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Collins et al.

[11] **3,815,367**

[45] **June 11, 1974**

[54] **FLOATING RESERVOIR COVER**

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[21] Appl. No.: **344,233**

[52] **U.S. Cl.** ..... **61/1,** 4/172.12, 220/26 R

[51] **Int. Cl.** ..... **E02b ,** B65g 5/00

[58] **Field of Search** ..... 61/.5, 1, 7; 220/18, 26 R, 220/26 S, 26 D, 26 SA; 4/172.12, 172.14, 172.13

[56] **References Cited**

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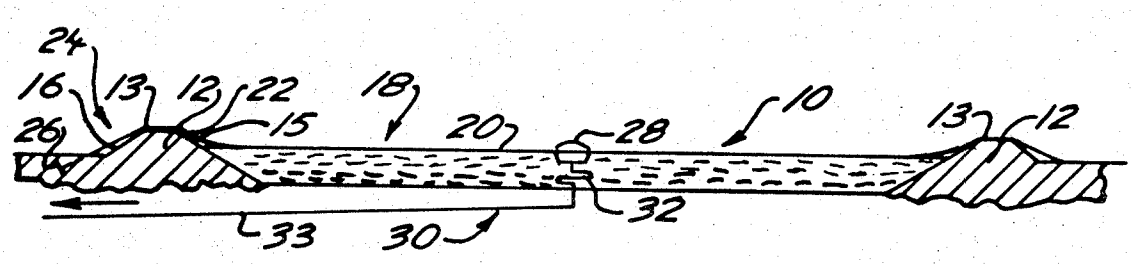
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Primary Examiner—W. C. Reynolds
Assistant Examiner—Philip C. Kannan
Attorney, Agent, or Firm—Carver and Company

[57] **ABSTRACT**

Floating cover assembly having diaphragm which lies directly on surface of body of liquid. Edges of diaphragm extend beyond edge of liquid and have stiffening members which are resiliently secured by anchoring lines to ground anchors. Resilient anchoring lines or freely hanging weights hold diaphragm in place relative to liquid, and permit diaphragm to move in response to change in liquid level. Thus diaphragm is always supported by liquid, and tension in diaphragm is low.

16 Claims, 12 Drawing Figures



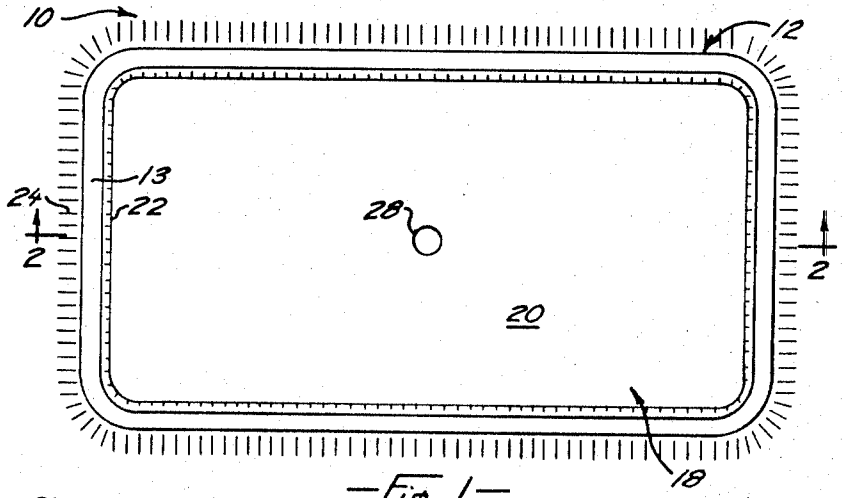


Fig. 1

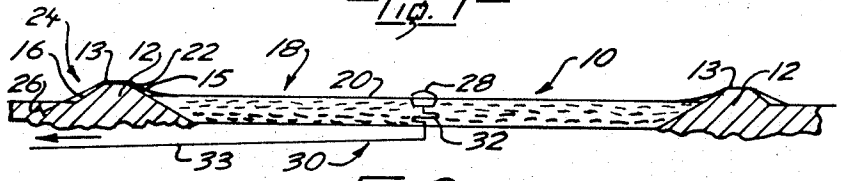


Fig. 2

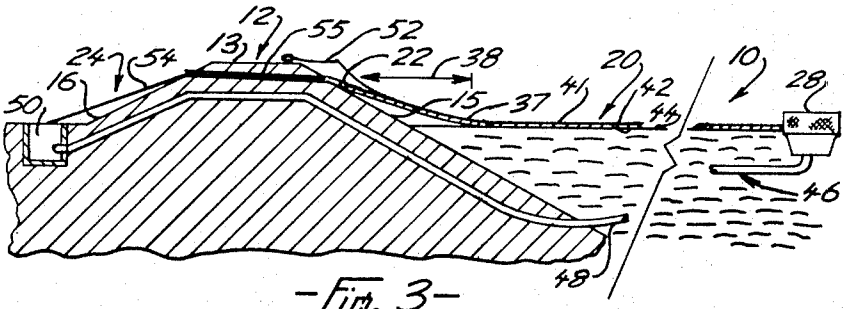


Fig. 3

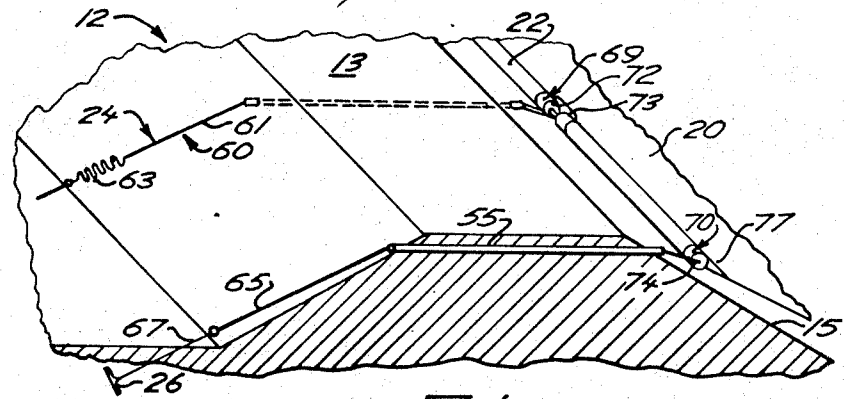


Fig. 4

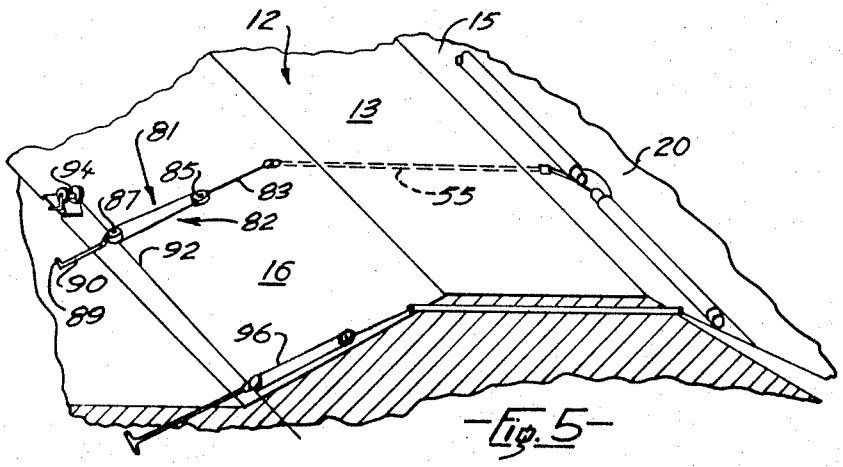


Fig. 5

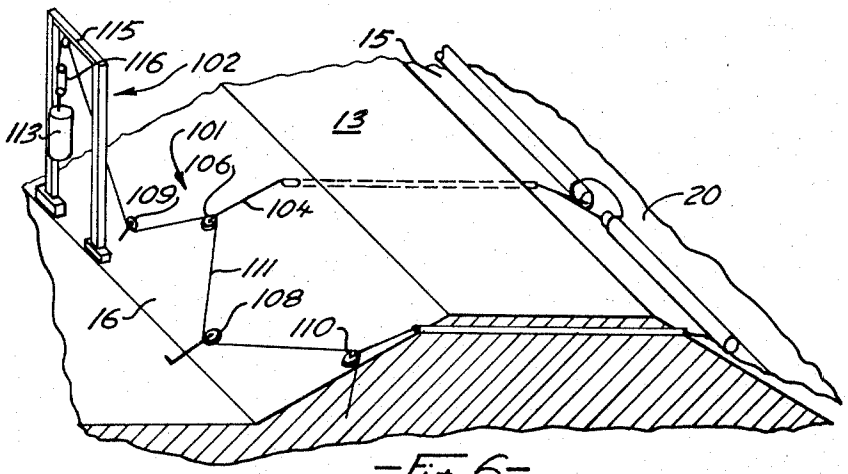


Fig. 6

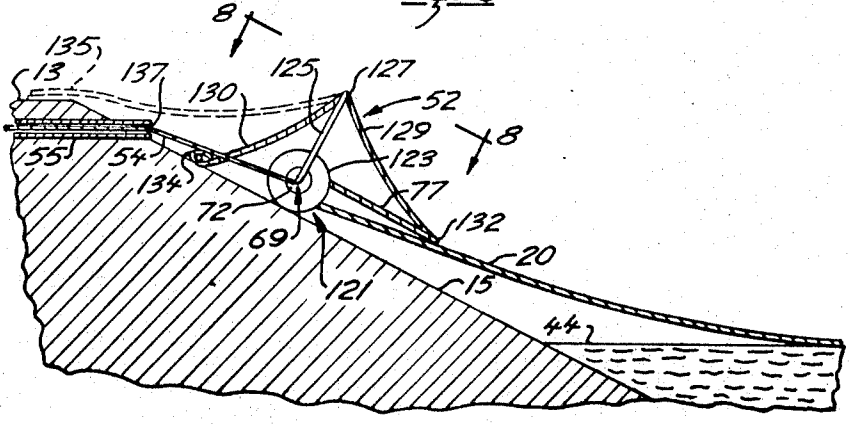


Fig. 7

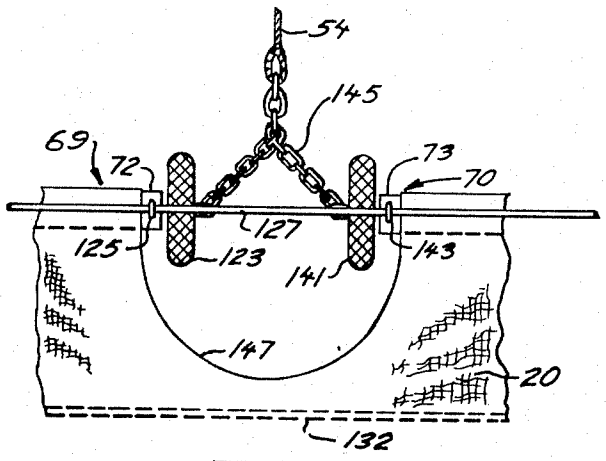


Fig. 8

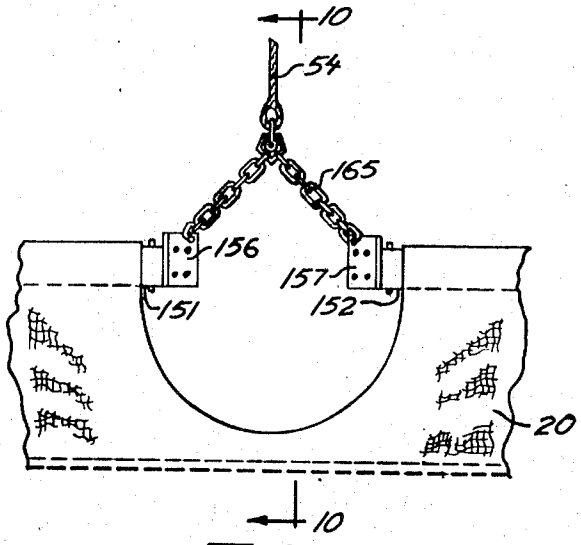


Fig. 9

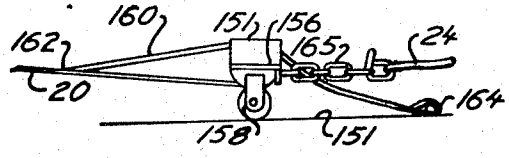


Fig. 10

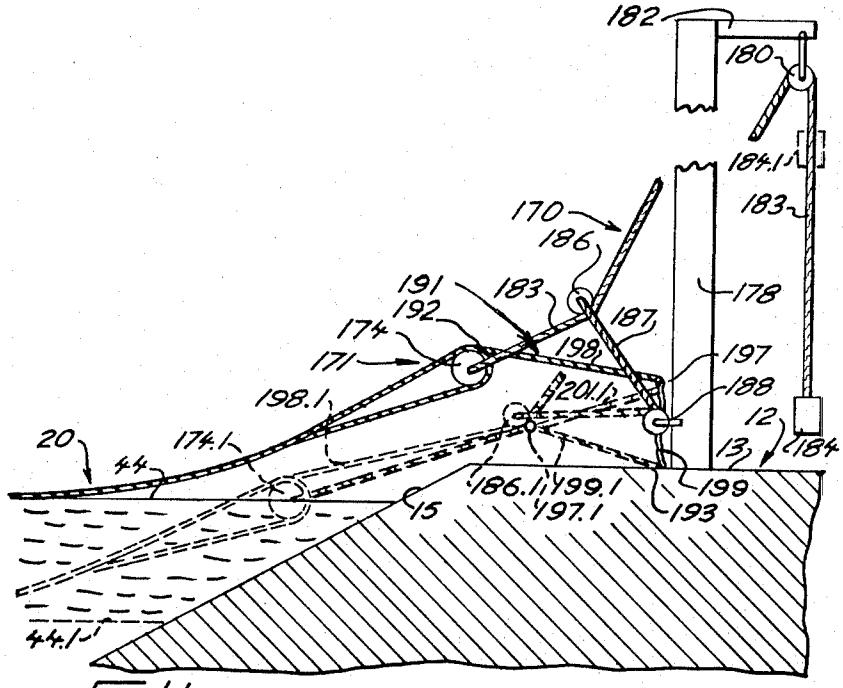

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Fig. 11

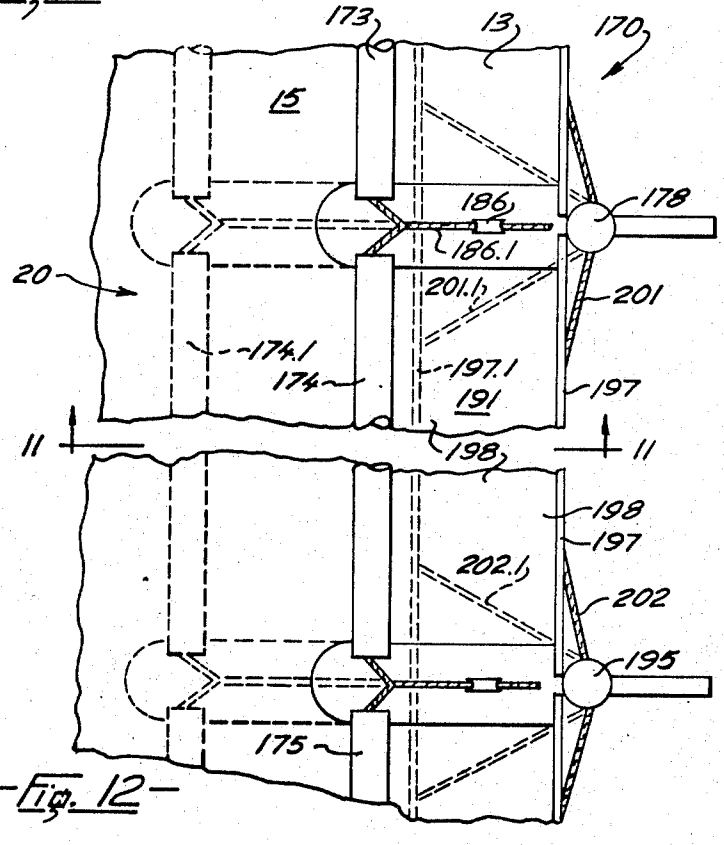

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Fig. 12

FLOATING RESERVOIR COVER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to a floating cover assembly for protecting a body of liquid, being particularly adapted for but not limited to use on a water reservoir.

2. Prior Art

Contamination of liquid reservoirs from airborne particles has been a problem in industrial areas for some time. One solution is to build a rigid cover spaced above about the reservoir, but this is expensive and is not easily adaptable to expansion of reservoir capacity. An alternative is to provide a cover floating on the surface of the reservoir. The floating cover has discrete floats secured to a lower surface thereof, the floats providing bouyancy so that portions of the lower surface of the cover are generally clear of the liquid, the bouyancy being sufficient to sustain loads from rain or snow. Means of draining the cover are provided, usually a pump draining a sump. Algae tends to grow on the surface of the water, on the lower surface of the cover, and on the floats, which algae can be difficult to remove. Difficulty associated with such a floating cover includes anchoring the periphery of the cover so that variation in liquid level can be accommodated by the cover without incurring excessive tension in the cover.

SUMMARY OF THE INVENTION

The invention reduces difficulties of the prior art by providing a cover assembly that is supported directly on the surface of the liquid and additional buoyancy is eliminated, thus facilitating cleaning. As the cover rests on the main portion of the liquid surface, air is excluded from the surface and, with an opaque cover to obstruct sunlight, algae growth is inhibited. The body of liquid to be protected has a periphery defined by inner faces of surrounding containing walls, which inner faces usually slope inwards and downwards.

One embodiment of the invention has a floating cover assembly having a flexible impermeable diaphragm having upper and lower faces, an edge defining a periphery thereof, the lower face being adapted to lie on the upper surface of the liquid, edges of the diaphragm being spaced outwards from the periphery of the liquid. A plurality of elongated stiffening members adjacent the periphery of the diaphragm cooperate with the diaphragm. Anchoring means secured relative to the containing walls are spaced outwards from the periphery of the diaphragm, and resiliently tensioned anchoring links extend between the diaphragm and the anchoring means. The periphery of the diaphragm is thus anchored to the containing walls and resilience in the anchoring links permits the diaphragm to move in response to a change in liquid level from a predetermined high level to a predetermined low level. Thus the diaphragm is always supported by the liquid, producing relatively low tension in the diaphragm. A sump is fitted at a lowest position of the diaphragm and drains liquid collected on the upper surface of the diaphragm, drain means in the sump removing liquid from the sump.

A detailed description following, related to the drawings, describes embodiments of the invention which is capable of expression in structure other than that particularly described and illustrated.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a simplified top plan view of a reservoir and reservoir cover assembly according to the invention,

FIG. **2** is a simplified section on **2—2** of FIG. **1**,

FIG. **3** is a fragmented section at enlarged scale on a portion of **2—2** of FIG. **1**, showing an alternative embodiment of a sump,

FIG. **4** is a simplified fragmented perspective of an edge of the cover assembly and associated containing wall, showing two embodiments of means to secure an edge of the assembly, some portions being removed,

FIG. **5** is a simplified fragmented perspective of a cover showing an alternative means of securing an edge of the cover assembly, some portions being removed,

FIG. **6** is a simplified fragmented perspective showing a further alternative means of securing an edge of the cover assembly, some portions being removed,

FIG. **7** is a simplified section through a portion of the containing wall showing one means of supporting a stiffening member associated with an edge of the cover assembly,

FIG. **8** is a simplified fragmented elevation on **8—8** of FIG. **7**, some portions being removed,

FIG. **9** is an alternative means of supporting stiffening members,

FIG. **10** is a simplified section on **10—10** of FIG. **9**,

FIG. **11** is a simplified fragmented side elevation of a further alternative anchoring means and edge of diaphragm, as seen from **11—11** of FIG. **12**,

FIG. **12** is a fragmented simplified top plan of the alternative anchoring means of FIG. **11**.

DETAILED DISCLOSURE

FIGS. **1** and **2**

A reservoir **10** has a periphery defined by inner faces of a surrounding containing wall **12**, commonly called a berm, the berm having a generally horizontal upper surface **13** serving as a walkway. Sloping inner and outer surfaces **15** and **16** extend downward from the walkway **13** at angles as shown. A floating cover assembly **18** according to the invention has a flexible impermeable diaphragm **20**, an edge **22** of which defines in part a periphery of the diaphragm. The edge of the diaphragm is spaced outwards from the periphery of the liquid so as to completely cover the liquid, thus substantially reducing contamination of the liquid with precipitation or airborne particles.

A plurality of anchoring lines **24** of flexible tension links extend outwards from the periphery of the diaphragm and across the berm, the links having inner and outer ends, the inner ends cooperating with edges of the diaphragm and the outer ends cooperating with anchoring means, several embodiments of which are to be described. One embodiment of the anchoring means, a ground anchor **26** is shown in FIG. **2**. The links are tensioned resiliently so as to apply an outwards force on the edges of the diaphragm to maintain the diaphragm in a desired position relative to the reservoir, and to prevent edges of the diaphragm sinking below the surface. Resilient tensioning is used so as to limit tension in the cover by permitting the diaphragm to move in response to a change in liquid level from a predetermined high level to a predetermined low level as will be explained.

A sump **28** is fitted at the lowest position of the diaphragm and drains liquid collected on the diaphragm, drain means **30** (FIG. **2** only) extending from the sump to a sewer or other liquid disposal means. FIG. **2** shows a simple gravity feed sump, in which a flexible pipe **32** connects the sump to a pipe **33** buried beneath the reservoir, the pipe **33** being connected to a sewer (not shown). More sumps can be fitted if necessary, the sumps having neutral bouyancy when empty so as to reduce load on the diaphragm. Water from the cover passes through a filtering screen to prevent oversize trash from entering the sump.

Material from which the diaphragm **20** is made is selected to withstand the expected conditions of service, which in some areas can include low temperatures of perhaps minus 60° F. to high temperatures of perhaps 120° F. The cover should have sufficient tensile strength and flexibility within the temperature range to resist relatively high local stress concentrations, for instance around the sump and at the edges of the diaphragm. The material should be resistant to ultra-violet deterioration, should be rot-and- mildew-proof, and should be opaque to sunlight to inhibit algae growth. A suitable material is a nylon-reinforced synthetic rubber such as Hypalon, (registered trade mark of DuPont) two layers of Hypalon sheet sandwiching a woven nylon fabric. Thirty ounces per square yard of material has been found to be adequate, but weight of the material is dependent upon size of the diaphragm and expected load.

Throughout the specification the cover is shown for a reservoir containing water. Clearly, it can be used with reservoirs containing other liquids, and material selected for the cover is dependent upon liquid to be protected. With some liquids a different type of material might be required. Nylon-reinforced Hypalon is particularly adaptable to this application as it has an inherent elasticity which effectively augments the resilient tensioning of the anchoring lines, further reducing chances of accidental tearing of the diaphragm. Also, such material can be easily cleaned should it become necessary.

FIG. **3**

The diaphragm **20** has upper and lower faces **41** and **42,** the lower face being adapted to lie on an upper surface **44** of the liquid. As the liquid level in the reservoir rises, periphery of the body of liquid increases and the edges of the diaphragm move upwards and outwards due to the sloping inner surface **15.** Thus effective periphery of the diaphragm in a horizontal plane, i.e., ignoring peripheral folds, increases to accommodate increase in periphery of the body of liquid. Conversely, as the liquid level drops, the effective periphery of the diaphragm decreases, peripheral folding increasing.

The lower face **42** of the diaphragm contacts the liquid surface **44** at a position **37,** a portion of the diaphragm extending as an unsupported span **38** from the edge **22** to the position **37.** The span **38** is likely to be between about 5 feet and 20 feet and can vary beyond these limits, the span being dependent on water level, loading on the diaphragm, and tension and position of the anchoring lines.

The sump **28** has an alternative drain means **46** which includes a flexible pipe **48** extending from the sump to a drain channel **50** on a side of the berm remote from the liquid. A pump (not shown) is provided either in the sump **28,** or in the drain channel **50** to pump a liquid from the sump to the channel. More than one pump can be provided in the sump, and the pumps can be set to operate automatically, each pump being actuated automatically by a different water level in the sump.

The edge **22** of the diaphragm **20** is enclosed by a mantle **52,** later particularized. One anchoring line **54** of the plurality of lines **24** has inner and outer ends, the inner ends cooperating with the anchors, not shown. To reduce deterioration of the anchoring lines, the lines pass through pipes under the walkway **13,** the line **54** being shown passing through a pipe **55** buried in the berm.

FIG. **4**

As previously stated the plurality of lines **24** are resiliently tensioned so as to accommodate changes in liquid level within the reservoir. One means of resilient tensioning is to provide a resilient anchoring line **60** in which an essentially inelastic link **61,** such as a thin steel cable, is joined to an elastic link **63,** such as a coil spring. The coil spring has sufficient extension under normal loads to accommodate the whole range of liquid level within the reservoir, without exerting excessive loads on the diaphragm. An alternative resilient line **65** is made from a synthetic fibre rope, such as nylon, which in suitable lengths and diameters has sufficient inherent resilience to accommodate liquid level changes.

The anchor **26** can be of the pole line hardware type, an expanding anchor such as stock No. C 64 as supplied by N. Slater Company Ltd., a corporation of Ontario, Canada, has been found to be suitable. A length of steel rope **67** extends from the anchor, which is joined at an outer end of the link **65,** the steel rope **67** and anchor **26** serving as anchoring means.

A plurality of elongated stiffening members, two being shown and designated **69** and **70,** are adjacent and cooperate with the periphery of the diaphragm. The stiffening members are disposed generally tangentially relative to edges of the diaphragm and have adjacent ends **72** and **73** spaced when the liquid approaches a predetermined low level in the reservoir. A plurality of tangential pockets, one pocket designated **77,** is spaced peripherally around the cover, each pocket accepting one stiffening member so as to distribute load applied to the stiffening members along the periphery of the cover. The pocket **77** accepts the member **70,** the outer ends **73** and **74** of which project beyond the pocket as shown. Ground bearing means, later particularized with reference to FIGS. **7** and **10,** are secured to each outer end of the stiffening member to support the stiffening member above the inner surface **15** of the containing walls. Resilient tensioning of anchoring line permits the ground bearing means to move over the surface **15** permitting the diaphragm to follow changes in liquid level.

FIG. **5**

An alternative means to resiliently tension the anchoring lines has an anchoring means which includes a tension distributing means **81** having a block and tackle **82.** An alternative anchoring line **83** has an inner end coupled to the diaphragm and an outer end carrying a first sheave **85** of the block and tackle **82.** The block and tackle has a sheave pair **87** complementary to the first sheave and aligned with and spaced from the first sheave, the sheave pair being coupled by an anchor connector **90** to a respective anchor **89** on a side of the second sheave remote from the first sheave. A coupling

line **92** of a flexible tension line such as nylon rope has first and second ends, and extends from the first end, around one sheave of the sheave pair around the first sheave and returning to the remaining sheave pair then extending to a second block and tackle **96.** A hand winch **94,** serving as a line tensioning means, cooperates with the first end of the line, the winch having a lock so as to maintain tension in the line. The line **92** passes from the second block and tackle **96** to further block and tackles (not shown) distributed along the berm. The second end of the line cooperates with an anchor (not shown), the anchor being spaced from the winch a distance which does not exceed an optimum when considering energy losses assocaited with the line and block and tackles. When the coupling line **92** is being tensioned, an operator operating the winch should pause frequently, lock the winch so as to prevent unwinding, and, on a side remote from the winch of each block and tackle apply a sideways force on the connecting line, i.e., at right angles to the line **92** as it extends to the adjacent block and tackle. Such sideways pulling will tend to distribute tension more evenly along the coupling line to reduce excessive tension build-up in one portion of the line whilst a remaining portion of the line experiences relatively little tension.

Movement of the diaphragm from a high water level position to a low water level position results in a corresponding movement of the first sheave **85** along the outer surface **16.** The sheave **85** is thus spaced a suitable distance from an outer end of the pipe **55** to accommodate such movement. The coupling line is a relatively light nylon rope, for example one-half inch diameter, and the anchoring lines are of a thicker rope, for example, three-quarter inch diameter. Such an arrangement provides an automatic safety feature in that the coupling line will break well before the anchoring line, should excessive tension be experienced. Use of a relatively light nylon coupling line provides a resilient tensioning of the coupling line, which resilience is transmitted partially to the anchoring lines to apply a resilient outwards force on the periphery of the diaphragm. The block and tackles clearly multiply force in the line **92,** which tends to compensate, to some extent, losses in the tension distribution means.

FIG. **6**

An alternative anchoring means has an alternative tension distribution means **101** tensioned by an alternative line tensioning means **102.** An anchoring line **104** extending from the diaphragm **20** is essentially similar to the line **83** of FIG. **5** and has an upper or diaphragm sheave **106** journalled for rotation at an outer end. A lower or anchor sheave **108** journalled for rotation and coupled to an anchor (not shown) is spaced below and laterally from the upper sheave, the sheaves being spaced sufficiently from the sloping surface **16** to permit rotation. A second lower or anchor sheave **109** is similarly spaced below and laterally from the sheave **106,** the sheaves **108** and **109** effectively straddling and spaced below from the sheaves **106.** A further upper or diaphragm sheave **110** is coupled to a similar anchoring line and is part of a row of spaced diaphragm sheaves extending along a portion of the containing wall adjacent the diaphragm, each sheave being coupled to a stiffening member. Further lower or anchor sheaves (not shown) similar to the sheaves **108** and **109** form a row of spaced anchor sheaves extending along a portion of the containing wall adjacent anchors, the rows of upper and lower sheaves being staggered relative to each other.

A flexible tension link coupling line **111** having first and second ends extends from the first end, around the anchor sheave **109,** across to the adjacent diaphragm sheave **106** and thence to the adjacent anchor sheave **108,** and thence successively to alternate sheaves in each row, the line describing a zig-zag along the outer surace **16** of the containing wall towards the second end of the line, which end cooperates with an anchor (not shown). A first end of the line cooperates with the line tensioning means **102** which includes a freely suspended weight **113** suspended from a frame **115.** A block and tackle **116** couples the weight to the first end of the line so that force from the weight **113** is effectively multiplied to increase tension applied to the line **111.** The weight **113** is elevated sufficiently to provide adequate travel to accommodate range of movement of the diaphragm **20.** Thus tension in the coupling line is distributed to the upper sheaves and maintains an outwards force on the diaphragm. The coupling line has less strength than the anchoring lines and diaphragm so that, in an excessive loading condition, the line **111** will break first.

The coupling line **111** can also be tensioned with a hand winch similar to the hand winch **94** of FIG. **5.** Likewise the coupling line **92** of FIG. **5** can be tensioned by a freely hanging weight similar to the weight **113** of FIG. **6.** With a freely hanging weight, movement of the weight provides a resilient tensioning independently of elasticity characteristics of the coupling line. Thus if a hanging weight is used the coupling line can be relatively inelastic wire rope, thus reducing load losses in tensioning. However, if a wire rope coupling line is used, the coupling line should have a lower tensile strength than the anchoring line, or a weak link should be provided, so as to protect the anchoring lines and diaphragm.

A further alternative (not shown) uses a plurality of hanging weights, each weight being coupled to a respective anchoring line. Each anchoring line passes over a pulley supported clear of the ground, the weight being secured to the outer end of the anchoring line. Tension in the line is thus transferred directly to the diaphragm, and, if sufficient weight is used the block and tackle can be eliminated.

FIG. **7**

The elongated stiffening member **69** is supported on ground bearing means above the inner face of the containing wall, the ground bearing means permitting the periphery of the diaphragm to move relative to the wall to follow changes in liquid level. One ground bearing means **121** secured to the outer end **72** is shown and includes a roller **123** journalled for rotation about an axis aligned with the elongated stiffening member. The stiffening member **69** is cylindrical, suitably a tube, which passes through the pocket **77,** the pocket being formed from a fold in the diaphragm, which pocket distributes load evenly along that portion of the periphery defined by the pocket. The anchoring line **54** cooperates with the outer end of the member **69** by means to be described with reference to FIG. **8.**

A support **125** extends from the end **69** and has an upper end having an eye (not shown), the eye accepting a peripheral line **127** (FIG. **8** only) threaded therethrough. The line **127** in combination with the support

125 supports the mantle 52 clear of the roller 123 to prevent wear of the mantle, which is made from a flexible sheet material, similar to but lighter than the sheet material used in the diaphragm. The mantle has an inner portion 129 extending from the line 127 to the diaphragm, and an outer portion 130 extending from the line 127 to the sloping inner surface 15. An inner edge 132 of the mantle is secured to the diaphragm adjacent the pocket, and an outer edge 134 is weighted to resist movement of the outer portion. The weight can be a length of heavy pipe in a pocket, or can be rocks or other ballast. The outer portion 130 extends beyond a normal upper limit of travel of the edge 22 so as to prevent the roller from rolling over the outer edge 134. Sufficient slack is provided in the mantle to accommodate normal daily movements of the diaphragm, however with an excessive draw-down the outer edge is free to follow movement of the periphery inwards, thus maintaining the lower surface of the diaphragm in contact with the surface of the liquid. Each stiffening member has an associated mantle, spaces between adjacent mantles providing clearance for the anchoring line 54.

An alternative outer portion 135 is shown in broken outline and extends from the surface 13 of the berm and functions similarly. To reduce wear of the anchoring line 24 as it passes through the ends of the pipe 55, a low friction, wear-reducing insert 137 is provided manufactured from a tough plastic material, suitably nylon.

FIG. 8

As previously stated, adjacent outer ends 72 and 73 of the stiffening members 69 and 70 are spaced sufficiently to permit movement of the ends towards each other as the diaphragm moves down the inner slope of the containing walls. The outer end 73 is supported on a roller 141 similar to the roller 123 and a support 143 similar to the support 125 carries the peripheral line 127. A flexible tension link connector 145 extends between the ends 72 and 73, midpoint of which connector is secured to the anchoring line 54 as shown. Pockets containing the stiffening members 69 and 70 are spaced by a U-shaped cut-out 147 in the periphery of the diaphragm 20.

The U-shaped cut-out is peripherally reinforced so that, when the liquid level approaches a predetermined high level and edges of the diaphragm are in a high position, there is sufficient strength or slackness in the U-shaped cut-out to essentially prevent tearing due to excessive peripheral tension. Common reinforcing means can be employed to strengthen the U-shaped cut-out.

FIGS. 9 and 10

An alternative ground bearing means for supporting alternative stiffening members 151 and 152 eliminates the rollers 123 and 124, the peripheral line 127, and the supports 125 and 143 of FIGS. 7 and 8. Brackets 156 and 157 extend from ends of the members 151 and 152 and each bracket supports a castor, one such castor 158 being shown in FIG. 10. An alternative mantle 160, FIG. 10 only, has an inner edge 162 secured to the diaphragm 20 and an outer edge 164 weighted to reduce movement, similar to the outer edge 134 of FIG. 7. The castor 158 extends below the bracket 156 and thus the mantle 160 is protected from the roller, thus the supports 125 and 143 and peripheral line 127 of FIG. 8 are not required. A flexible tension link connector 165 extends between ends of the members 151 and 152, a mid-point of which is secured to the anchoring line 24, similarly to the connector 145 of FIG. 8.

Commonly the sloping inner surface 15 of the containing wall is loose gravel and, particularly with a small diameter castor 158, a runway for the castor is required to facilitate rolling along the inner surface. Such a runway can be a fabric-covered metal strip or other similar relatively stiff surface which extends between upper and lower limits of travel of the roller, and has a width sufficient to accommodate variation in tracking of the ground bearing means. Ground bearing means that are journalled for rotation rotate about axes parallel to the respective stiffening member. Other types of ground bearing means, such as skids, can be used to support the stiffening members.

OPERATION

Irrespective of the type of anchoring line attachment, installation and operation of the diaphragm follows a similar procedure. The diaphragm is manufactured in one piece and transported to the site in a rolled condition. Assuming a generally rectangular reservoir shown in FIG. 1, an outer edge of the rolled diaphragm is secured to respective anchoring lines and the diaphragm is unrolled from the secured end. As portions of adjacent edges of the diaphragm are progressively exposed, the portions are secured to respective anchoring lines until the diaphragm is completely unrolled and secured on all four sides. This securing is relatively loose and the position of the diaphragm relative to edges of the body of liquid can be adjusted by loosening anchoring lines on one side and tightening lines on opposite side.

Under normal conditions the lower surface of portions of the diaphragm remote from the periphery is supported on the upper surface 44 (FIG. 2) of the liquid, limit of such support being the position 37 (FIG. 3). At the position 37 the diaphragm extends from the surface to the stiffening member which is supported on the sloping inner surface 15. Sufficient resilience in the anchoring lines is provided so that, when the liquid reaches a predetermined low level the position 37 is not more than about twenty feet from the containing wall. The diaphragm has sufficient strength to support its own weight, plus some precipitation, for a short unsupported span, but for a long unsupported span in which the diaphragm is not carried on the upper surface of the liquid, excessive diaphragm tension might be experienced unless a weak link is provided as previously described. At all time the sump is supported by the liquid, and should an excessive draw down of liquid below the predetermined low level occur, tension in the diaphragm is limited by one or more of the coupling lines or weak links breaking, thus relieving load on the diaphragm. As repair or replacement of a broken line is easy, this is a relatively fail-safe arrangement.

For routine maintenance the cover can be rolled back off the liquid surface to be cleaned. An operator can work adjacent one edge of the diaphragm at a time, rolling the diaphragm back to expose the lower surface thereof for cleaning.

FURTHER ALTERNATIVE

FIGS. 11 and 12

In the following description, position of components of the anchoring means when the diaphragm is in a high

position are shown in full line, and when the diaphragm is in a low position are shown in broken line.

An alternative anchoring means **170** cooperates with an edge **171** of the diaphragm **20**, which diaphragm is supported on the surface **44** of the liquid shown in a high position. Alternative elongated stiffening members **173** through **175** cooperate with the edge **171** and differ from previous stiffening members by being supported clear of the containing wall **12**, that is ground bearing means of previously described embodiments are not provided.

The anchoring means **170** has a post **178** extending upwards from the walkway **13** adjacent the sloping surface **15**. An elevated pulley **180** is supported clear of the walkway **13** by an arm **182** extending from an upper end of the post **178**. An anchoring line **183** has an inner end connected to the stiffening member **174** and an outer end carrying a weight **184** hanging freely from the elevated pulley so as to tension the anchoring line. A snatch block **186** is secured relative to the containing wall by a connecting line **187** which is coupled to a winch **188**. The anchoring line **183** passes from the stiffening member **174**, under the snatch block **186** and over the elevated pulley **180** to the hanging weight, which, when the diaphragm is in the highest position, is clear of the ground. The pulley **180** is sufficiently high so that, when the diaphragm moves to the low position (broken outline) the weight can move to an elevated position **184.1** (broken outline) without interfering with the pulley.

An alternative mantle **191** has an inner edge **192** secured adjacent the periphery of the diaphragm and an outer edge **193** lying on the walkway **13**, space between the inner and outer edges defining width of the mantle. The outer edge **193** is secured relative to the containing wall, preferably by a peripheral guy line (not shown) extending along the edge and secured to the post **178** and an adjacent post **195**, FIG. **12** only. A mantle bar **197**, best seen in FIG. **12**, is parallel to the stiffening member **174** and secured to and extending across the mantle at a position about midway between the inner and outer edges. The bar **197** defines an inner portion **198** of the mantle between the stiffening member and the mantle bars, and an outer portion **199** between the mantle bar and the outer edge **193**. Resilient mantle links **201** and **202** extend between the posts **178** and **195** and the mantle bar **197** and have sufficient length and resilience to retain the mantle bar adjacent the post when the diaphragm is in the high position. In the high position the inner portion **198** of the mantle is essentially taut and the outer portion **199** is slack, extending downwards from the mantle bar to the walkway. The inner portion is inclined so as to shed precipitation collected on the mantle, reducing chance of puddles forming on the mantle. The outer portion **199** hangs downwards and is secured adjacent the ground at the outer edge **193**, effectively sealing edges of the diaphragm from wind which might otherwise blow under the diaphragm.

When the water level approaches a low position, as shown in broken outline at **44.1**, the edge of the diaphragm moves inwards to a low position, the stiffening member **174** assuming a low position **174.1**, and the snatch block **186** swinging to a low position **186.1**. If necessary the winch **188** can be loosened to increase length of the connecting lines **187**, thus reducing load on the diaphragm. If required, the reel of the winch can be spring-loaded so as to apply a load on the line **187** proportional to extension.

When the mantle is in the low position the mantle bar **197** is moved to a low position **197.1** by tension in the inner portion **198**, which assumes a low position **198.1** (broken line), FIG. **11** extending from the stiffening member, and inclined so as to shed precipitation onto the diaphragm. The resilient mantle links **201** and **202** extend towards the diaphragm, assuming stretched positions **201.1** and **202.1** the outer portion of the mantle assuming an extended position **199.1** (broken outline) (FIG. **11**) being taut and inclined so as to shed precipitation outwards from the diaphragm. As previously stated the weight **184** moves to elevated position **184.1**, the anchoring line having sufficient length to accommodate movement of the periphery from the high position of the diaphragm to the low position.

The alternative anchoring means **170** eliminates the pipes **55** (FIGS. **3** and **4**) extending across the walkway, and as the ground bearing means are eliminated, there is no requirement for runways to support the ground bearing means. Operation of the means **170** follows closely that of the previously described embodiments. A major difference is that tension in the anchoring lines is sufficient to suspend the stiffening members clear of the containing wall to prevent abrasion. Also, because each anchoring line is individually tensioned by a suspended weight, additional tension can be easily added where required to maintain the stiffening members clear of the wall.

We claim:

1. A floating cover assembly for a body of liquid having a periphery defined by inner surfaces of surrounding containing walls, the assembly having:

a. a flexible impermeable diaphragm having upper and lower faces, and an edge defining a periphery thereof, the lower face being adapted to lie on the upper surface of the liquid, the edge of the diaphragm being spaced outwards from the periphery of the liquid,

b. a plurality of elongated stiffening members adjacent and cooperating with the periphery of the diaphragm, the stiffening members having outer ends,

c. anchoring means secured relative to the containing walls and spaced outwards from the periphery of the diaphragm,

d. anchoring lines of flexible tension links extending outwards from the periphery of the diaphragm, the lines having inner and outer ends, the inner ends cooperating with edges of the diaphragm, and the outer ends cooperating with the anchoring means, the lines being tensioned resiliently so as to apply an outwards force on the edge of the diaphragm,

e. a sump fitted in the diaphragm at a lowest position thereof, so as to drain liquid collected on the upper face of the diaphragm, the sump having drain means to drain the liquid collected, so that the periphery of the diaphragm is anchored to the containing walls and can move in response to a change in liquid level from a predetermined high level to a predetermined low level.

2. A floating cover assembly as claimed in claim **1** wherein the stiffening members are disposed generally tangentially relative to edges of the diaphragm and cooperate with the edges of the diaphragm so that

i. when the liquid level is somewhat above the predetermined low level, the edges of the diaphragm are in a low position and the ends of the stiffening members are spaced from ends of adjacent stiffening members,

ii. when the liquid level approaches the predetermined high level, the edges of the diaphragm are in a high position and have sufficient length to reduce a chance of tearing resulting from excessive peripheral tension in the diaphragm.

3. A floating cover assembly as claimed in claim **2** in which

i. a plurality of tangential pockets are spaced peripherally around the edges of the cover, the pockets accepting the stiffening members so as to distribute load applied to the stiffening members along the periphery of the cover.

4. A floating cover assembly as claimed in claim **3** in which

i. the outer ends of each stiffening member project beyond the respective pocket,

ii. ground bearing means are secured to each outer end of each stiffening member to support the stiffening member above the inner faces of the containing walls,

so that when the liquid level changes, resilience in the tension lines permits the ground bearing means to move over the inner surface of the wall, permitting the diaphragm to follow changes in liquid level so as to maintain the lower face of the diaphragm generally in contact with the surface of the liquid.

5. A floating cover assembly as claimed in claim **4** in which the ground bearing means include:

i. rollers journalled for rotation about an axis parallel to the respective stiffening member.

6. A floating cover assembly as claimed in claim **1** in which the anchoring means includes a tension distribution means having:

i. a block and tackle having a first sheave coupled to the outer end of the anchoring line, and a sheave pair complementary to the first sheave, the sheave pair being coupled to a respective anchor on a side of the sheave pair remote from the first sheave,

ii. a flexible tension link coupling line having first and second ends, the line extending from the first end, around one sheave of the sheave pair, around the first sheave and returning to the remaining sheave of the sheave pair, then extending to the second end,

iii. a line tensioning means cooperating with the first end of the line,

iv. an anchor cooperating with the second end of the line, so that tension in the coupling line is distributed to the first sheave and maintains an outwards force on the diaphragm.

7. A floating cover assembly as claimed in claim **1** in which the anchoring means includes a tension distribution means having:

i. a row of spaced diaphragm sheaves journalled for rotation and extending along a portion of the containing wall adjacent the diaphragm, each sheave being coupled to a stiffening member,

ii. a row of spaced anchor sheaves journalled for rotation, the anchor sheaves being spaced along a portion of the containing wall adjacent anchors, each sheave being coupled to an anchor, the rows of sheaves being staggered relative to each other,

iii. a flexible tension link coupling line having first and second ends, the line extending from the first end, around a sheave of one row, across to an adjacent sheave in the other row, and thence successively to alternate sheaves in each row, the coupling line describing a zig-zag along the surface of the containing wall towards the second end of the line,

iv. a line tensioning means cooperating with the first end of the line,

v. an anchor cooperating with the second end of the line,

so that tension in the coupling line is distributed to the diaphragm sheaves and maintains an outward force on the diaphragm.

8. A floating cover assembly as claimed in claim **6** in which the line tensioning means includes:

i. a weight hanging freely from the first end of the line.

9. A floating cover assembly as claimed in claim **6** in which the line tensioning means includes:

i. a winch secured to the first end of the coupling line to apply tension to the line, the winch having a lock so as to be locked in position to maintain tension in the line.

10. A floating cover assembly as claimed in claim **1** in which

i. a roller is journalled for rotation at each outer end of each stiffening member, adjacent outer ends of adjacent stiffening members being spaced to prevent interference between adjacent rollers,

ii. a flexible tension link connector extends between the spaced adjacent outer ends of the adjacent stiffening members,

iii. a first sheave is coupled to the connector extending between the outer ends of the adjacent stiffening members,

iv. a sheave pair complementary to the first sheave is aligned with and spaced from the first sheave, the sheave pair being coupled to a respective anchor on a side of the sheave pair remote from the first sheave,

v. a flexible tension link coupling line having first and second ends, the line extending from the first end, around one sheave of the sheave pair, around the first sheave and returning to the remaining sheave pair, thence extending to the second end,

vi. a line tensioning means cooperating with the first end of the line,

vii. an anchor cooperating with the second end of the line,

so the tension in the coupling line is transferred to the first sheave and maintains an outwards force on the diaphragm.

11. A floating cover assembly as claimed in claim **1** further including:

f. a mantle having spaced inner and outer edges straddling the stiffening member, the inner edge being secured to the upper surface of the diaphragm inwards of the edge of the cover, the outer edge of the mantle being spaced on a side of the stiffening member remote from the inner edge, spacing between the inner and outer edges providing sufficient slack in the mantle to permit movement of the stiffening member beneath the mantle, the outer edge of the mantle being supported on and restricted against movement relative to the

containing wall, the mantle having clearance for the anchoring line to extend therethrough.

12. A floating cover assembly as claimed in claim **1** wherein the drain means includes:

i. a pipe extending from a sump to a position beyond the containing wall.

13. A floating cover assembly as claimed in claim **1** in which:

i. the anchoring line includes an elastic portion to provide resilience for securing the periphery of the diaphragm.

14. A floating cover assembly as claimed in claim **1** in which the anchoring means includes:

i. a pulley supported clear of the ground, one anchoring line passing over the pulley,

ii. a weight secured to the outer end of the anchoring line so that the weight hangs freely from the pulley, and applies a tension to the anchoring line, which tension is transferred to the edge of the diaphragm.

15. A floating cover assembly as claimed in claim **2** in which the anchoring means includes:

i. a snatch block secured relative to the containing wall,

ii. an elevated pulley supported clear of the ground; and the inner ends of the anchoring lines are coupled to the stiffening members, and the anchoring line passes under the snatch block and over the elevated pulley to the outer end;

iii. a weight coupled to the outer end of the anchoring line, the weight hanging freely so as to tension the anchoring line, the anchoring line having sufficient length to accommodate movement of the periphery of the diaphragm from a low position to a high position.

16. A floating cover assembly as claimed in claim **15** further including:

i. a mantle having inner and outer edges defining a mantle width, the inner edge being secured adjacent periphery of the diaphragm, the outer edge being secured relative to the containing wall, mantle width being sufficient to accommodate the diaphragm in low position,

ii. a mantle bar, parallel to the stiffening member and secured to and extending across the mantle at a position about mid-way between the inner and outer edges, the mantle bar together with the inner and outer edges defining inner and outer portions of the mantle respectively,

iii. resilient mantle links connecting the mantle bar with the containing wall,

so that when the diaphragm is in the high position the mantle bar is held by the resilient mantle links so that the inner portion of the mantle is essentially taut and the outer portion is slack, and when the diaphragm is in the low position the inner and outer portions are essentially taut and the resilient links are stretched.

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