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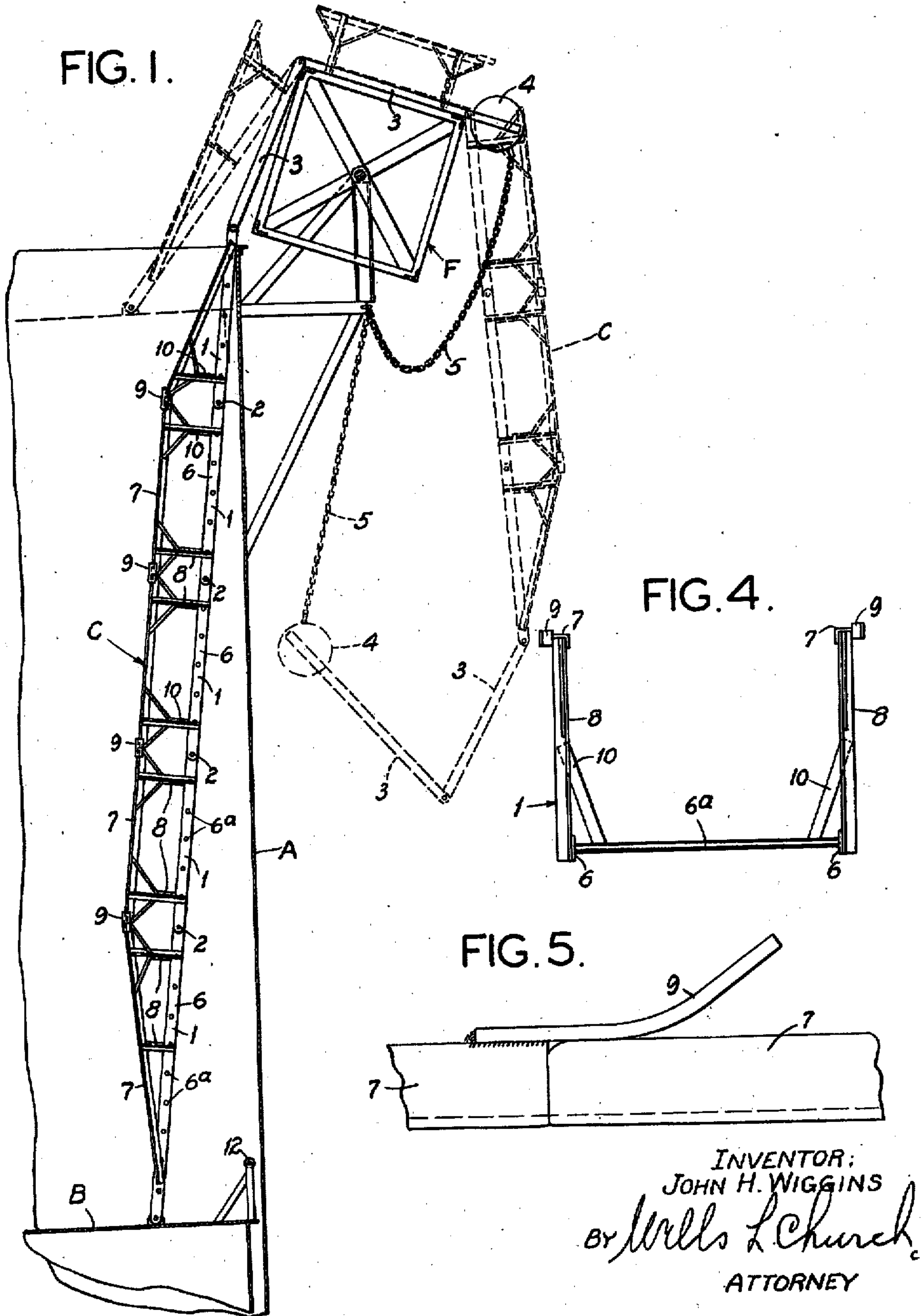
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2,341,890

FOLDING LADDER AND SHIFTABLE PLATFORM FOR FLOATING TYPE TANK ROOFS

Filed Oct. 7, 1942

2 Sheets-Sheet 1



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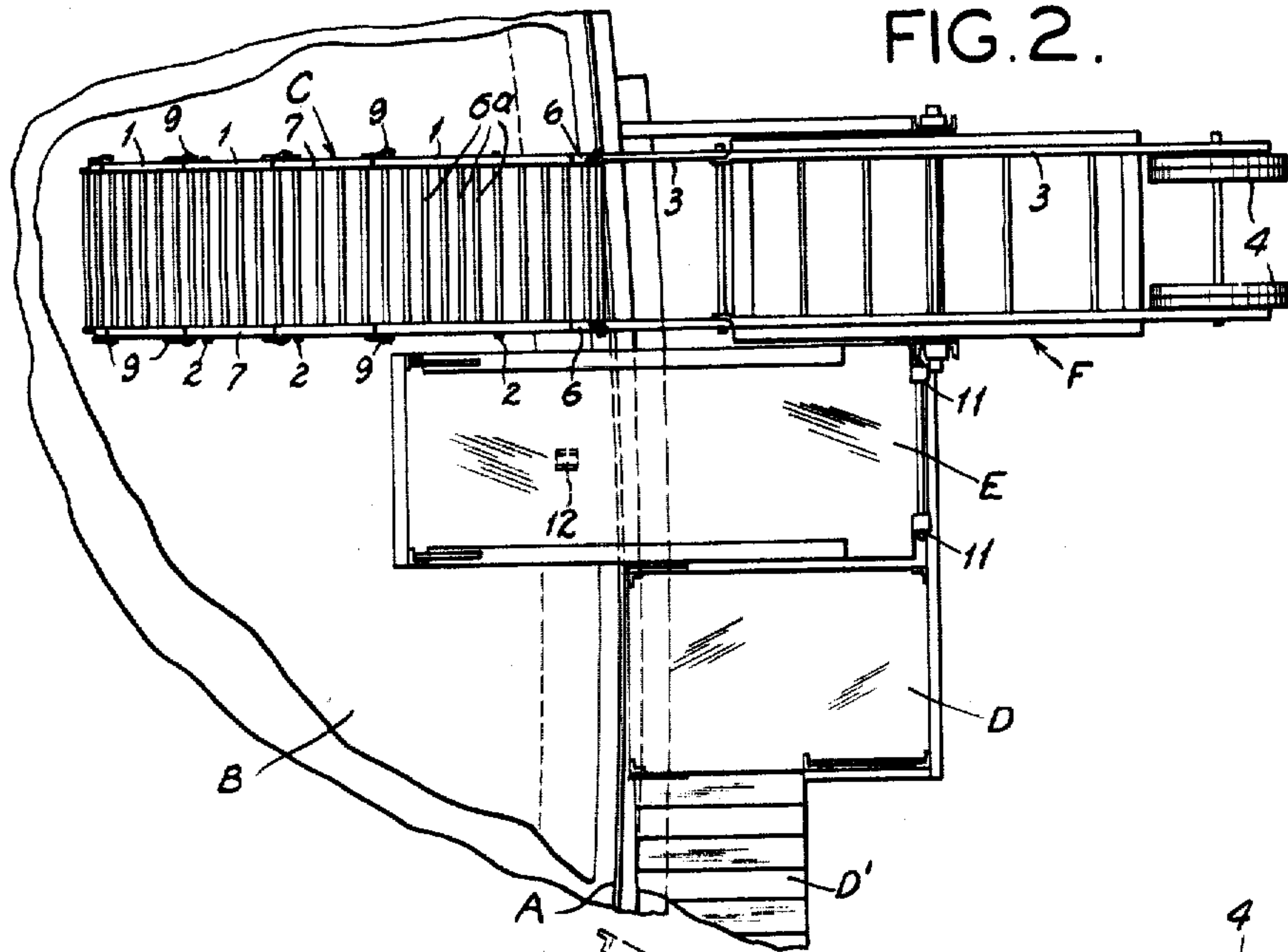
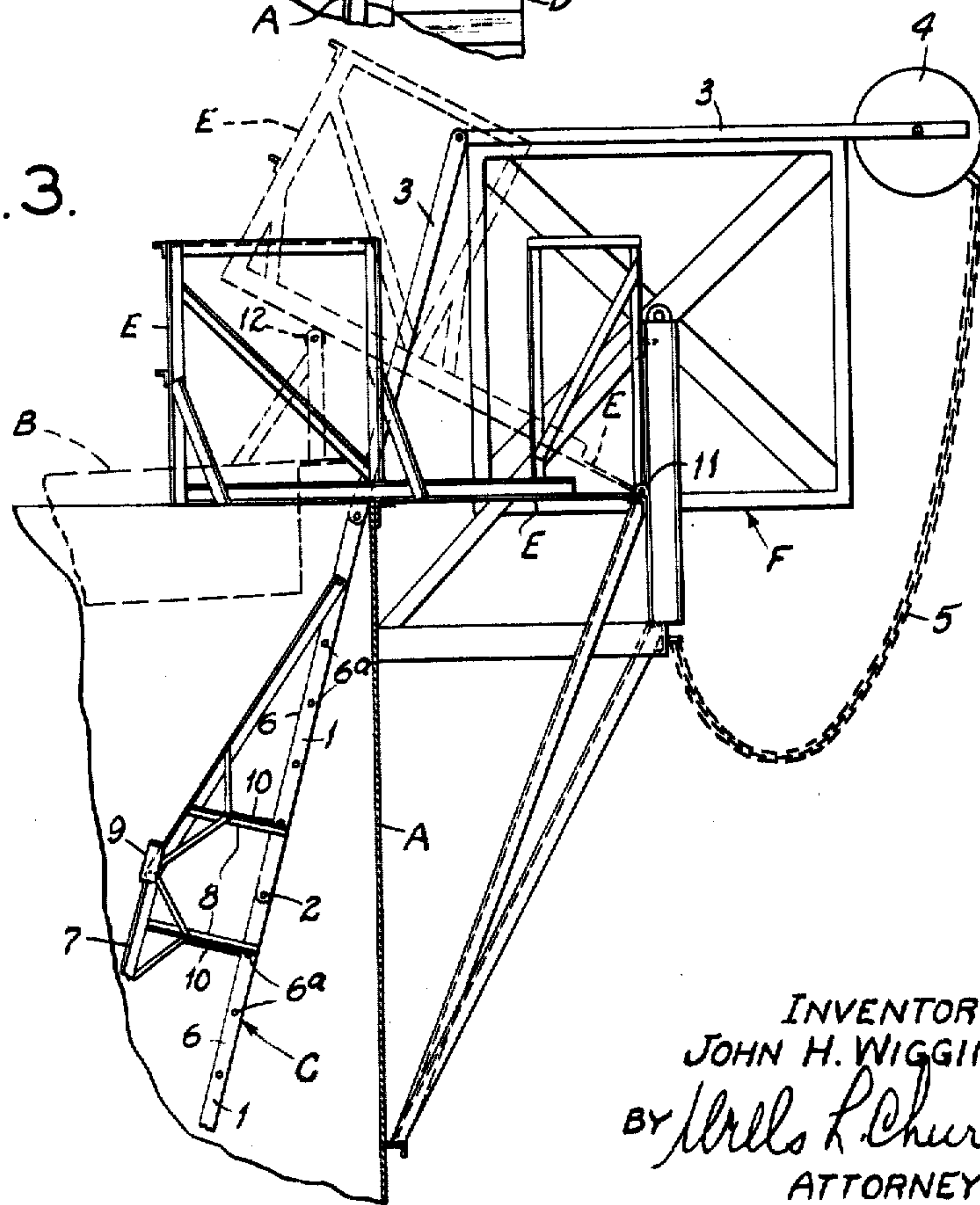


FIG. 2.

FIG. 3.



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# UNITED STATES PATENT OFFICE

2,341,890

## FOLDING LADDER AND SHIFTABLE PLATFORM FOR FLOATING TYPE TANK ROOFS

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Application October 7, 1942, Serial No. 461,220

9 Claims. (Cl. 228—1)

This invention relates to ladders or stairs of the kind that are used with floating type tank roofs to provide access to the roof when it is located at the bottom of the tank and when it is floating on the liquid in the tank.

One object of my invention is to provide a strong, light-weight floating tank roof ladder that is of simple design, easy to erect, convenient to use, and of inexpensive construction.

Another object is to provide a floating roof ladder that has sufficient stiffness or rigidity to prevent it from flexing or swaying from its own weight or the added weight of a person using same, and which is of such design or construction that the portion of same disposed between the roof and the top edge of the side wall of the tank will maintain approximately the same slope or angle during the major portion of the vertical travel of the roof.

Another object is to provide a ladder or stair for floating tank roofs, that will not impose an objectionable or excessive load on the roof, or subject the roof to thrusts or strains tending to rotate the roof or lift or tilt it.

Another object is to provide a floating roof storage tank, that is equipped with a novel ladder provided with a hand rail, and a platform disposed at the top edge of the side wall of the tank in overhanging relation with the roof so as to provide easy access to the roof ladder, said platform being constructed so that it will shift automatically into an inactive position, and thus not strike against the side wall seal or other parts carried by the roof, when the roof approaches its extreme elevated position.

And still another object of my invention is to provide a novel way of counterbalancing a ladder or stair for floating tank roofs. Other objects and desirable features of my invention will be hereinafter pointed out.

Briefly described, my invention contemplates the use of an articulated or hinged structure composed of a plurality of pivotally connected sections, so constructed and combined that they co-act with each other to form a ladder or stair that comprises a rigid portion disposed preferably in an inclined position on the inside of a liquid storage tank between a floating roof and the top edge of the side wall of the tank. The lower end of said ladder is pivotally attached to the roof or is rockably mounted in bearings on the roof, and accordingly, when the roof moves vertically, the ladder will rise and fall with the roof, without materially changing the angle or slope of the ladder. During the upward move-

ment of the roof, the upper portion of the ladder folds, preferably downwardly and outwardly over the top edge of the side wall of the tank and assumes an inactive position on the exterior of the tank. During the downward movement of the roof, the portion of the ladder on the exterior of the tank which previously had folded, will unfold and assume an active or operative position on the interior of the tank so as to constitute a rigid trussed ladder, disposed between the roof and the top edge of the side wall of the tank.

In order to prevent the ladder from imposing an excessive or objectionable load on the roof, or subjecting the roof to thrusts or strains tending to rotate the roof or tilt or lift it, I have equipped the ladder with a counterbalancing mechanism which is preferably constructed in such a manner that the folded portion of the ladder on the exterior of the tank, is utilized as a load to assist in counterweighting the rigid portion of the ladder disposed on the interior of the tank between the roof and the top edge of the side wall of the tank. The specific construction of the co-acting sections of the ladder is immaterial so far as my broad idea is concerned, but I prefer to use ladder sections of girder construction, pivotally connected together in such a way that when they are disposed in longitudinal alignment with each other, they form a trussed ladder that is equipped with a hand rail and which has sufficient rigidity both longitudinally and transversely to prevent it from flexing or buckling, notwithstanding the fact that it is of relatively great length.

Figure 1 of the drawings is a fragmentary, vertical transverse sectional view through the tank, showing the ladder in side elevation and the floating roof arranged adjacent the bottom of the tank, the platforms and associated parts being omitted.

Figure 2 is a top plan view showing the ladder, the wheel, the shiftable platform, the stationary platform and the outside stairway leading to the stationary platform.

Figure 3 is a fragmentary side elevational view, showing in dotted lines how the shiftable platform tilts upwardly so as to not interfere with the side wall seal or other parts carried by the floating roof, when the roof approaches its extreme elevated position.

Figure 4 is a traverse sectional view, taken through one of the sections of the ladder; and

Figure 5 is a detail plan view, illustrating the construction of the guides on the ladder sections



that prevent the top chord members or hand rail members of said sections from moving laterally relatively to each other.

In the accompanying drawings which illustrate the preferred form of my invention, A designates the side wall of a tank or container that is adapted to be used for storing oil or other liquid, B designates a floating roof that floats on the liquid in the tank, C designates a ladder or stair mounted on the top side of the roof and supported in an upright, sloping or inclined position by the side wall of the tank, D designates a stationary platform (see Figure 2) mounted on the exterior of the side wall of the tank and projecting outwardly from the top edge portion of same, E designates a shiftable platform arranged alongside of said stationary platform and projecting inwardly into the tank in overhanging relationship with the roof B, so as to provide easy access to the ladder, and F designates a wheel or reel mounted on the exterior of the side wall A of the tank at the top edge of same, as shown in Figure 1, so as to form a rotatable bearing over which the pivotally connected sections of the ladder C move when said ladder folds and unfolds during the rise and fall of the roof B, said wheel or reel F being of any preferred cross-sectional shape and mounted in any preferred manner on the tank side wall.

The ladder C is composed of a plurality of truss sections 1, comprising bottom chord members pivotally connected together at 2 and top chord members or hand rail members constructed so that they are effectively held against relative rocking movement in one direction, but are free to separate and rock relatively to each other in the opposite direction. When said truss sections 1 are in longitudinal alignment with each other, the adjacent ends of the top chord members or hand rail members of said sections are in abutting relationship, and hence, co-act with each other to produce a rigid ladder that extends upwardly from the roof to the top edge of the side wall of the tank, as shown in Figure 1. The lower end of the ladder C is pivotally connected to the roof B, or is rockably mounted in bearings on said roof, and the upper end of said ladder has attached to same pivotally connected links or flexible devices 3 that lead over the reel F and carry a counterweight 4. Accordingly, during the upward movement of the roof, the truss sections 1 of the ladder rock relatively to each other in such a manner that the ladder will fold over the wheel F and hang suspended from said wheel on the exterior of the tank, as shown in broken lines in Figure 1, and during the downward movement of the roof said ladder sections will unfold progressively and move into longitudinal alignment with each other with the adjacent ends of the hand rail members in abutting relation so as to form a trussed ladder on the interior of the tank that is perfectly rigid, even when the roof is in its lowermost position at the bottom of the tank.

The counterweight 4 exerts a sufficient upward pull on the ladder C when the roof B is in its extreme low position, to prevent said ladder from imposing an excessive load on the roof. As the ladder rises, due to the upward movement of the roof, the counterbalancing effect produced by the counterweight 4 first becomes less, due to the change in the position of the links 3 that carry said counterweight, and then becomes greater, due to the added weight of the folded sections of the ladder that have moved down-

wardly over the wheel F and the reduction in weight of the rigid or unfolded portion of the ladder located inside of the tank between the wheel F and the roof B. This effect would eventually become so great as to create too large a lift on the roof, which would be objectionable, because it would tend to affect gaging the liquid contents of the tank, and might also create a radial pull on the roof, tending to pull the roof off center. Therefore, I attach the counterweight 4 to one end of a chain or flexible element 5, whose opposite end is attached to a stationary part on the tank side wall, said chain 5 being of such length that the counterweight 4 will hang on said chain under certain conditions. For example, when the counterbalancing effect becomes a certain amount, the counterweight 4 itself is picked up by the chain 5. At this point the rigid or unfolded portion of the ladder on the inside of the tank may actually change from, say a hundred pound pull to a hundred pound load, but as the roof B rises higher, this load reaches zero and then goes into a pull on the roof again. By the means above described, I keep the pressure or tension produced on the roof by the ladder, to a minimum; and another desirable characteristic of said means is that it insures that the radial pulls and pushes on the roof will be small and alternate, thus tending to prevent the roof from being pulled off center. Obviously, other counterbalancing means or devices than the one above described could be used, without departing from the spirit of my invention.

The specific construction of the truss sections 1 of the ladder C is immaterial, so far as my broad idea is concerned. I prefer, however, to use truss sections of girder construction, each of which comprises two bottom chords 6 that carry rungs or foot treads 6<sup>a</sup>, two top chords 7 that constitute portions of hand rails, and struts or uprights 8 that connect together the top and bottom chords at each side of the ladder. At one end of each ladder section flared guides 9 are attached to the top chord members or hand rail members 7, so as to guide the adjacent ends of said hand rail members into proper abutting relationship, during the downward movement of the roof and also to prevent relative lateral movement of the adjacent ends of said hand rail members. The guides 9 also co-act with the hand rail members 7 to produce continuous hand rails, which help to counter side sway and to resist forces applied to the ladder in a direction circumferentially of the tank. If desired, the truss sections of the ladder can also be provided with inclined braces 10, as shown in Figure 4, to aid in this result. In a ladder of the design above described, each of the sections 1 is a stiff truss in itself, and when said sections are disposed in longitudinal alignment with each other with the ends of the top chord members 7 in abutting or interlocked relationship, they produce a stiff, rigid ladder extending downwardly from the top edge of the tank side wall to the roof, which an operator can use with perfect safety, due to the fact that it will not flex, swing, or sway. Another very desirable feature of the ladder and counter-balancing mechanism above described, is that they are inexpensive to construct, easy to install, and contain less metal, and are lighter in weight than floating roof ladders of conventional design.

Access to the stationary platform D is afforded by a stationary stairway D' leading from the ground, on the exterior of the tank, as shown



in Figure 2. The shiftable platform that projects into the tank in overhanging relationship with the floating roof, may be of any preferred construction, so long as it is of such design that it will shift automatically into an inactive position, and thus not interfere with the side wall seal or other parts carried by the floating roof, when the roof moves into its extreme elevated position. In the preferred form of my invention herein illustrated the outer end of the platform E rocks on a horizontally-disposed pivot or bearing 11, shown in Figure 2, and the floating roof B is provided at its peripheral portion with a wheel or equivalent part 12, disposed so that as said roof approaches its extreme elevated position, the wheel 12 will engage the platform E and tilt it upwardly, as shown in broken lines in Figure 3, out of the way of any of the parts on the roof which might be damaged by striking against the platform E.

A floating tank roof ladder of the construction above described is desirable, in that it never assumes an angle that makes it difficult for the user to traverse same; it is perfectly rigid and has no tendency to sway when a person is using the same to reach the roof or leave the roof; it has continuous hand rails which can be grasped easily by the user's hands; it reduces the time required to pass onto or off of the roof when the roof is located in an intermediate position or elevated position, due to the fact that at such times the rigid portion of the ladder located on the interior of the tank comprises fewer rungs or foot treads; it imposes no objectionable loads or strains on the roof that interfere with the proper functioning of the roof; it is easy to step onto or off of, notwithstanding the fact that it is equipped with hand rails due to the fact that it is disposed at one side of a platform on the side wall of the tank which projects into the tank in overhanging relationship with the floating roof; and it is light in weight, inexpensive to construct, and easy to install.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A liquid storage tank provided with a floating roof, a jointed or foldable ladder mounted on said roof in an inclined position and extending upwardly from the same, said ladder having provision for enabling it to fold outwardly and downwardly over the top edge of the tank side wall when the roof moves upwardly, and a hand rail combined with said ladder so as to constitute the top chord of a truss which imparts rigidity to the portion of the ladder, disposed between the roof and the top edge of the tank side wall, said hand rail being formed by a plurality of longitudinally-aligned members in abutting relationship, that are capable of completely separating or pulling apart when the ladder folds outwardly and downwardly over the tank side wall.

2. A liquid storage tank provided with a floating roof, a jointed or foldable ladder disposed in an inclined position on the roof, and a means at the top edge of the side wall of the tank over which a portion of said ladder folds outwardly and downwardly when the roof rises, said ladder being composed of two parallel side trusses, each of which comprises a bottom chord formed by a plurality of rung or tread carrying members whose ends are pivotally connected together, a top chord formed by an equal number of hand rail members whose ends are arranged in separable abutting relationship, and struts or up-

rights which rigidly connect together corresponding members of said top and bottom chords.

3. A liquid storage tank provided with a floating roof, a jointed or foldable ladder mounted in an inclined position on said roof, a device at the top edge of the tank side wall over which the upper portion of the ladder folds and hangs in a suspended condition on the exterior of the tank side wall when the roof moves upwardly, and a hand rail structure that imparts rigidity to the portion of the ladder disposed between the roof and the device at the top edge of the side wall over which the ladder folds, said hand rail structure comprising longitudinally-aligned top chord members connected by struts with the rung or tread carrying members of the ladder and disposed with their ends in separable abutting relationship.

4. A liquid storage tank provided with a floating roof, an inclined ladder rockably mounted on said roof and supported by the tank side wall, and a means at the top edge of said side wall over which the upper portion of the ladder folds and hangs suspended on the exterior of the tank when the roof moves upwardly, said ladder comprising a series of bottom chord members pivotally connected together, rigid struts or sheer members on said bottom chord members, and top chord members rigidly combined with said struts and arranged in separable abutting relationship.

5. A liquid storage tank provided with a floating roof, an inclined ladder rockably mounted on said roof and supported by the tank side wall, a means at the top edge of said side wall over which the upper portion of the ladder folds and hangs suspended on the exterior of the tank when the roof moves upwardly, said ladder comprising a series of bottom chord members pivotally connected together, rigid struts or shear members on said chord members, and a series of hand rail members having no direct connection with each other but adapted to move into abutting relationship with each other so as to co-operate with said bottom chord members, and struts to form a trussed ladder.

6. A liquid storage tank provided with a floating roof, a trussed ladder mounted in an inclined position on the roof with its weight sustained by the tank side wall, said ladder comprising bottom chords formed by two series of rung or tread carrying members pivotally connected together and top chords formed by two series of hand rail members arranged in separable abutting relationship, a shiftable platform on the tank side wall arranged adjacent said ladder in overhanging relationship with the roof, and means on the roof that moves said platform into an inactive position when the roof approaches its extreme elevated position.

7. A liquid storage tank provided with a floating roof, a jointed or foldable ladder mounted on said roof in an inclined position and extending upwardly from same, said ladder comprising pivotally connected rung or tread carrying members that are capable of rocking or moving relatively to each other so as to permit the ladder to fold outwardly and downwardly over the top edge of the tank side wall when the roof moves upwardly, and means for imparting rigidity to the portion of the ladder disposed between the roof and the top edge of the tank side wall, consisting of longitudinally-aligned, abutting hand rail members rigidly combined with the rung or tread carrying members and adapted to move out of abutting relationship with each other as said



rung carrying members fold over the top edge of the tank side wall.

8. A liquid storage tank provided with a floating roof, a ladder mounted in an inclined position on the roof and composed of two side trusses, each of which comprises a bottom chord made up of a plurality of rung or tread carrying members pivotally connected together and a top chord made up of a plurality of longitudinally-aligned, abutting hand rail members that have no direct connection with each other, said ladder being adapted to fold outwardly and downwardly over the top edge of the tank side wall when the roof moves upwardly, and means for minimizing the vertical load and radial thrusts of said ladder on the roof during the upward movement of the roof.

9. A liquid storage tank provided with a float-

ing roof, a ladder mounted in an inclined position on the roof and composed of two side trusses, each of which comprises a bottom chord made up of a plurality of rung or tread carrying members pivotally connected together and a top chord made up of a plurality of longitudinally-aligned, abutting hand rail members that have no direct connection with each other, said ladder being adapted to fold outwardly and downwardly over the top edge of the tank side wall when the roof moves upwardly, a counter weight for preventing the ladder from imposing an excessive load on the roof, and means that becomes operative during the upward movement of the roof to remove or destroy the effect produced on the ladder by said counterweight.

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