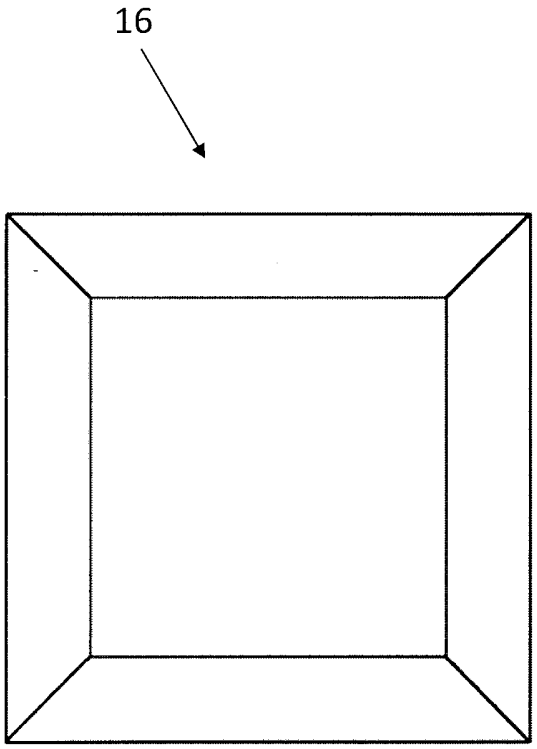


FIG. 1

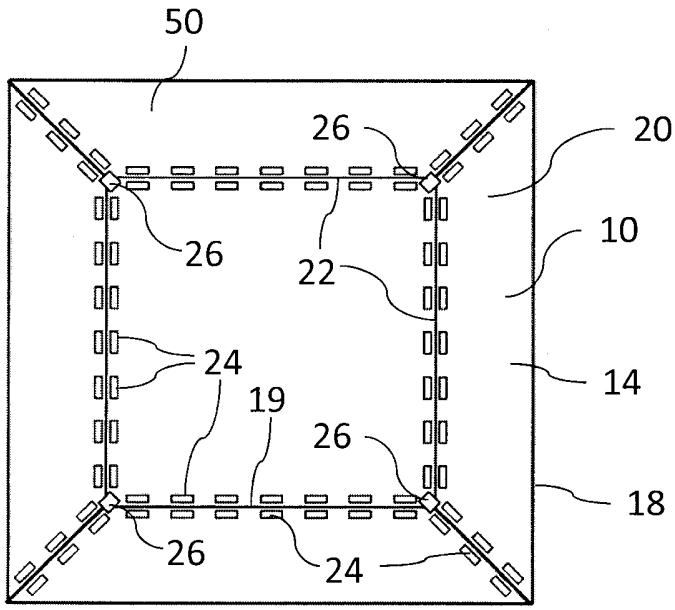

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FIG. 2A

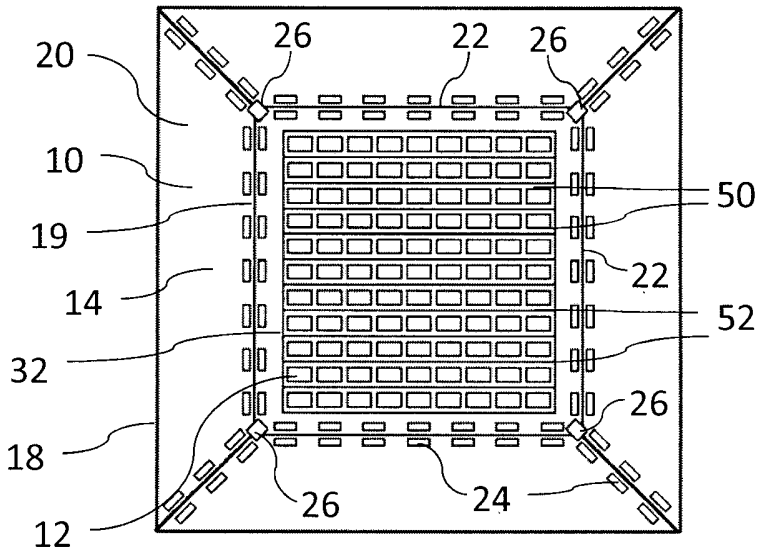
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FIG. 2B

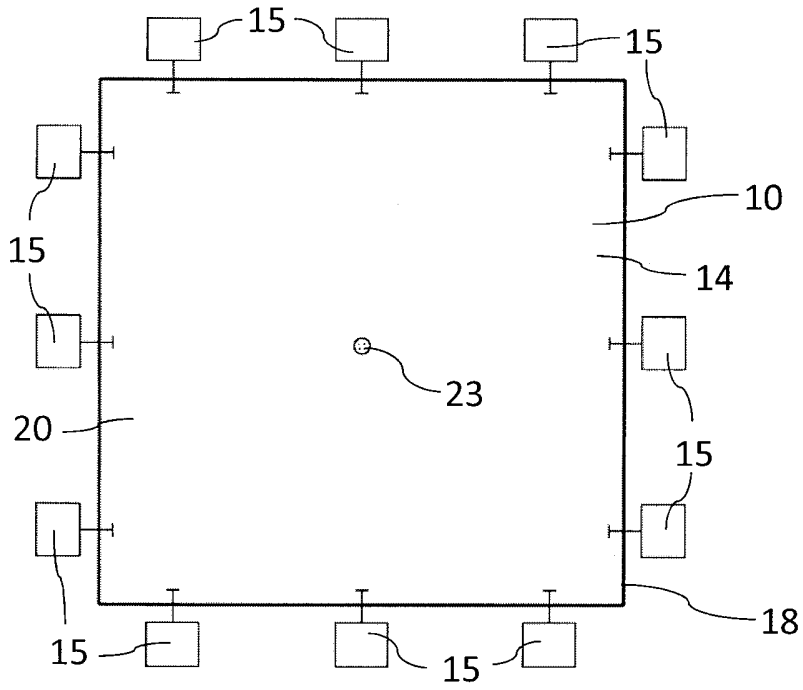
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FIG. 3A

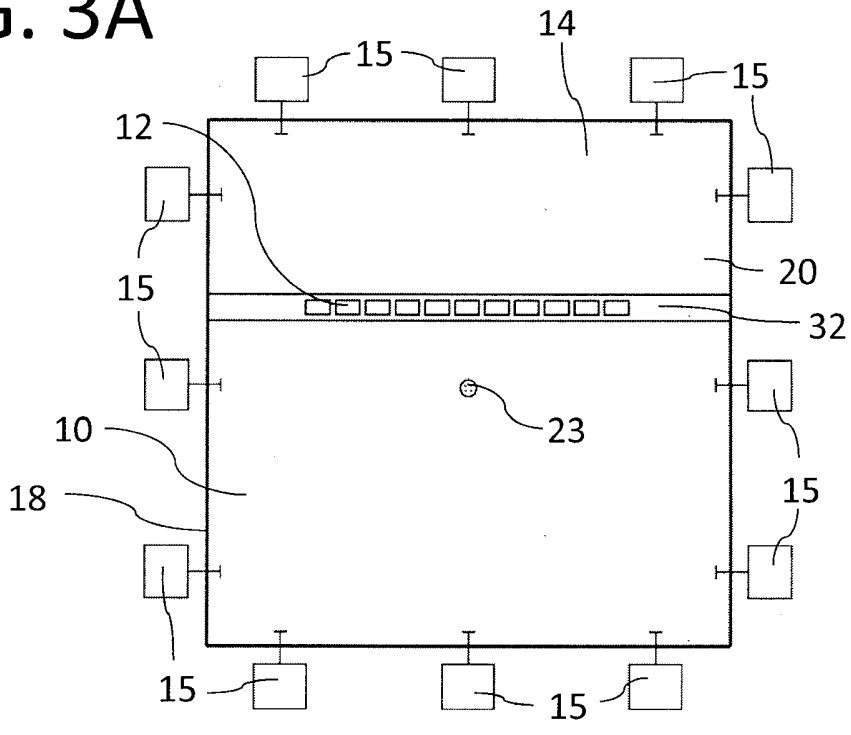
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FIG. 3B

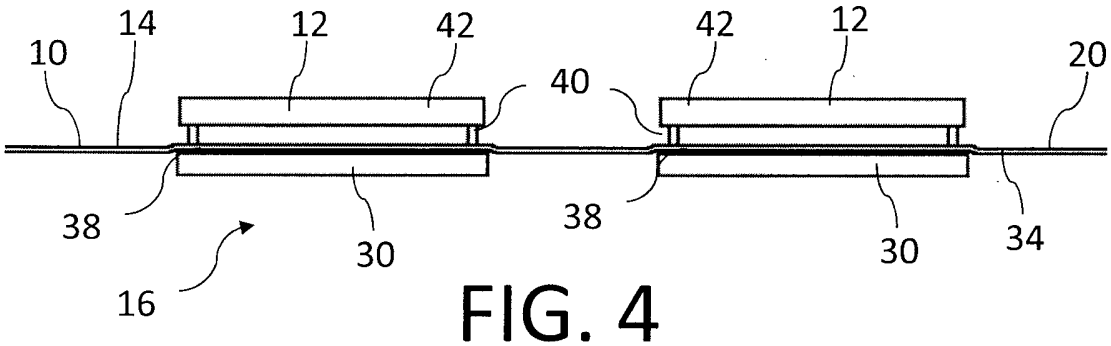


FIG. 4

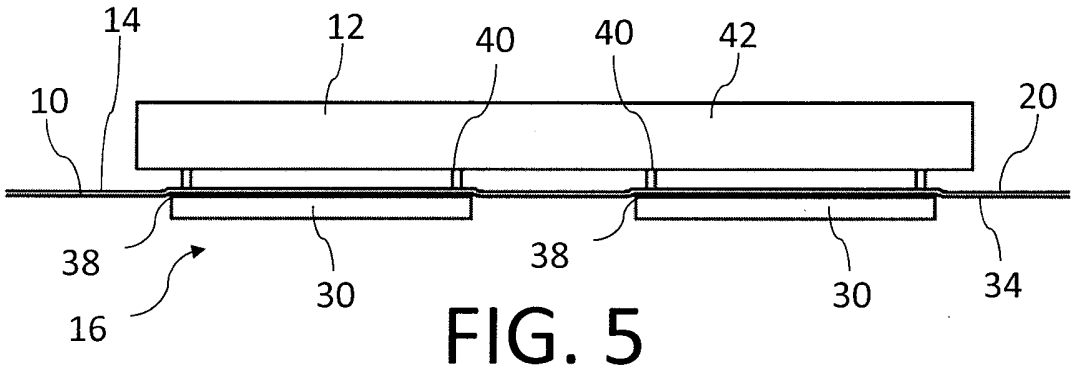


FIG. 5

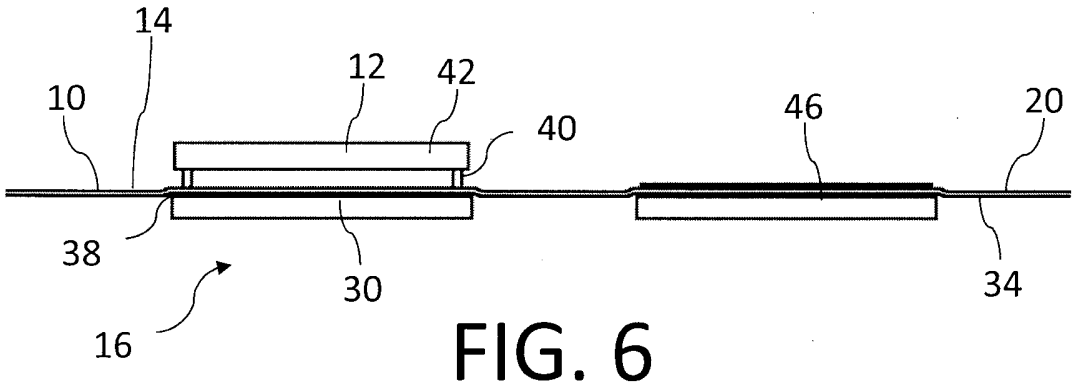


FIG. 6

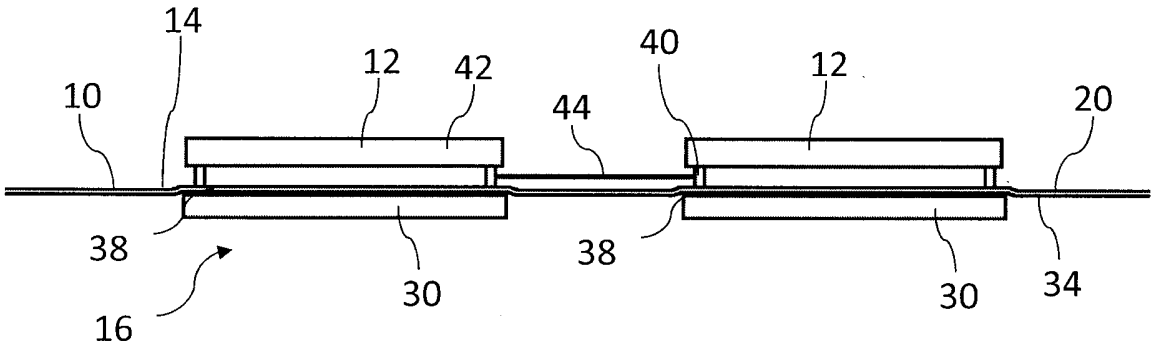


FIG. 7

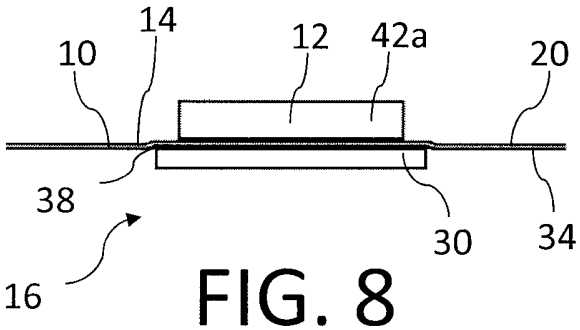


FIG. 8

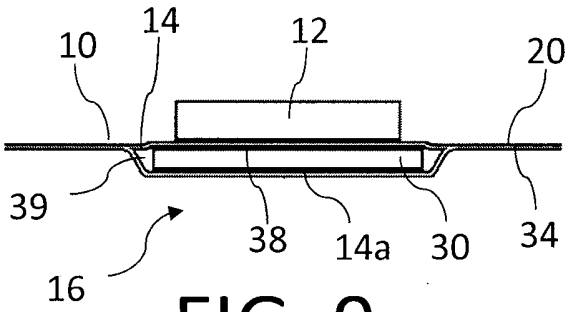


FIG. 9

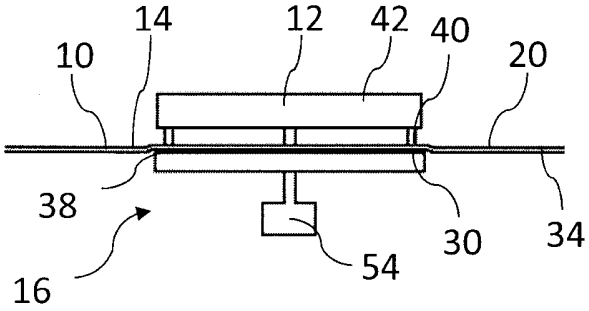


FIG. 10

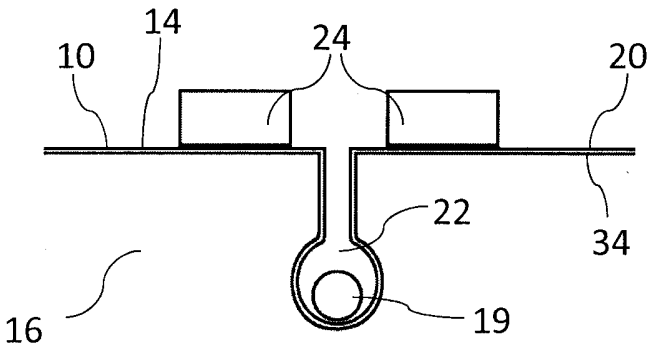


FIG. 11

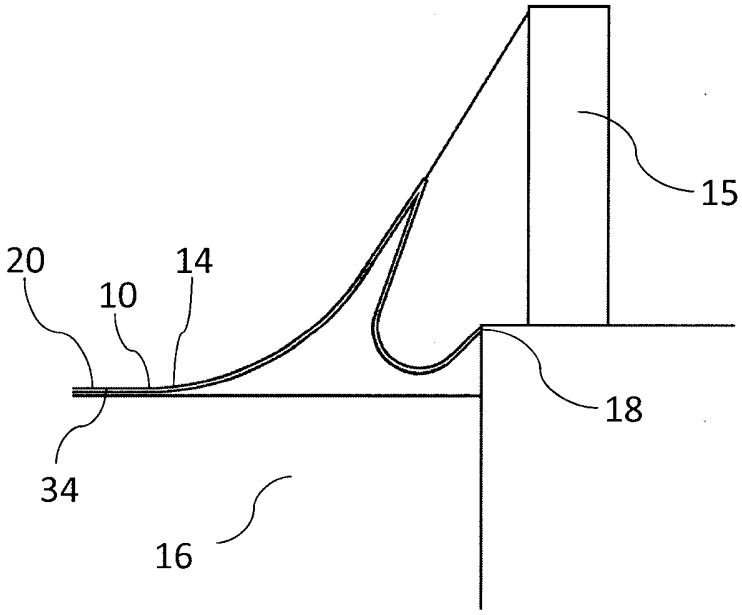


FIG. 12

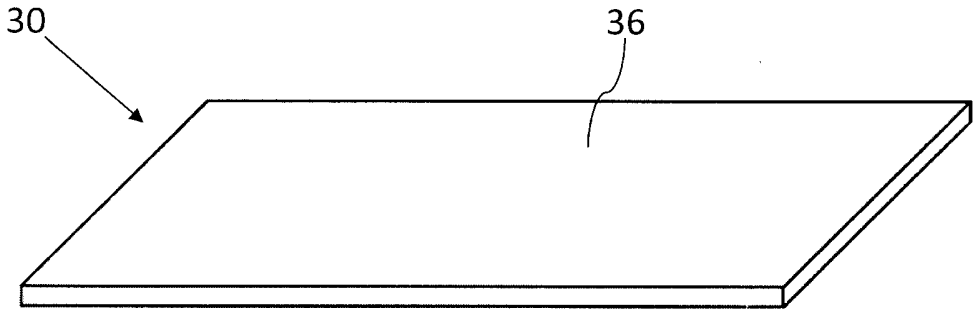


FIG. 13

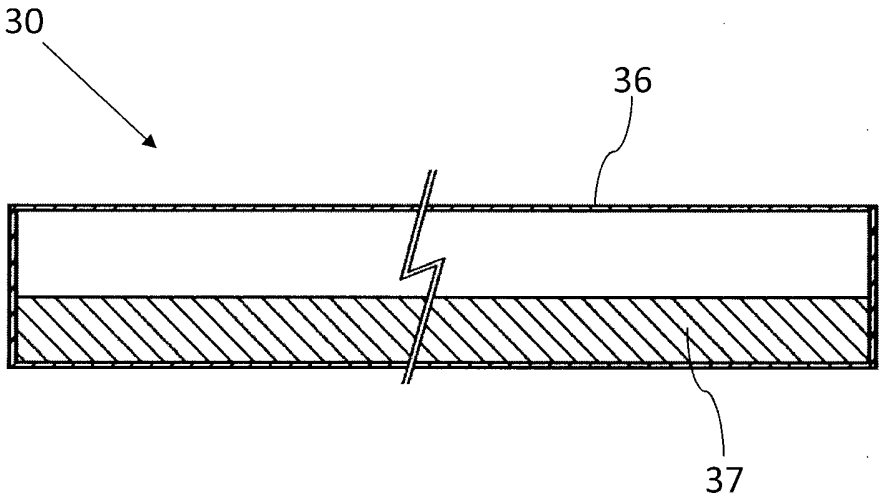


FIG. 14

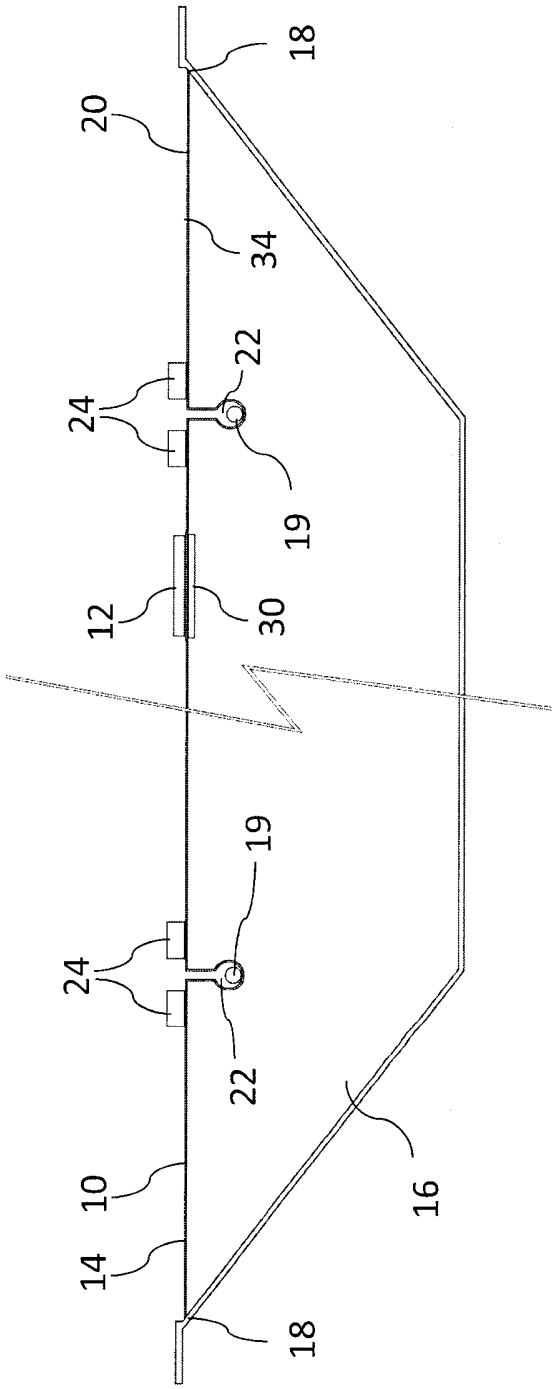


FIG. 15

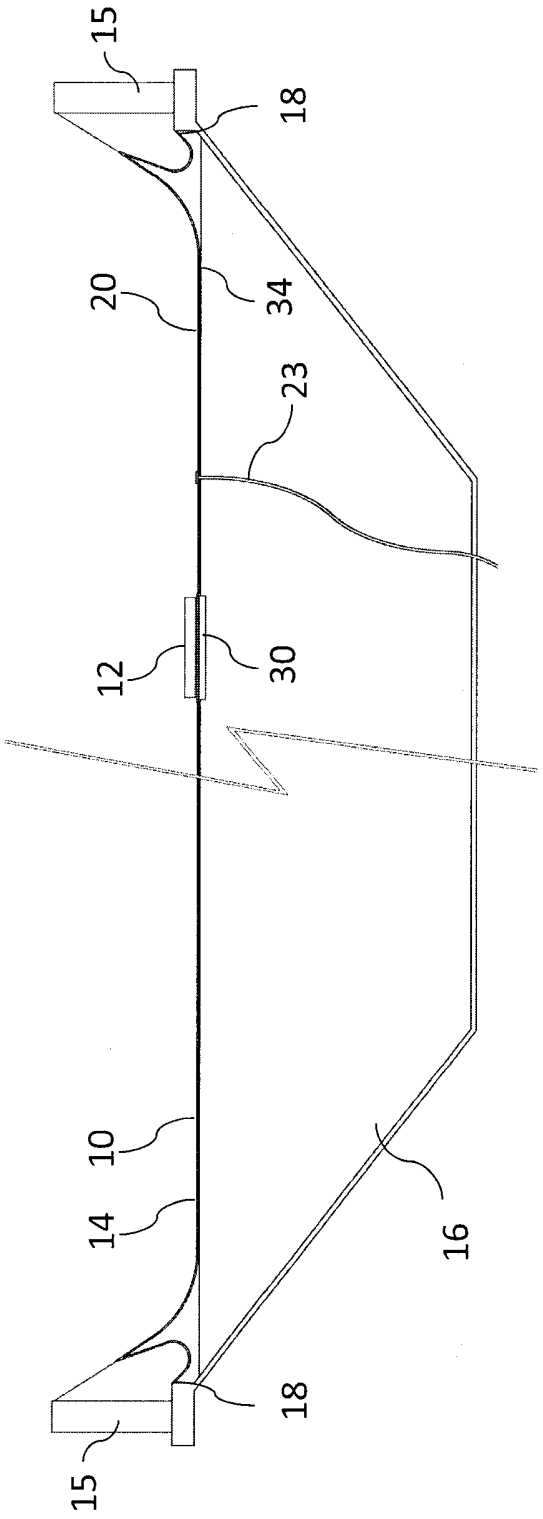


FIG. 16

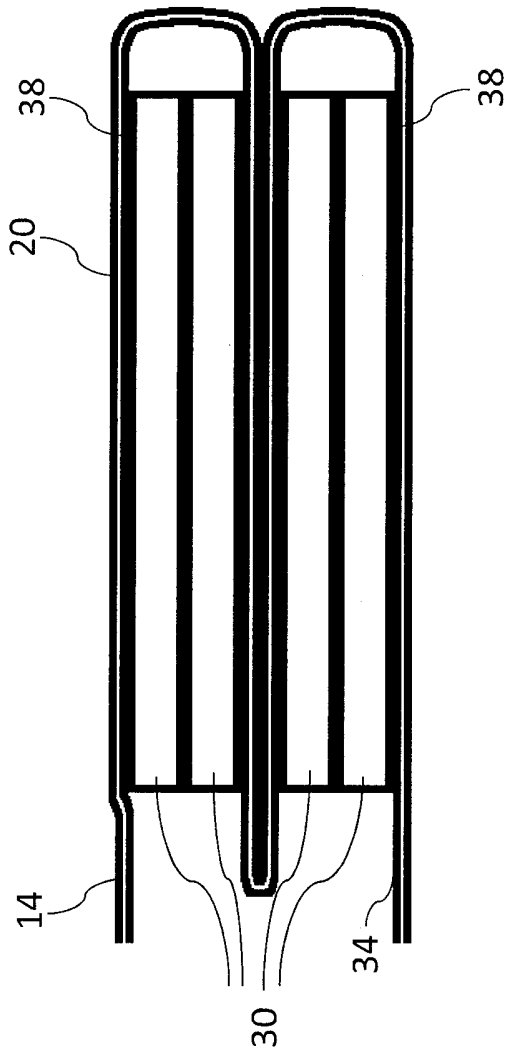


FIG. 17

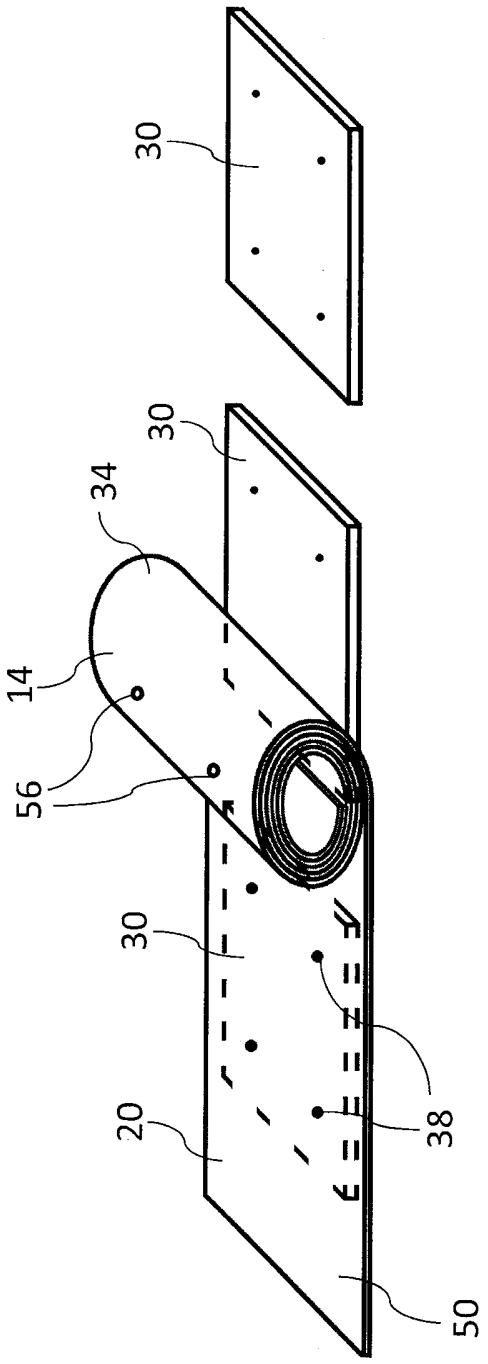
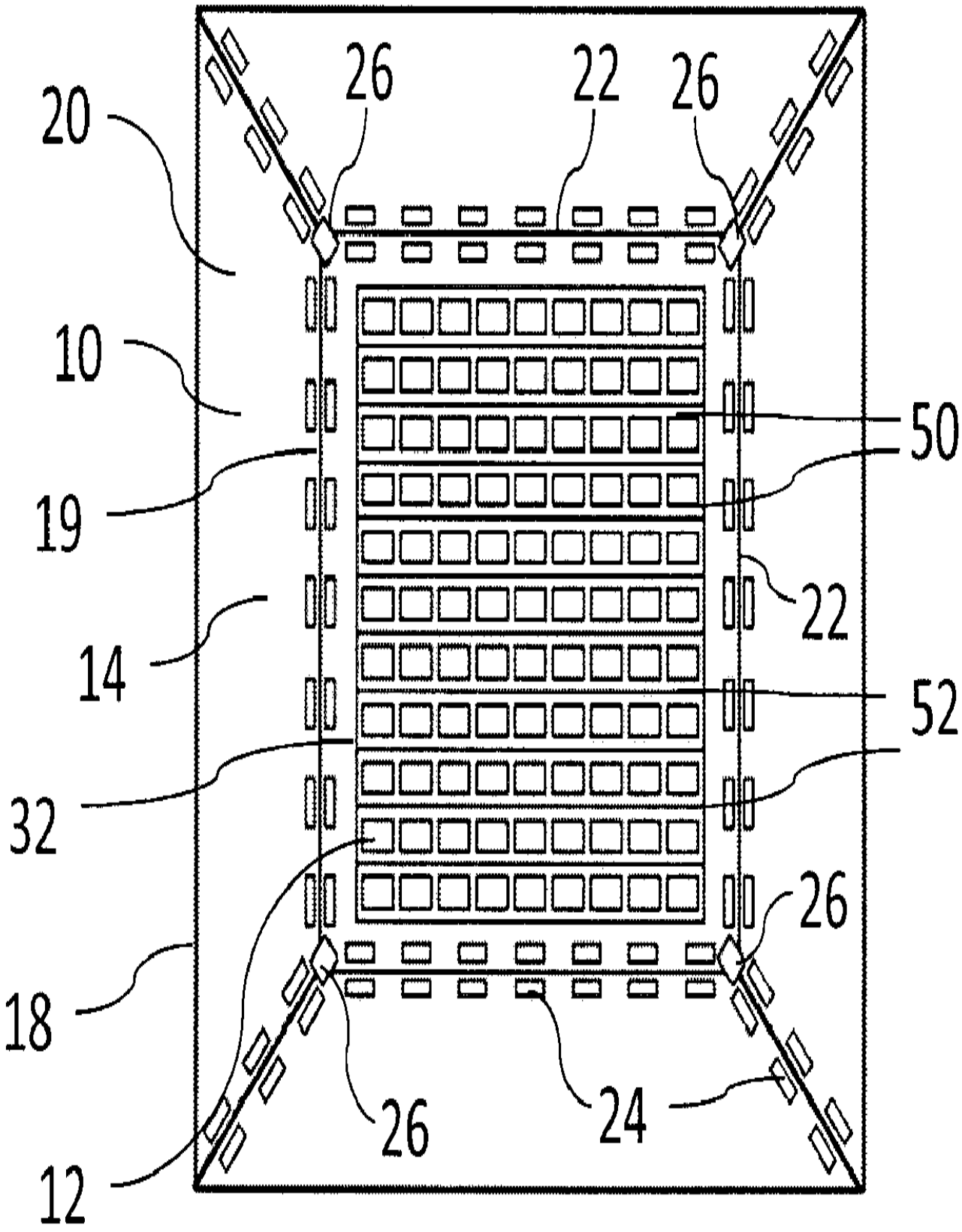


FIG. 18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