Dec. 3, 1935. S. G. CANTACUZENE 2,023,308

FLOATING ROOF FOR TANKS

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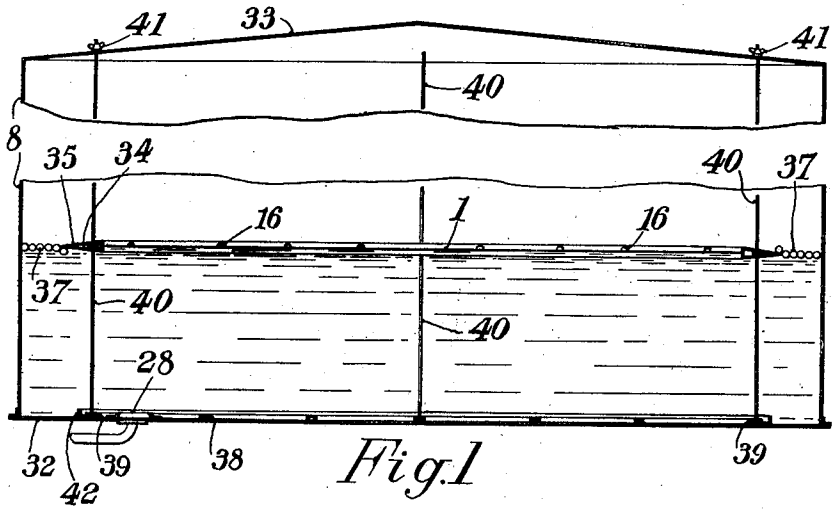

Fig. 1

Fig. 2

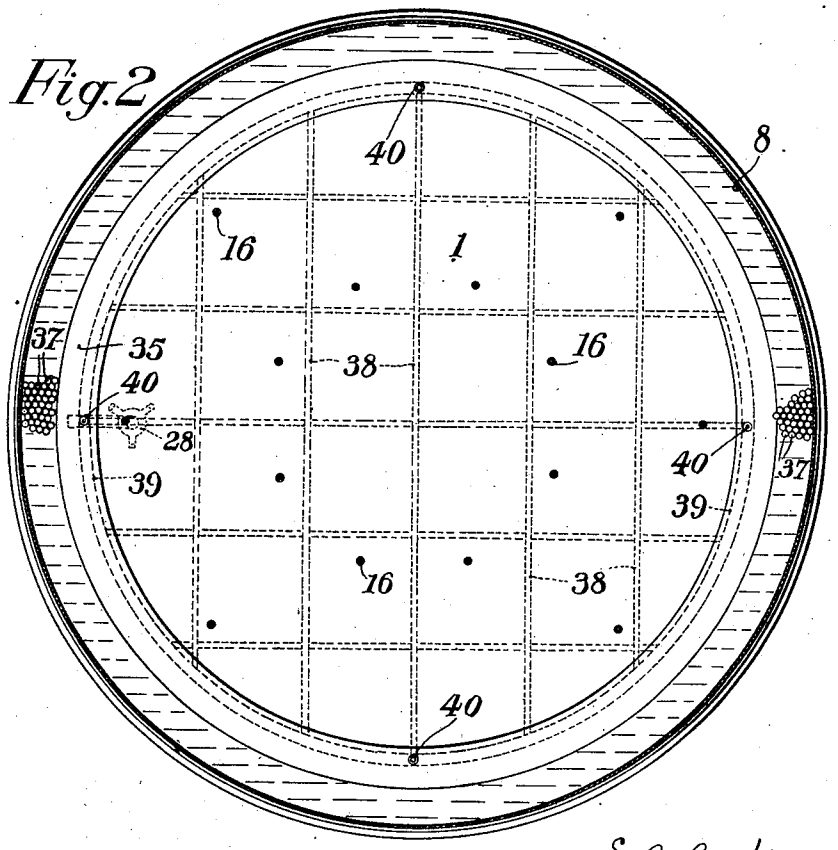

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Fig. 3

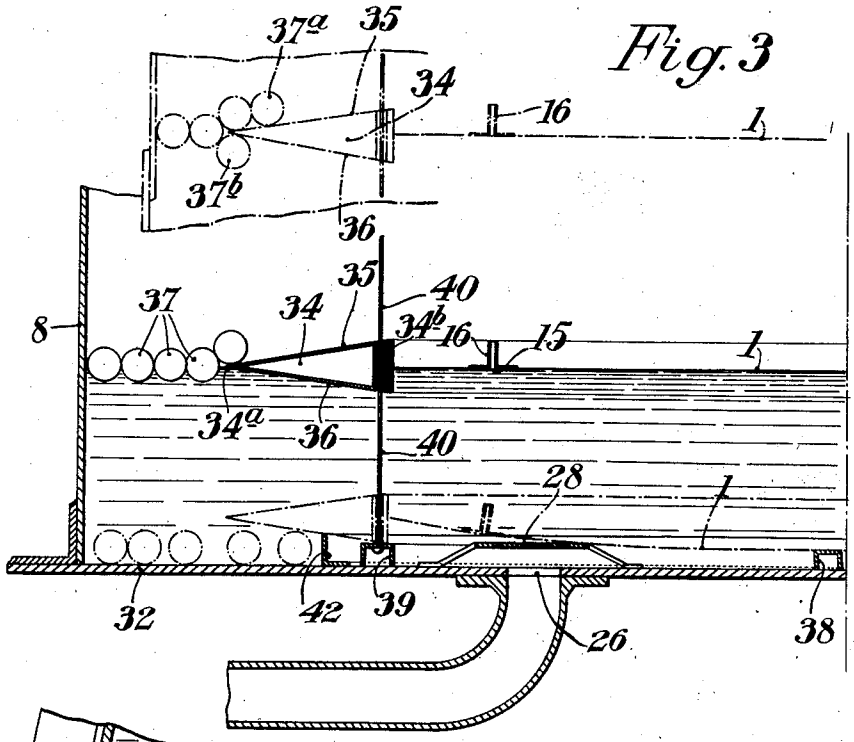
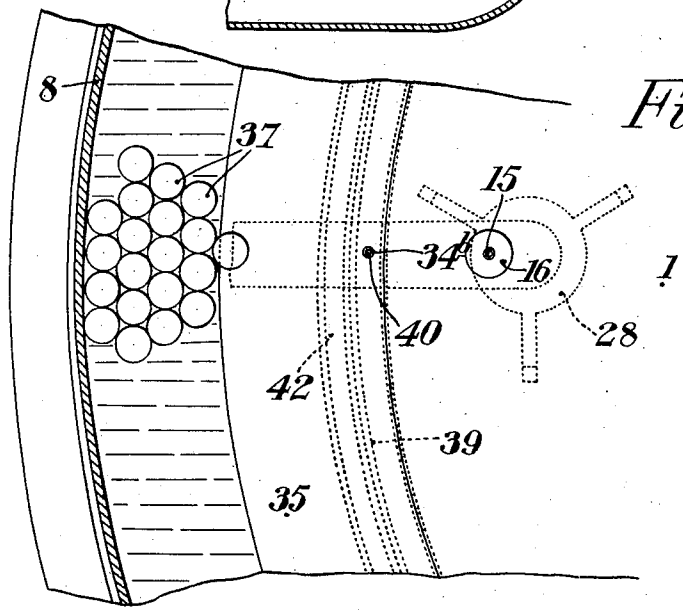


Fig. 4



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UNITED STATES PATENT OFFICE

2,023,308

FLOATING ROOF FOR TANKS

Servan Georges Cantacuzene, Paris, France

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In Rumania November 27, 1931

10 Claims. (Cl. 220—26)

This invention has for its object a floating roof adapted to be used within usual tanks, that is to say those having a fixed roof.

This floating roof has the following advantages: it is much more simple and less costly to manufacture and maintain than those usually employed, it covers the surface of the liquid so as to ensure greater fluid-tightness, it satisfactorily operates on the entire height of the tank up to complete exhaustion of the liquid contained in the latter, it is easily applicable to all tanks of known type without necessitating any important modification of the same, and, finally, it allows of easily cleaning the bottom of the tank.

A form of carrying out the subject-matter of the invention will be described hereinafter, by way of example only, with reference to the accompanying drawings, in which:

Figs. 1 and 2 are respectively a vertical section and a horizontal section above the floating roof.

Fig. 3 is a partial vertical section.

Fig. 4 is a corresponding horizontal section.

In the drawings, 8 designates the side wall of the tank, 32 its bottom, and 33 its fixed roof, which is of the ordinary type.

On the liquid contained in this tank floats a fluid-tight ring 34, the outer edge 34*a* of which constitutes the edge of a wedge, the upper face 35 of which is downwardly inclined from the interior towards the exterior of the ring, and the lower face 36 of which is inclined in the reverse direction. The ring is loaded in such a way that the edge 34*a* is approximately at the level of the liquid.

The external diameter of this ring 34 is slightly smaller than that of the minimum internal diameter which the tank 8 may have at any point of its height.

Small spheres 37 float on the surface of the liquid between the ring and the inner wall of the tank, these spheres being of relatively small diameter, for instance of the order of 1 to 3 centimeters, and being made of any suitable material, such as wood, metal, celluloid, etc.

The weight of these spheres is such (owing eventually to the fact that they are suitably loaded) that they are partially immersed, preferably midway of their height, and they are sufficient in number so that, at the largest inner diameter of the tank, they cover the entire free surface of the liquid between the ring and the wall 8 by being in contact with each other.

When, during its vertical displacement, the floating roof is at a point of the tank the inner diameter of which has a value lower than the maximum value above mentioned (see the part in dot and dash lines at the top of Fig. 3), the spheres 37 move, relatively to the ring 34, inwardly of the latter, so that the spheres adjacent to the edge 34*a* are compelled, either to ride up the upper wall 35 of the ring, as indicated at 37*a*, or to pass under the lower wall 36, as indicated at 37*b*.

The weight of the spheres 37*a*, lifted out of the liquid, and the hydrostatic thrust exerted on the spheres 37*b*, completely immersed in this liquid, conjointly with the inclination of the faces 35, 36, exert on the spheres which still float a radial stress directed towards the wall 8.

The spheres are thus always maintained in contact with each other and the greatest possible portion of the free surface of the liquid is covered.

If the spheres are immersed exactly midway of their height, and regularly arranged, in stable equilibrium, in contact with each other, that is to say, if each of them is in contact with six other spheres at six points of its great horizontal circle, it is easy to calculate that the covered surface of the liquid, that is to say the sum of the equatorial sections of the spheres, represents about 90% of the total surface on which they float.

If the spheres assume a position of unstable equilibrium, such that each of them is in contact with four other spheres only, the covered surface still represents about 80% of the total surface.

Even in the most unfavourable case, this device covers therefore a much more important fraction of the free surface of the liquid between the tank and the edge of the floating roof than ordinary devices.

Instead of a single layer of spheres immersed midway of the liquid, several layers might be used, the spheres being in this case of smaller diameter and less dense, so that one sphere plunges in the liquid according to a fraction only of its radius, the lower spheres being partially immersed in the liquid by the weight of the upper spheres.

Instead of spheres, bodies of any shape can be used, for instance ovoids or ellipsoids the great axis of which is held vertical by suitably loading them.

The surface of the liquid within the ring 34 is covered by a foil or impervious film 1, in contact, throughout the extent of its lower face, with the liquid on which it rests, and secured in a fluid-tight manner by its edge to the ring 34.

The foil or film can be made of any suitable material, such as aluminium foil, cellulose products of the celloidine type, thin stainless sheet metal, celluloid, canvas or paper waterproofed, or metallized, or reinforced by wire gauze, these various elements being utilizable either separately, or combined in any suitable manner.

This film 1 being adapted to prevent any contact between the volatile liquid and the atmosphere and being very flexible owing to its small thickness, it is necessary to avoid the formation, between the film and the liquid, of pockets of gas which, dissolved in the liquid, might evolve therefrom; for that purpose, at several points of the film surface, orifices 15 are provided, each of these orifices communicating with the atmosphere through a small vertical tube 16, the height of which is sufficient for preventing the liquid from passing above the film 1.

For allowing to clean the bottom of the tank, to effect repairs of the above mentioned device, etc., a metal grating is provided under the said device, this grating being preferably made of section members and freely resting on the bottom 32.

The said grating comprises a series of bars 38 secured to a circular angle iron 39, the diameter of which is approximately equal to that of the ring 34.

The grating is attached, at a number of points of the angle iron 39, to vertical cables or bars 40 which pass through the ring 34 in conduits 34b provided in the latter and suitably devised for preventing the passage of the liquid, and through the roof 33, through fluid-tight orifices; these cables or bars can be lifted from the exterior by any suitable means: winch, or a nut control 41 for instance.

When the tank is empty, the ring 34 and film 1 rest on the grating (see the part shown in dot and dash lines at the bottom of Fig. 3) and it is possible, when a job has to be effected, to lift the entire structure, by means of the above device, to the required extent for allowing to have access between the bottom 32 and the floating roof.

It is to be noted that during normal working conditions, these cables or bars 40 serve as guides along which the floating roof slides parallel to the walls.

When the grating is raised, the spheres 37 remain on the bottom 32; they are prevented from scattering by an angle iron 42 secured on this bottom, concentric with the side wall 8.

For preventing suction at the outlet, or pressure at the inlet from breaking the thin film 1 or from displacing the spheres 37, each orifice, such as 26, will be concealed by a sheet metal plate 28, secured at a sufficient distance in front of this orifice, for breaking the force of the stream.

It is to be noted that, as the ring 34 is of small height, for instance 4 to 5'' above and below the level of the liquid, this floating roof practically operates until it comes in contact with the fixed roof, on the one hand, and with the bottom of the tank, on the other hand.

Moreover, the film rests, throughout its area on the liquid, or, when the tank is empty, it is supported by the grating; it is not therefore subjected to any stress, and it can be made of very small thickness, this rendering the device very economical.

The form of construction described above solely by way of example, can of course be modified in its details in any suitable manner, without thereby departing from the scope of the invention; in particular, concerning the arrangement of the floating roof and of the device allowing to raise it, any suitable arrangements can be provided for maintaining the spheres, or floating bodies of any other shape, in contact with each other; for instance, instead of giving the edge of the ring 34 the shape of a wedge, it might be made in the shape of a truncated cone or pyramid having a sufficient height above and below the surface of the liquid in order that, when the inner diameter of the tank diminishes, the spheres are simply lifted above the liquid if the said truncated cone flares downwardly, or plunged in this liquid if it flares upwardly. The profile of the ring 34 can also be given an ogival shape or another rounded shape. In order to cover the most important fraction possible of the free surface of the liquid, spheres of different diameters can be used, the proportions of spheres of different diameters being determined so as to provide the best "covering" of this surface.

Having now particularly described the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. In a tank adapted to contain a liquid, the combination of a floating roof and of a series of bodies generated by a surface of revolution, so loaded as to float on the liquid with their axes of revolution vertical, their plane of flotation being that of their maximum horizontal section, these bodies being in sufficient number for forming, by being in contact with each other in floating position, a continuous layer of a single thickness on the free surface of the liquid between the edge of the floating roof and the inner wall of the tank, at the place where the area of the section of this tank is maximum.

2. In a tank adapted to contain a liquid, the combination of a floating roof, of a series of bodies adapted to float at the surface of the liquid, these bodies being in sufficient number for forming, by being in contact with each other in floating position a layer of a single thickness, at least the free surface of the liquid between the edge of the floating roof and the inner wall of the tank, at the place where the area of the inner section of this tank is maximum, at the periphery of the floating roof, and of a wall inclined downwardly and from the interior towards the exterior of the floating roof, the floating bodies being adapted to slide on this wall when, in position of flotation, they are subjected to a horizontal stress directed from the exterior towards the interior of the roof.

3. In a tank adapted to contain a liquid, the combination of a floating roof, of a series of bodies adapted to float at the surface of the liquid, these bodies being in sufficient number for forming, by being in contact with each other in position of flotation a layer of a single thickness, at least the free surface of the liquid between the edge of the floating roof and the inner wall of the tank, at the place where the area of the inner section of this tank is maximum, at the periphery of the floating roof, and of a wall inclined upwardly and from the interior towards the exterior of the floating roof, the floating bodies being adapted to slide under this wall when, in position of flotation, they are subjected to a horizontal stress directed from the exterior towards the interior of the roof.

4. In a tank adapted to contain a liquid, the combination of a floating roof, of a series of bodies adapted to float at the surface of the liquid, these bodies being in sufficient number for forming, by being in contact with each other in position of flotation a layer of a single thickness, at least the free surface of the liquid between the edge of the floating roof and the inner wall of the tank, at the place where the area of the inner section of this tank is maximum, at the periphery of the floating roof, the border of said floating roof having, in diametral section, the shape of a wedge open towards the interior of the floating roof, this roof being so adapted that the apex of this wedge is approximately located at the level of the surface of the liquid in position of flotation, and the floating bodies being adapted to slide along the faces of the wedge when in position of flotation, they are subjected to a horizontal stress directed from the exterior towards the interior of the roof.

5. In a tank adapted to contain a liquid the combination of a floating roof, of a series of bodies adapted to float at the surface of the liquid, these bodies being in sufficient number for forming, by being in contact with each other in position of flotation a layer of a single thickness, at least the free surface of the liquid between the edge of the floating roof and the inner wall of the tank, at the place where the area of the inner section of this tank is maximum, and, at the bottom of the tank, of a projecting ledge adapted to hold the floating bodies between it and the side wall of the tank when the latter is empty.

6. In a tank adapted to contain a liquid, a floating roof comprising a frame adapted to float on the liquid and a thin foil made of a flexible material impervious to the liquid of the tank and inert relatively to this liquid, this thin foil being secured to the frame in a fluid-tight manner and adapted to be in contact with the surface of the liquid throughout the extent of its lower face in position of flotation and means for automatically evacuating the gases generated under said thin foil.

7. In a tank adapted to contain a liquid, a floating roof comprising a frame adapted to float on the liquid and a thin foil made of a flexible material impervious to the liquid of the tank and inert relatively to this liquid, this thin foil being secured to the frame in a fluid-tight manner, adapted to be in contact with the surface of the liquid throughout the extent of its lower face in position of flotation, and perforated with small gas outlet holes, and, on these holes, tubes substantially vertical and having a sufficient height for preventing the liquid from passing through the holes, above the floating roof.

8. In a tank adapted to contain a liquid, a floating roof comprising a frame adapted to float on the liquid and a thin foil made of a material impervious to the liquid of the tank and inert relatively to this liquid, this thin foil being secured to the frame in a fluid-tight manner and adapted to be in contact with the surface of the liquid throughout the extent of its lower face in position of flotation, and, opposite the inner wall of the tank, in front of the filling up and outlet orifices, deflectors adapted to prevent the production of eddies by contact with the said thin foil.

9. In a tank adapted to contain a liquid, a floating roof comprising a frame adapted to float on the liquid and a thin foil made of a material impervious to the liquid of the tank and inert relatively to this liquid, this thin foil being secured to the frame in a fluid-tight manner and adapted to be in contact with the surface of the liquid throughout the extent of its lower face in position of flotation, a movable support for the said floating roof and arranged under the latter, and means for vertically moving the said support in the tank.

10. In a tank adapted to contain a liquid, a floating roof comprising a frame adapted to float on the liquid and a thin foil made of a material impervious to the liquid of the tank and inert relatively to this liquid, this thin foil being secured to the frame in a fluid-tight manner and adapted to be in contact with the surface of the liquid throughout the extent of its lower face in position of flotation, a movable support for the said floating roof and arranged under the latter, guides parallel to the side walls of the tank, having their lower ends attached to the said support, and along which the roof is adapted to slide, these guides passing through the fixed roof of the tank through fluid-tight orifices, and means for longitudinally moving the said guides.

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