

Feb. 26, 1963

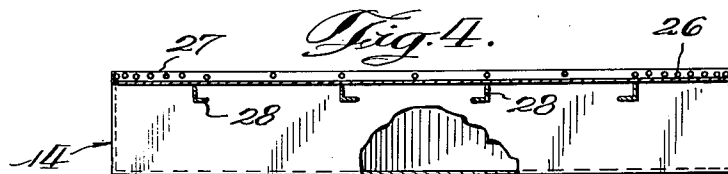
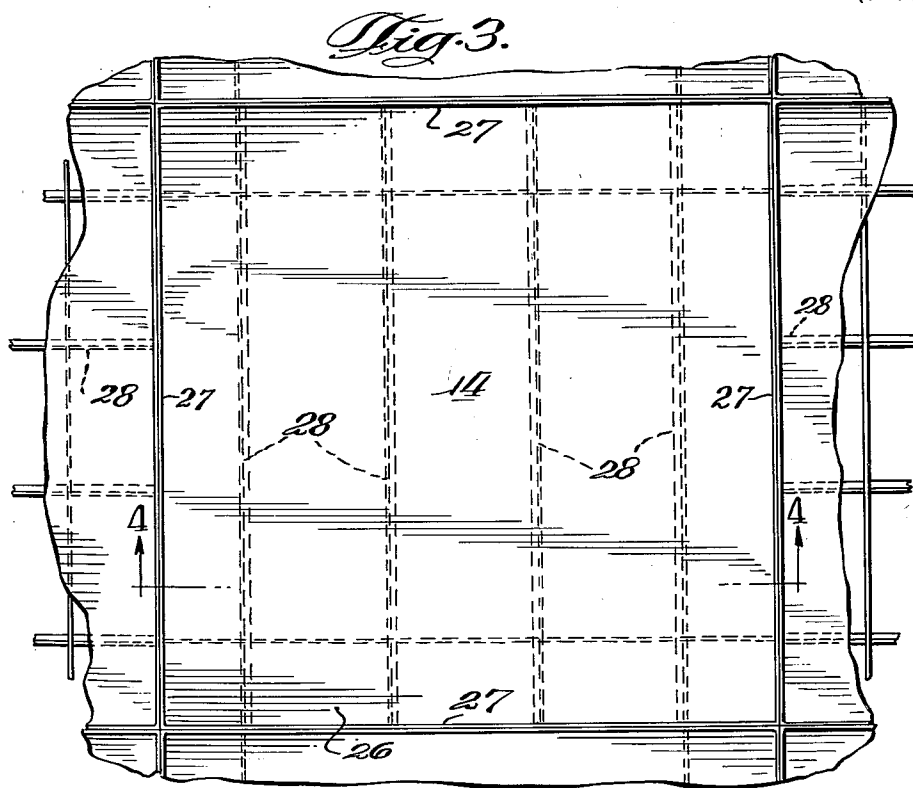
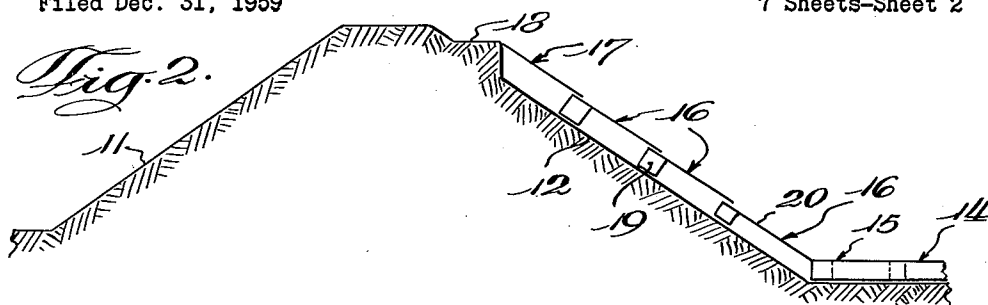
F. D. MOYER

3,079,030

FLOATING COVER FOR SLOPED WALL RESERVOIR

Filed Dec. 31, 1959

7 Sheets-Sheet 2



Feb. 26, 1963

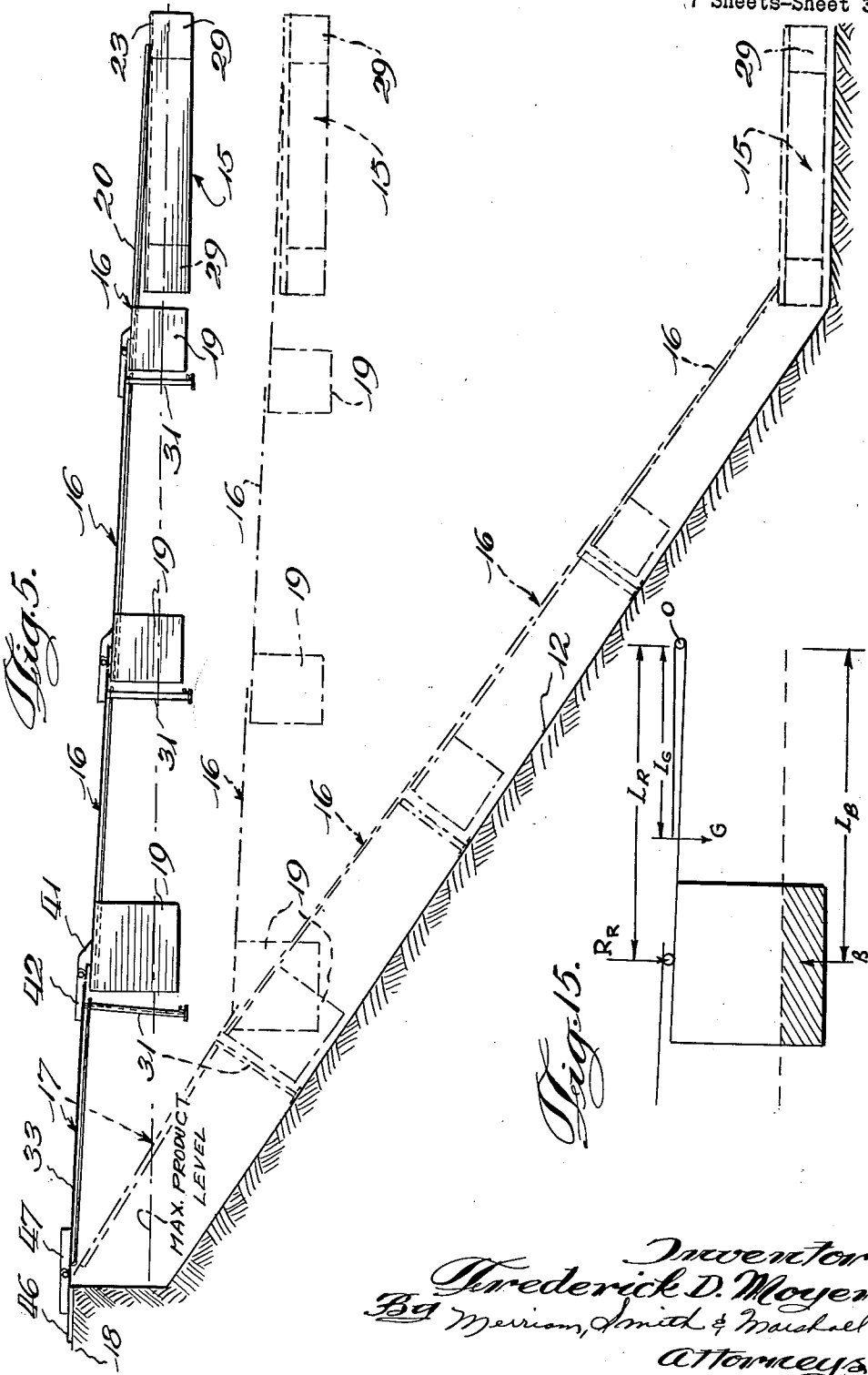
F. D. MOYER

3,079,030

FLOATING COVER FOR SLOPED WALL RESERVOIR

Filed Dec. 31, 1959

7 Sheets-Sheet 3



Inventor
Frederick D. Moyer
By Merriam, Smith & Marshall
Attorneys

Feb. 26, 1963

F. D. MOYER

3,079,030

FLOATING COVER FOR SLOPED WALL RESERVOIR

Filed Dec. 31, 1959

7 Sheets-Sheet 4

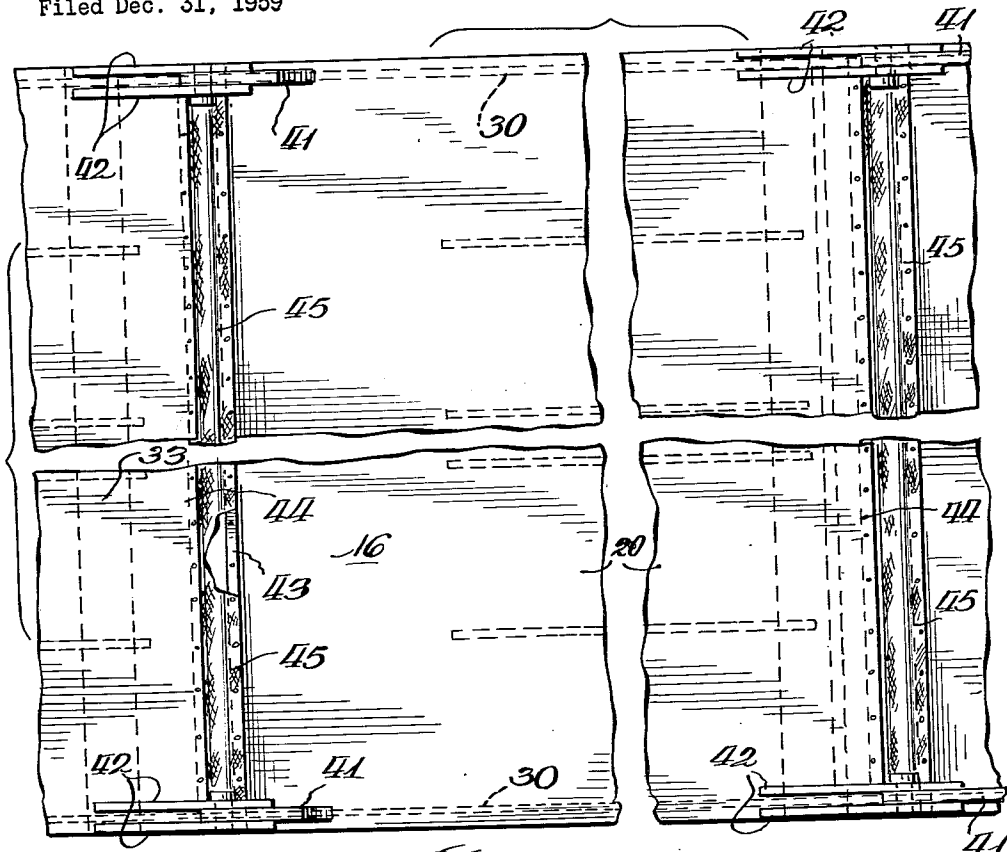


Fig. 7.

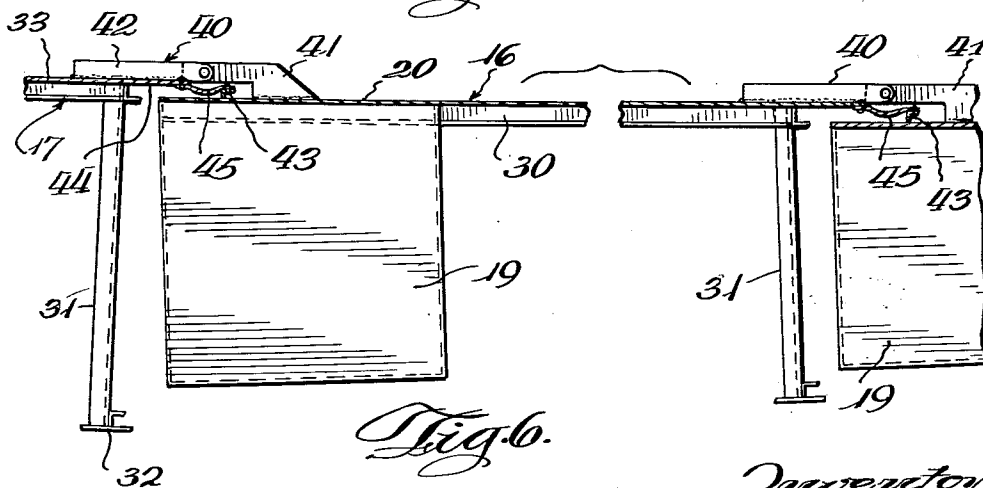


Fig. 6.

Inventor
Frederick D. Moyer
By Merriam, Smith & Marshall
attorneys

Feb. 26, 1963

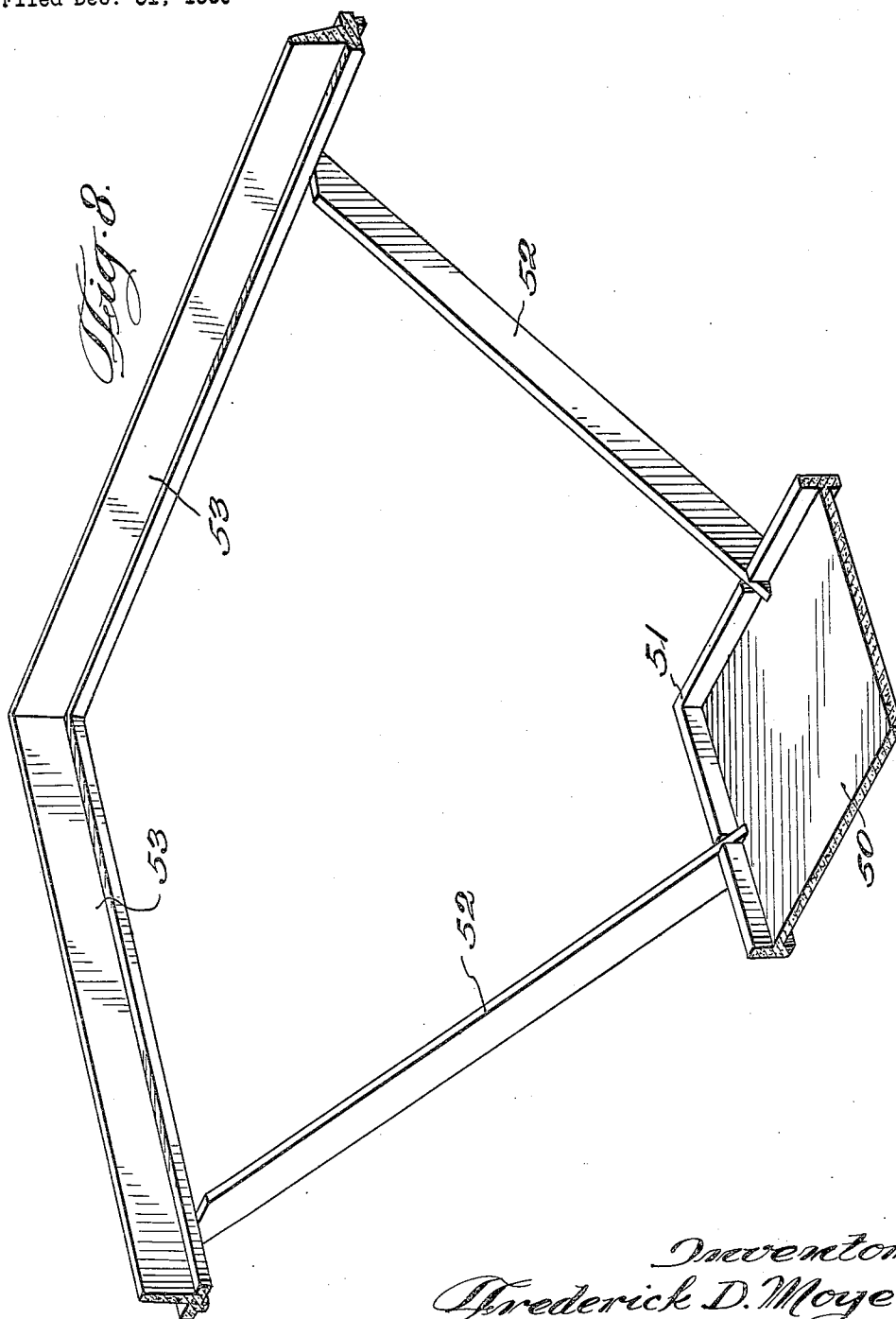
F. D. MOYER

3,079,030

FLOATING COVER FOR SLOPED WALL RESERVOIR

Filed Dec. 31, 1959

7 Sheets-Sheet 5



Inventor
Frederick D. Moyer
By Merriam, Smith & Marshall
Attorneys

Feb. 26, 1963

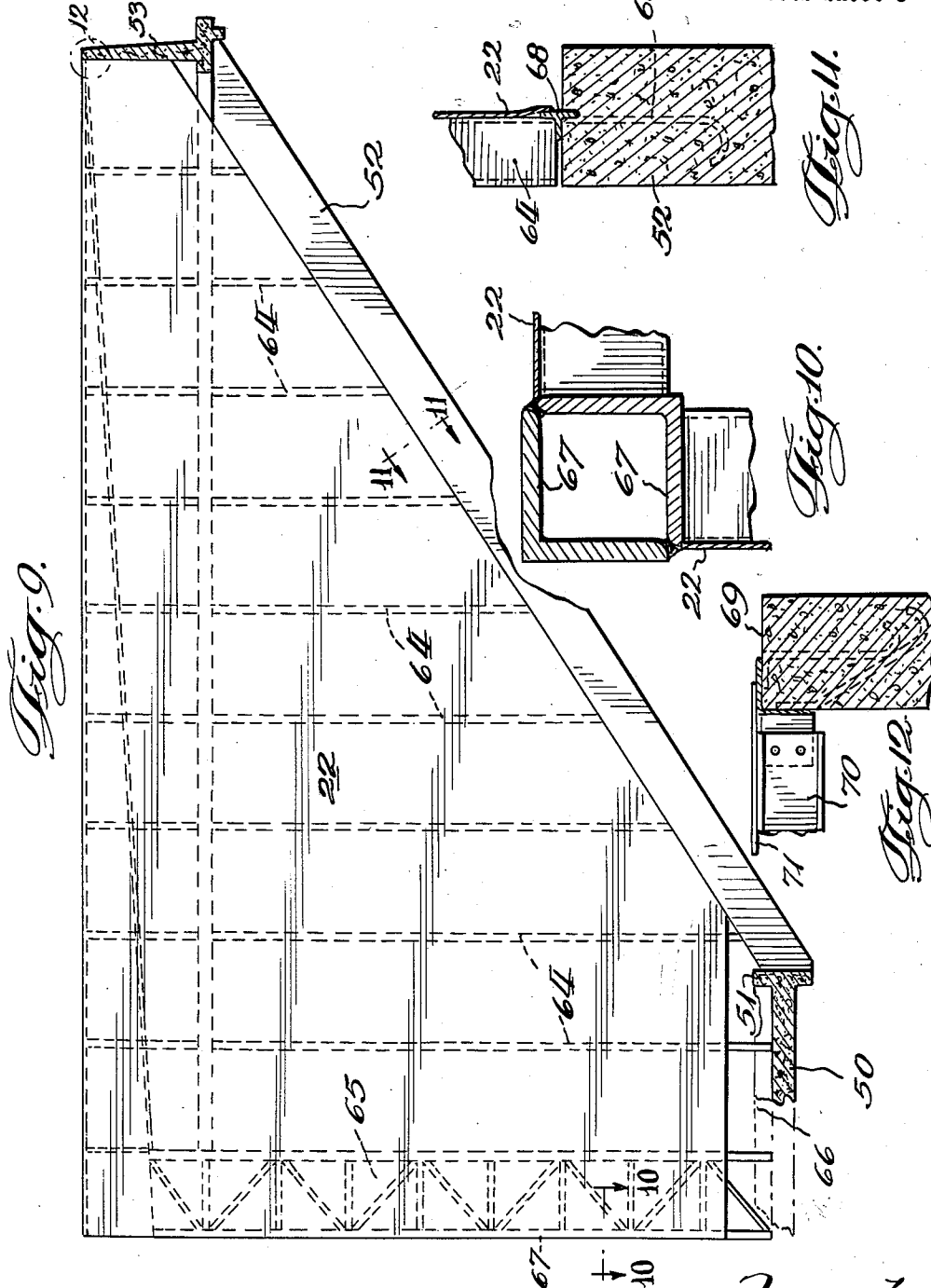
F. D. MOYER

3,079,030

FLOATING COVER FOR SLOPED WALL RESERVOIR

Filed Dec. 31, 1959

7 Sheets-Sheet 6



Inventor
Frederick D. Moyer
By Mavris, Smith & Marshall
Attorneys

Feb. 26, 1963

F. D. MOYER

3,079,030

FLOATING COVER FOR SLOPED WALL RESERVOIR

Filed Dec. 31, 1959

7 Sheets-Sheet 7

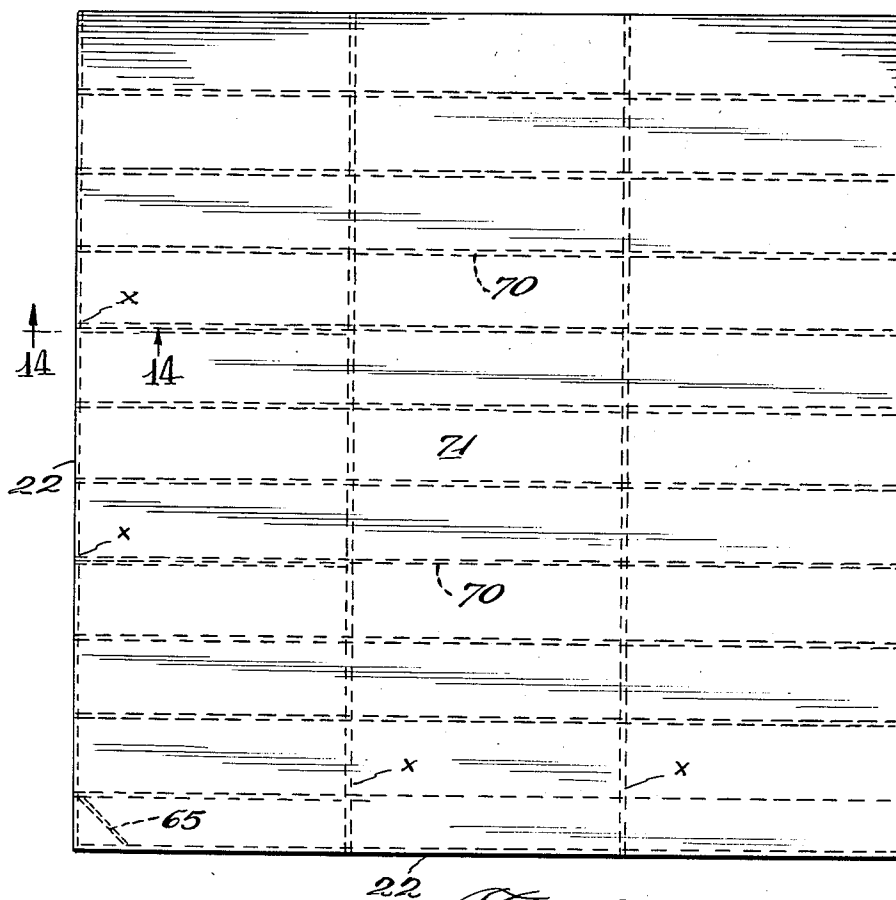


Fig. 13.

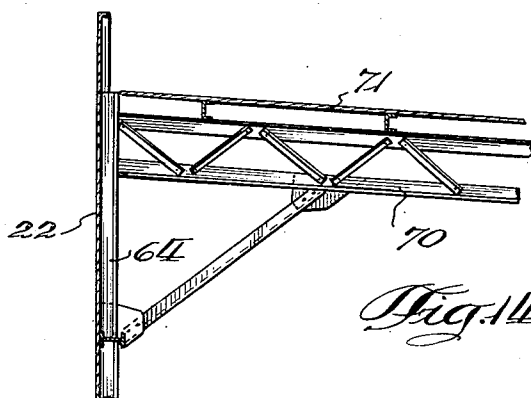


Fig. 14.

Inventor
Frederick D. Moyer
By Merriam, Smith & Marshall
Attorneys

1

3,079,030

FLOATING COVER FOR SLOPED WALL RESERVOIR

Frederick D. Moyer, Chicago, Ill., assignor to Chicago Bridge & Iron Company, Chicago, Ill., a corporation of Illinois

Filed Dec. 31, 1959, Ser. No. 863,188
8 Claims. (Cl. 220-26)

This invention is concerned with a floating cover for a liquid storage reservoir. It more particularly relates to an articulated floating cover for use in large area, earthen storage reservoirs having sloping walls.

Although the conventional method of storing petroleum oils is in steel storage tanks, this method is costly where large quantities are involved because the capacity of such tanks is 100,000-200,000 barrels and large areas of tank farms and extensive piping systems are required. It is frequently possible where the nature of the petroleum oil permits to employ large earthen reservoirs economically. Earthen reservoirs for example have been successfully used to store 3.5 to 8.5 million barrels of fuel oil. Although such storage facilities are generally employed in the storage of substantially non-volatile oils it is desirable to enclose the reservoir with a suitable roof. Obviously the large areas involved complicate the construction of suitable roof structures.

Floating covers for storage tanks in use previously have been used in conjunction with vertical walled storage tanks such as cylindrical oil storage tanks in which a circular roof floats upon the stored product, rising and falling as the level of the stored product rises and falls. Such floating roofs have been useful in conserving valuable petroleum fractions which otherwise would volatilize and be lost to the atmosphere, and also in reducing the fire hazard which occurs in the storage of petroleum products by reducing the amount of surface area exposed to oxygen and also the amount of petroleum vapor in the air.

Where a floating roof is used in a vertical walled vessel such as a cylindrical storage tank, it is possible to construct a floating roof of fixed size and shape to conform to the shape of the vessel. In the case of a vessel having sloping side walls, however, such as an earthen reservoir, it no longer is possible to construct a roof of fixed size and shape that will rise and fall freely as the liquid level rises and falls. According to this invention there is provided a floating cover for a reservoir having sloping side walls, that can rise and fall freely as the liquid level in the reservoir rises and falls, maintaining contact at all times with most of the liquid surface. The floating cover of this invention employs a cooperating series of articulated panels rather than the rigid construction of conventional floating covers.

FIGURE 1 is a fragmentary plan view of an embodiment of the articulated floating cover of this invention showing each of the end sections and the middle portion of the central section;

FIGURE 2 is a vertical cross-sectional view of the floating cover taken in the section 2-2 shown in FIGURE 1 showing a fragmentary view of the earthen reservoir walls;

FIGURE 3 is an enlarged plan view of one of the rectangular pontoon segments and portions of neighboring segments going to make up the central portion of the floating cover;

FIGURE 4 is a vertical cross-sectional view taken in the plane 4-4 of FIGURE 3;

FIGURE 5 is an enlarged sectional view of the peripheral pontoon segments of the floating cover, taken in the plane 5-5 of FIGURE 1, and showing the position of such segments both when the reservoir is full and when the reservoir is empty;

2

FIGURE 6 is a vertical sectional view on an enlarged scale of a portion of the pontoon device shown in FIGURE 5, showing the hinging and sealing arrangement;

FIGURE 7 is a plan view of the pontoon construction shown in FIGURE 6;

FIGURE 8 is an isometric view of the foundation structure for the corner sections of said reservoir;

FIGURE 9 is an elevation view of the corner wall structure supported by the foundation structure shown in FIGURE 8, taken in the plane 9-9 of FIGURE 1;

FIGURE 10 is a cross-sectional view along line 10-10 of the corner column employed in the wall structure shown in FIGURE 9;

FIGURE 11 is a cross-sectional view along line 11-11 of a foundation detail for mounting the side wall on the foundation;

FIGURE 12 illustrates a connection employed to secure the roof of the corner structure to the foundation;

FIGURE 13 is a plan view of the corner structure roof;

FIGURE 14 shows the details of a knee brace employed for supporting the corner structure roof; and

FIGURE 15 is a force analysis diagram employed in the design of the articulated pontoon segments employed in the peripheral sections enclosing the side wall areas.

In the specific embodiment of this invention illustrated in the drawings an earthen reservoir 10 having a substantially rectangular configuration is employed as a storage basin. An earthen embankment 11 substantially triangular in cross-section is employed as the side walls of the reservoir. Construction of the earthen embankment will depend upon foundation conditions, availability of natural materials, etc. For example, see Civil Engineering, August 1959 at p. 58 et seq. for a description of typical construction techniques used in preparing earthen embankments. Although the inside side wall 12 of the embankment 11 exposed to the stored oil has a single slope, a multiple slope side wall, with or without beams, can also be used. The side walls will generally have a gentle slope (about 1:2½) to improve erosion resistance and preferably will be faced with a suitable coating to improve erosion resistance.

Referring now to FIGURES 1 and 2, the floating cover consists of a planar, central pontoon section 13, comprised of a plurality of decked inner pontoon segments 14 and a plurality of intermediate pontoon segments 15 joined each to the other to form a unitary central roof section with the general shape of a Greek cross. A plurality of articulated peripheral pontoon segments 16 surrounds the central pontoon section 13, except at the four corners thereof. Each of the peripheral pontoon segments 16, with the exception of a marginal segment 17 positioned adjacent a peripheral rim 18 of the reservoir 10, is composed of a single pontoon 19 and a deck portion 20, cantilevered therefrom as shown in FIGURE 2. The articulated segments 16 are hinged to each other with the outer marginal edge of the assembly being hinged to the rim 18 of the reservoir side wall and the inner marginal edge slidably engaging the deck of intermediate pontoon segments 15. A fixed corner structure 21 having vertical walls 22 is located at each of the four corners of the floating cover within the rectangular notches in the cover assembly.

Abutting edges of adjacent inner and intermediate segments 14 and 15 are connected together in such manner to maintain the pontoon segments in fixed relationship with each other to form the rigid, central pontoon section 13. The peripheral pontoon segments 16 are so articulated that the inner edge of each segment is supported by the outer edge of the adjacent segment, and each row of segments is free to rotate within an angle having limits defined by the slope of the side walls of

the reservoir and substantially the horizontal position, without affecting the adjacent or any other row of such peripheral pontoon segments. A plurality of outermost marginal deck segments 17 is arranged in a manner such that the outer edges bear upon the rim 18 reservoir side wall and the inner edges bear upon the outermost edge portion of the outermost row of peripheral pontoon segments 16. In the preferred embodiment, a means is provided for relative movement of the deck portions 20 of the innermost row of peripheral pontoon segments 16 upon the deck 23 of the row of intermediate pontoon segments 15, for the purpose of accommodating to the dimensional changes resulting from the rising and falling of the floating cover upon the stored liquid as the reservoir is filled and emptied. It should be understood, however, that other embodiments can be utilized in which the provision for dimensional changes referred to above is located wholly or partly at other points of the floating cover, as for example in the various joints between adjacent rows of peripheral pontoon segments 16.

In the preferred embodiment shown in FIGURES 1 and 2 it will be noted that the inner pontoon segments 14 of the central pontoon section 13 are arranged in such manner that the pontoons of one segment are at right angles to the pontoons of each adjacent segment, thus creating a "herringbone" effect and improving the stability of the floating cover, but it should be understood that this arrangement, while preferred, is not essential to the invention.

The inner pontoon segments 14 are shown in greater detail in FIGURES 3 and 4 in which, in addition to a deck portion 26 there is shown a vertical rim 27 extending about the periphery of the pontoon segment 14, extending downwardly into the stored liquid and upwardly to slightly above the deck portion 26 for the purpose of facilitating connection to corresponding rims of adjacent segments and preventing rain water from running off the deck into the stored product. In addition, horizontal stiffeners 28 such as angle shapes are attached in spaced relationship to the deck 26 of the inner pontoon segment 14 to provide rigidity of each segment. These stiffeners 28 are required only where each pontoon segment 14 is of substantial size and constructed of relatively thin plate material. In a typical structure built according to this invention each central segment can be twenty-four feet or more square and the decks constructed of $\frac{3}{16}$ " or $\frac{1}{4}$ " thick steel plate, thus necessitating stiffening as shown. In the preferred embodiment in which the pontoon segments 14 of one segment are arranged so as to be perpendicular to the alignment of pontoons 29 in each adjacent segment, it is desirable to secure the stiffener 28 at the point of juncture of the inner vertical pontoon wall with the deck in order that the alignment of stiffening reinforcement across the entire central portion of the floating cover will be substantially straight.

The need for the stiffening reinforcement mentioned above is readily apparent when consideration is given to the effect of wind moving across the tremendous area of the floating cover. In a typical installation, for example, the central portion alone of the floating cover can be 500 feet square or more. The force of any significant wind blowing across this huge area must be resisted, and a means for providing such resistance in this invention is the combination of the fixed vertical corner structure 21 forming a notch in the floating cover and the stiffening arrangement mentioned above. The intermediate segments 15 are positioned in a single file peripherally about the edges of the inner pontoon segments with the pontoons 29 of these intermediate pontoon segments 15 in parallel alignment with the abutting edges of the inner pontoon segments 14. When these intermediate segments are connected together the pontoons 15 form in effect two continuous box girders extending the entire distance between each fixed corner structure 21 at

one corner and the fixed corner structure 21 at an opposite corner. Thus the entire force of all wind loads acting upon the inner pontoon 14 can be transmitted by means of the stiffening in each inner segment to the intermediate pontoon segments 15 and through those intermediate segments, and particularly the box girder formed by the pontoons 29 of those segments, directly to whichever rigid corner structures are downwind. The rigid corner structure 21 must, therefore, be designed of sufficient strength to resist these transmitted wind reactions.

FIGURE 5 shows the marginal deck segment 17 which is connected to the peripheral pontoon segment 16 by means of a hinge and seal as shown more clearly in FIGURE 6. Similar hinges and seals are provided between each row of peripheral pontoon segments 16, while a sliding connection is provided between the free edge of deck 20 of the innermost row of peripheral pontoon segments 16 and the row of intermediate pontoon segments 15. Stiffeners 30 are also laterally spaced to reinforce the deck 20 of the peripheral pontoon segments 16 and also the single deck outermost marginal segments 17, in the same manner as is described above with respect to the stiffening of the inner and intermediate pontoon segments 14 and 15. Fixed spacing posts 31 are attached to downwardly depend from the corners of the deck 20 adjacent the terminal free end thereof to provide a minimum spacing of the deck away from the sloping side wall of the reservoir to prevent any portion of the pontoons 19 from coming into contact with the sloping side walls 12, thus preventing friction and displacement thereof, particularly when such pontoons may be rotating due to changes in level of the floating cover. A transverse base plate 32 spanning the spacing posts 31 is used as a bearing surface when the marginal and peripheral segments are at rest on the slope. While the provision of such fixed posts 31 is the preferred embodiment where the reservoir walls are earthen or otherwise unstable, it should be understood that such posts may be omitted if spaced rails are laid along the sloping side walls of the reservoir for the purpose of absorbing any frictional contact that might take place because of the rotation of the pontoons as above mentioned. In such an embodiment, the pontoons rest directly against such spaced rails and the inner edges of the decks 20 and 33 would be supported by the pontoon of the next adjacent peripheral segment to which it is hingedly connected. Moreover, even the rails may be omitted if the reservoir walls are stable, such as steel plate or concrete walls.

FIGURE 6 shows an illustrative method by which the adjacent rows of peripheral pontoon segments 16 and the outermost marginal single deck segments 17 are connected together. A hinge 40 capable of rotating through an angle measured by the angular distance between the horizontal and the slope of the reservoir side walls has an inwardly directed arm 41 rigidly attached to deck 20 and an outwardly projecting arm 42 rigidly attached to deck 33. These arms must be of sufficient strength to support substantially all of the weight of the pontoon 19 located immediately below the hinge and a portion of the deck 20 in the preferred embodiment, and this weight is in turn supported by post 31 bearing against the sloping side wall of the reservoir. Similarly the marginal segment is pivotally connected to the rim 18 of the reservoir which is provided with a bearing plate 46 to which a suitable hinge 47 is attached.

In order to prevent water, debris, dust and the like from getting into the stored product through the space between adjacent rows of peripheral pontoon segments a seal is provided as shown in FIGURE 6. A flange 43, such as an angle shape, is attached to deck 20 in an alignment parallel to the long edge of the segment. Deck 33 extends beyond the edge of the adjacent pontoon segment and above it, as shown at 44, and a flexible

sealing material, such as a rubber impregnated fabric 45, is attached to both the attachment angle 43 and the extended portion 44 of deck 33. A similar construction is employed at each joint between adjacent rows of peripheral pontoon segments.

Provision must also be made for draining rain water from the floating cover, as is well known. This can be done, for example, by providing sumps (not shown) in each central pontoon segment and connecting a drain line thereto. The drain lines can be manifolded into a draw-off line or, if contact between the stored product and water is not undesirable, each sump may merely drain water directly into the stored product, where it settles to the bottom and from time to time is removed. In addition, in order to provide a proper slope for drainage, particularly when the reservoir is full and the cover is therefore floating substantially level edge to edge, it is necessary to select dimensions for pontoons 14, posts 31 and related portions of the peripheral segments 16 with care so as to provide a continuous slope of the top plates of the peripheral pontoons inwardly toward the central pontoons.

As can be seen from FIGURE 15, in a typical peripheral pontoon several forces will be acting which must be in equilibrium. There will be a reaction R transmitted to the pontoon from the next outwardly adjacent segment representing a portion of the weight of that next adjacent segment. The weight of the typical segment will, of course, be acting downwardly and is represented by the force G acting through the center of gravity of the segment. If moments are taken about the point O the buoyant force B of liquid displaced by that portion of the pontoon submersed in said liquid must be sufficient to place the forces in equilibrium. Thus:

$$Bl_B = Rl_R + Gl_G$$

The height and width of the pontoon is therefore selected so that when this state of equilibrium is achieved the top deck of the segment will be at the proper slope, such as, for example, about 0.4 feet per foot. Obviously, therefore, the dimensions of the pontoons in different rows of peripheral segments may vary.

Because of the sloping characteristic of the side walls of the reservoir on which the floating cover of this invention is placed, it is necessary to make special provision for the corners of the floating cover on account of the horizontal forces such as wind, mentioned above, and the vertical motion of the floating cover as the reservoir is filled and emptied and the corresponding dimensional changes in the overall measurements of the roof. FIGURES 8 through 14 demonstrate a preferred arrangement for taking care of this problem. In FIGURE 8 there is shown an isometric view of a foundation to support the corner structure. A rectangular or square pad 50 is placed at about the level of the reservoir bottom, and has a peripheral footing 51 monolithically attached along the two edges defining the corner of the bottom of the reservoir. The foundation is preferably constructed of cast in place concrete. Attached monolithically to the pad 50 are angularly disposed struts 52, also of concrete, which are positioned to conform to the slope of the sloping side walls 11 of the reservoir and to be immediately adjacent and below the lateral edge of the peripheral pontoon segments located immediately adjacent to the corner structure. The struts 52 are monolithically attached at their opposite ends to a concrete footing 51 and rim 53 which provides a support for a fixed cover, as hereinafter described.

FIGURE 9 shows the manner in which smooth vertical walls, such as steel plate walls, are placed immediately above the struts 52 shown in FIGURE 8. In FIGURE 9 a steel plate wall 22 is placed above strut 52 and stiffened by means of vertical stiffener angles 64. The rectangular corner should be suitably reinforced by means of struts or other reinforcement generally shown 65. An opening

66 is provided in the lower portion of the vertical walls 22 to afford communication between the corner enclosed by the vertical walls 63 and the remainder of the reservoir, but the top edge of this opening 66 should not extend above the lowest level of any inner pontoon segments 15 hereinabove described. Illustrative assembly details are shown in FIGURES 10-14. In FIGURE 10 is shown a built up column assembly consisting of two angles 67 welded together to form a hollow rectangular column. FIGURE 11 shows a technique for securing the side walls to the angular struts. One arm of T-shape 68 is imbedded in the surface of the concrete strut and further secured by tie rod 68' which is buried in the concrete with one end welded to the imbedded arm. The stiffeners 64 are joined to the leg and upright arm of the T-shape 68 and the wall plates 22 secured in place and flashed over the upright arm. FIGURE 12 illustrates a suitable connection for securing the roof girders 70 to the upper rim 69 of the concrete structure 50. A roof 71 is shown in FIGURE 13 disposed within the square or rectangle described by the two vertical walls 22 and the two reservoir rims 69, and held in place by transverse roof girders 70. This roof 71 should preferably be sloped so as to provide easy drainage and to prevent the roof from becoming overloaded because of water accumulated thereon. Knee braces illustrated in FIGURE 14 are employed to strengthen the corner structure 21 and are placed in the structure at the positions labelled "X." A wiper type seal of a construction that is generally well known in the floating roofs for storage tanks can be attached to the lateral edge of each row of peripheral pontoon segments 16 in slidable contact with the vertical corner walls 22, for the purpose of preventing moisture and other impurities from entering at those locations and also preventing vapors escaping from any volatile products stored in the reservoir.

The method of attaching edges of the various pontoon segments of this floating cover to adjacent edges of other such segments is important, especially in the case of the longitudinal attachments of the peripheral segments shown and described in relation to FIGURES 5 and 6.

In order to maintain the floating cover in the required shape despite the horizontal forces induced by wind and other live loads, the entire central portion of the floating cover should be made rigid. In the preferred embodiment this is accomplished by bolting the inner pontoon segments 14 to each abutting inner segment 14. In utilizing such construction it is possible to prefabricate each segment at a fabrication yard adjacent to the reservoir and then to transport each segment to the reservoir and set it in place, either on the reservoir bottom or by floating it on liquid in the reservoir, thus eliminating all assembly work at the final location except for the bolting mentioned. It should be understood, however, that other means may be employed for making the central portion of the cover rigid. For example, the central segments might be set in place and not bolted together, but in that event it would be necessary to erect a strong continuous box girder completely about the periphery of the central portion to resist the bending tendency that would result from the action of wind where the forces are resisted only at the extreme corners of the central portion of the cover. In the preferred construction, as pointed out above, the girder arrangement is accomplished by bolting together the adjoining intermediate segments 15, but the rigidity of the cover is greatly enhanced by also bolting together the abutting inner segments 14.

All vertical rims such as the rims 27 shown in FIGURES 3 and 4 are preferably provided of sufficient depth that the lower edges will always be immersed in the stored liquid. The space between abutting vertical rims is sufficiently narrow that no appreciable amount of water or dust can enter that space if the rims extend above the deck, and in addition the amount of volatilization of stored product will likewise be negligible. If desired, however,

seal may be extended between abutting rims, such as a rubberized fabric as described above.

In operation, a floating cover built in accordance with this invention works in an articulated fashion, rising and falling freely as the liquid in the reservoir rises and falls, with the peripheral pontoon segments and the marginal segments both rising and falling and also moving angularly, one row at a time, the dimensional change being taken up by sliding contact between the innermost row of peripheral pontoon segments and the row of intermediate pontoon segments as above described. When the reservoir is full the entire floating cover is substantially level except for the slight slope necessary for effective drainage. When the reservoir is empty the entire floating cover rests upon the side walls and bottom of the reservoir and conforms generally to the conformation of the reservoir. At intermediate stages between the empty and the full stage, all of the central and intermediate pontoon segments float on the liquid stored in the reservoir and one or more rows of peripheral pontoon segments also float on the stored liquid in a substantially horizontal alignment, while the remaining rows of peripheral pontoon segments and the outermost marginal segments remain angularly disposed from the horizontal and partly or totally supported by the sloping side walls of the reservoir rather than wholly supported by the stored liquid. The ends of the various rows of peripheral pontoon segments are slidably sealed against the vertical corner walls of the fixed corners, as above described. The corner structure, while detached from the articulated floating cover structure, nevertheless cooperates with it to form a unified whole in which all the surface area of the liquid stored in the reservoir is covered and protected at all times.

Although the present invention is not limited with respect to size, it is especially well suited for extremely large storage reservoirs. For example, a floating cover has been designed in accordance with this invention for a reservoir having overall dimensions more than 700 feet on a side. It will be recognized by anyone familiar with the art of storing volatile liquids such as crude petroleum and petroleum fractions that such a reservoir is of a capacity far greater than the capacity of existing conventional storage tanks having floating roofs. This unique reservoir is ordinarily constructed of selected earth fill material available locally, rather than of metal plates, and for this reason, together with its enormous capacity, affords a much more economical storage vessel than is the case with conventional cylindrical floating roof storage tanks made of metal plates. Where local soil conditions make it necessary, thin gage metal plates, a thin layer of concrete or asphalt or a fabric or plastic liner may be placed on the earth fill to provide an impervious membrane, all at less cost than the cost of conventional all-metal floating roof tanks of the same capacity.

It should be obvious to anyone skilled in the art that various modifications of the specific embodiment shown may be made without departing from the scope or intent of this invention. For example, while the central pontoon segments are shown to be square in the preferred embodiment, they might for instance be rectangular or hexagonal. Likewise, the pontoons can be of any shape conducive to a stable pontoon segment. Provisions for accommodation to dimension changes caused by the rising and falling of the roof need not be made either partially or entirely at the connection between the innermost row of peripheral pontoon segments and the outermost row of central segments. The slope of the reservoir side walls is optional, depending upon such factors as the stability of the materials of which the reservoir is constructed, the depth of the reservoir in relation to its horizontal dimensions, and the like. The preferred embodiment of the corner structure as shown and as described above is not mandatory, although it does provide

the advantage of additional storage capacity in the corner. Another embodiment might, for example, merely provide vertical walls forming a notch in each corner without provisions for storage within that notch, thus avoiding the necessity for a fixed cover in the notched corner as shown and described. Having described the subject invention by means of the illustrative embodiments and the foregoing description, it is evident that other modifications will be suggested which are within the scope of this invention.

Accordingly what is claimed is:

1. A cover for a liquid storage reservoir having a storage basin with a polygonal peripheral rim configuration and a substantially rectangular central flat bottom area circumscribed by inwardly sloping basin side walls, which comprises a plurality of stationary corner sections mounted on the side walls of said basin, the inner edge of said corner sections formed by inwardly directed, vertical walls thereof onto said bottom to form a cruciform bottom area having an inner rectangular area and opposed intermediate side areas sloping upwardly and outwardly from said inner area and extending between adjacent corner sections, a substantially rigid, inner floating section having extending therefrom intermediate floating sections integral therewith, the peripheral outline of said inner and intermediate floating sections being substantially congruent with the peripheral configuration of said cruciform bottom area, a plurality of floating peripheral sections registering with the side wall area and cooperating with said intermediate segments to enclose said reservoir, said peripheral sections including an inner portion having a deck area joined to said intermediate section and having an extent sufficient to bridge the gap between said inner section and the inner portion of said peripheral section and a marginal section pivotally joined to the peripheral rim of said storage basin, the inner portion and marginal section having articulated means for hingedly joining the inner portion and marginal portion of said peripheral section without increasing the overall width thereof during rise and fall of said peripheral section said hinge means having a single pivot common to adjacent segments whereby portions of said peripheral section can rest upon said side walls when non-buoyant and provide an additional outwardly directed horizontal dimension for said inner section when buoyant, the vertical side walls of said corner sections being sufficiently strong to resist the horizontal forces of wind loads imposed on said floating sections.

2. The reservoir of claim 1 in which the portions of said inwardly extending vertical walls extending onto said bottom area are provided with passages therethrough whereby the liquid stored in said reservoir remains in contact with both surfaces of each said wall, said corner sections being enclosed to protect the liquid stored within said corner section against atmospheric conditions and to prevent the escape of volatile vapors therefrom.

3. A floating cover in accordance with claim 1 in which the sides of said peripheral sections engage said corner sections in a substantially fluid tight relationship.

4. The floating cover of claim 3 in which the ends of said peripheral section are slidably sealed to said vertical walls to prevent communication between the area above the decks of said sections and the area below said decks while permitting vertical movement of said rows with respect to said vertical walls.

5. A floating cover for a liquid storage reservoir having inwardly sloping side walls provided with an upper peripheral rim, said floating cover comprising a substantially rigid, planar, floating, central section disposed above the central area of the reservoir and circumscribed by the side walls, a series of floating, planar, substantially rigid segments spanning the space between said central section and the rim, and hinge means having a single pivot common to adjacent segments for preventing separational

9

movement between adjacent segments and for pivotally connecting adjacent segments.

6. The invention as defined in claim 5 wherein the segments of said series of floating segments adjacent to said central section are slidably sealed to said central section.

7. The invention defined in claim 6 including a flexible sealing material sealably connecting said adjacent segments.

8. A floating cover for a liquid storage reservoir having inwardly sloping side walls provided with an upper peripheral rim, said floating cover comprising a substantially rigid, planar, floating, central section disposed above the central area of the reservoir and circumscribed by the side walls, a series of adjacent floating segments spanning

10

the space between said central section and the rim, a hinge means having a single pivot common to adjacent segments and including a pair of pivotally connected arms, one arm of said hinge rigidly attached to one floating segment and the other arm of said hinge rigidly attached to an adjacent floating segment, whereby said segments are prevented from separating from each other when the liquid level in the reservoir changes.

References Cited in the file of this patent

UNITED STATES PATENTS

1,734,623	Griffin	Nov. 5, 1929
1,909,484	Bjerregaard	May 16, 1933
2,006,505	Lentschewsky	July 2, 1935
2,970,716	McCammon	Feb. 7, 1961