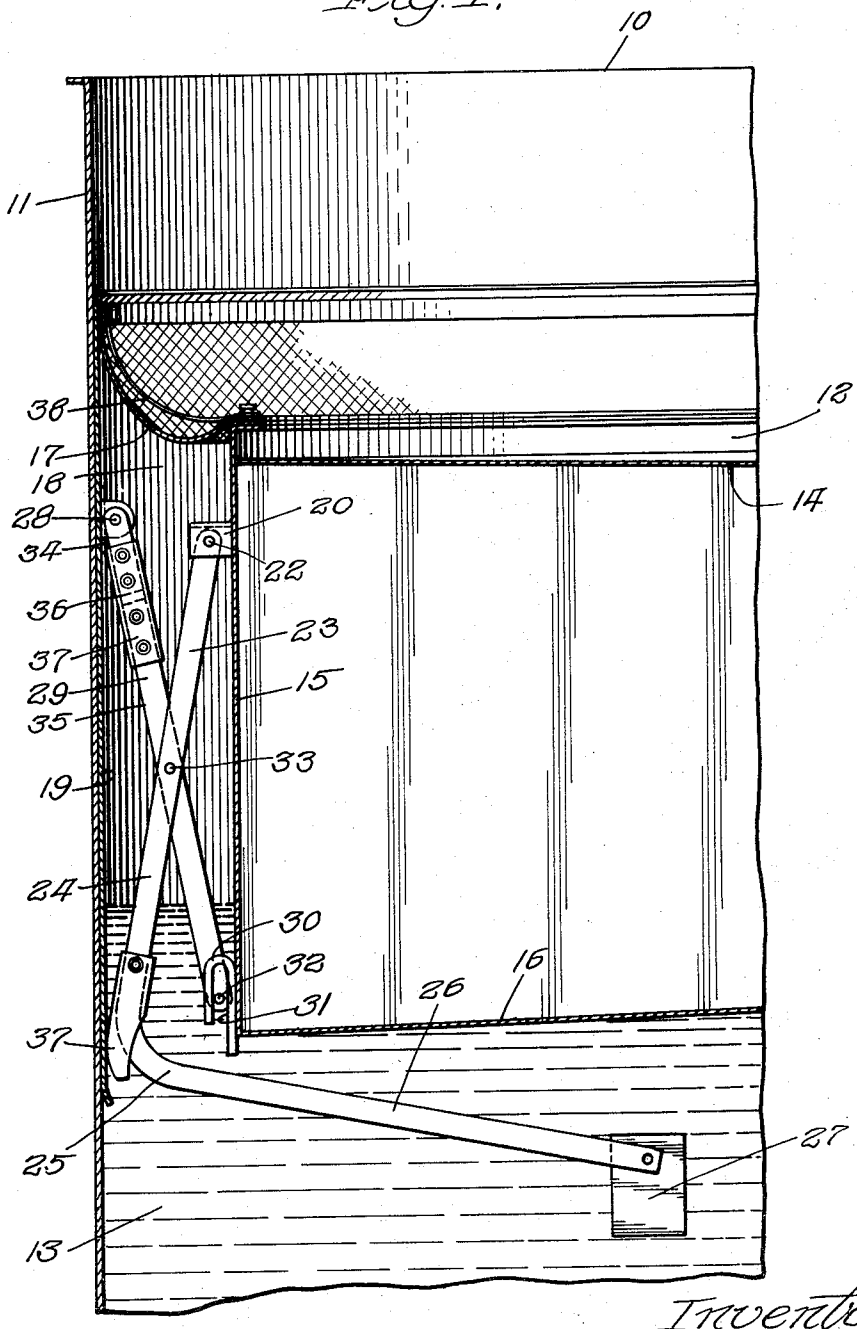
May 17, 1960 F. D. MOYER ET AL 2,936,925

ELECTRICALLY INSULATED FLOATING ROOF

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Fig. 1.



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Fig. 2.

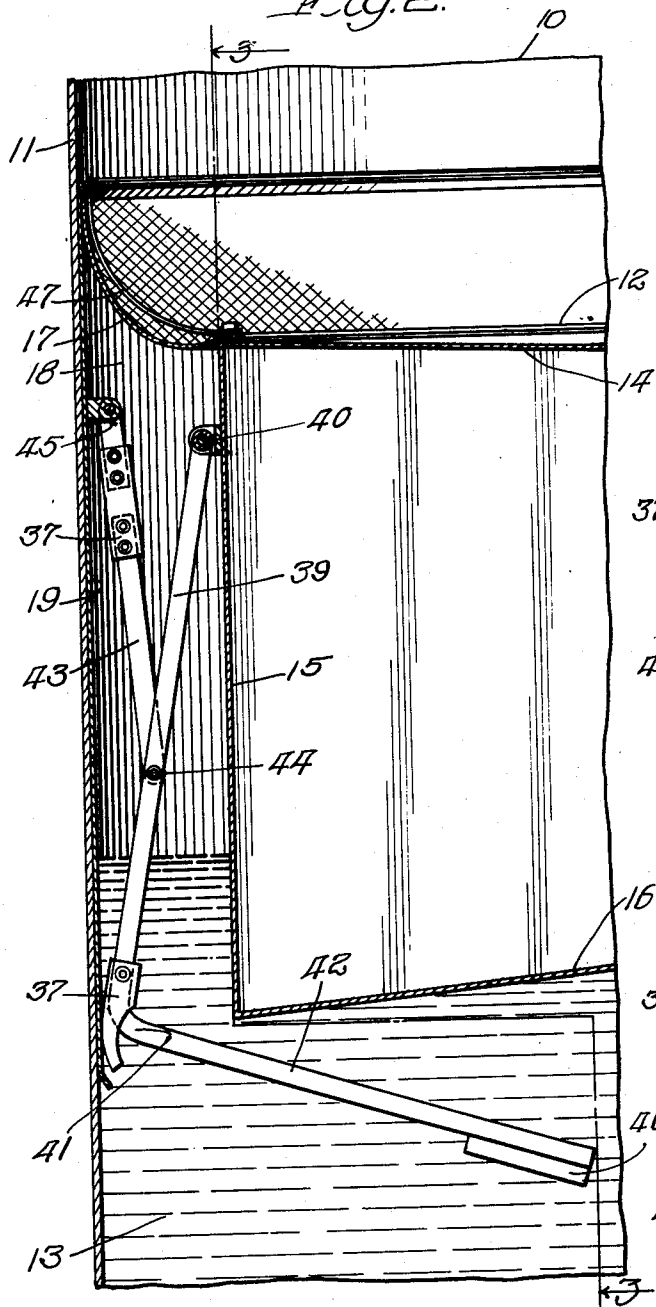
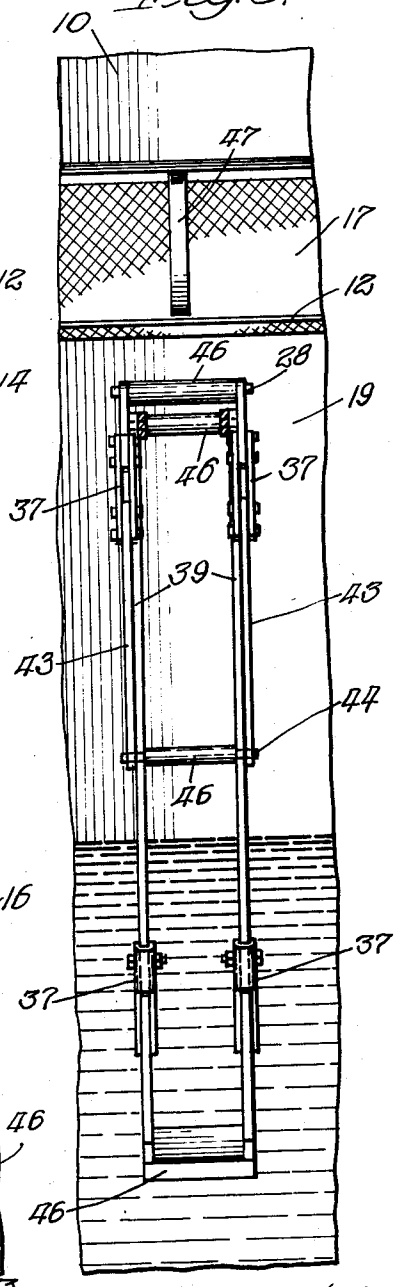


Fig. 3.



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Fig. 4.

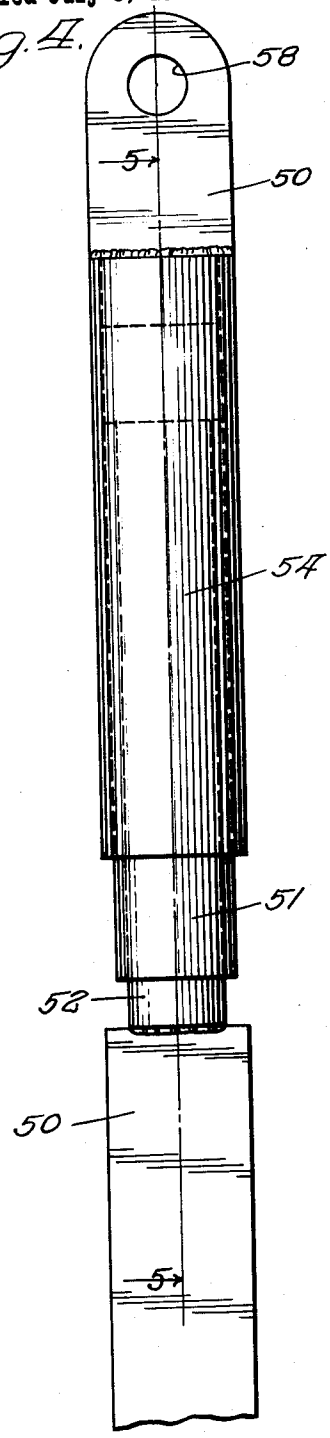
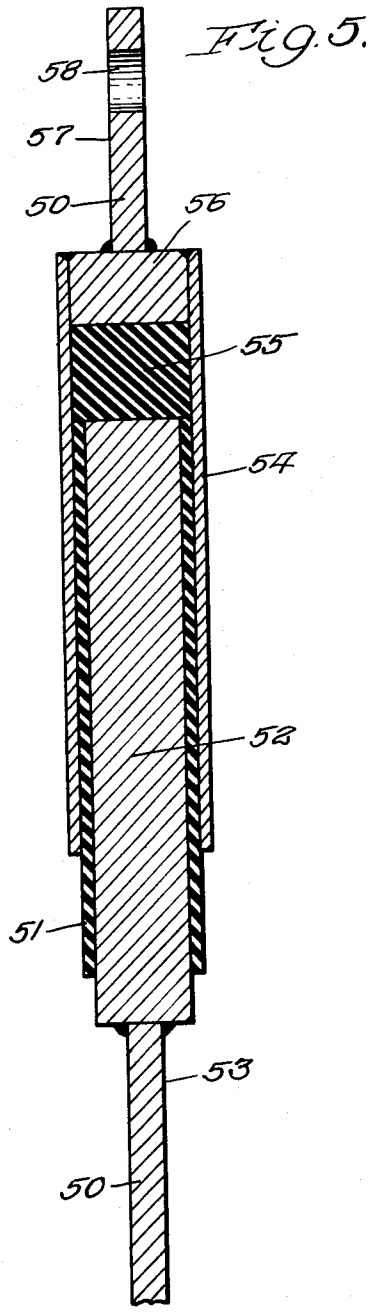


Fig. 5.



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2,936,925

ELECTRICALLY INSULATED FLOATING ROOF

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Application July 5, 1957, Serial No. 670,289

8 Claims. (Cl. 220—26)

This invention relates to liquid storage tanks having floating roofs. More particularly, this invention is concerned with means to prevent fires in floating roofs caused by high electrical charges such as are induced by lightning.

As is well known in the art, as shown by United States Patent Nos. 2,554,497 and 2,587,508, floating roofs are constructed with a diameter less than the inside diameter of the tank. Accordingly, a seal must be provided between the edge of the floating roof and the inner side walls of the tank to seal that space against liquid loss through evaporation. Such a seal must, of course, not interfere with the up-and-down movement of the roof as the liquid contents of the tank are increased or decreased. The most successful devices for effecting the seal use a sealing ring or shoes which run around the inside of the tank between the tank shell and the edge of the roof pressing against the tank shell. The ring is usually of relatively thin metal plate and of a height suitable for use with the tank and roof. A flexible vapor-tight material is positioned to extend from the roof to the shoes to cover the open area and provide a vapor barrier. Hanger and pusher means are provided to support the shoes and keep them pressed firmly against the inside tank surface. The pusher and hanger means are generally located below the vapor barrier and come in contact with the roof and also the tank through the shoes.

At the time of an electrical storm, an electrical charge is induced on the floating roof in the tank by the electric field of a thunder cloud. When the field is suddenly removed by the discharge of the cloud by a lightning stroke, the charge on the roof is released rapidly and passes to the earth by way of the grounded tank shell. This electrical charge must accordingly pass over or go through the rim space between the roof edge and tank wall. In the case of hangers and pushers located in the vapor space below the vapor barrier, the charge can ignite the vapor with sparks generated at points of imperfect or inadequate electrical contact such as where the hangers and pushers contact the roof or shoes or at the pin connections between the hanger and pusher members. This sparking can occur if the lighning stroke terminates on the floating roof, on the tank shell or elsewhere nearby.

According to the present invention it has been found that the danger of floating roof fires ignited by lightning can be largely eliminated by barring electrical discharge through the hanger and pusher mechanism by properly insulating the mechanism and providing electrical shunts between the roof and shoes.

The invention will now be described in conjunction with the attached drawings in which:

Fig. 1 is a vertical section through a liquid storage tank showing portions of the side walls and a floating roof with shoes and insulated hanger and pusher mechanism in place floating on liquid stored in the tank;

Fig. 2 is similar to Fig. 1 but shows a different type insulated hanger and pusher mechanism;

Fig. 3 is a vertical section along the line 3—3 of Fig. 2.

Fig. 4 shows another embodiment used to insulate a hanger and pusher mechanism; and

Fig. 5 is a section of Fig. 4 along the line 5—5.

As to all the figures, **10** indicates a liquid storage tank having a side wall **11** and a floating roof **12** floating upon the surface of the liquid **13** contained in the tank. The floating roof has a top **14**, a side **15** and a bottom **16**. An annular seal **17** of flexible material seals the vapor space **18** between the side **15** of the tank and a shoe **19** which slidably contacts the side wall of the tank.

In Fig. 1, lug **20** is welded to the upper portion of the side **15** and has a hole provided therein in which a pin or shaft **22** is journaled, the shaft being attached to the upper end of a lever **23** to provide a pivotal connection of the lever to the upper portion of the roof. The lever **23** has a downwardly extending portion **24**, an angle **25** and an inwardly extending portion **26**. A weight **27** is provided on the inwardly extending portion to exert a downward force upon the lever. Pivotally connected at **28** to the upper portion of the shoe is a shoe supporting member **29**. The other end of the shoe supporting member is connected to the lower portion of the side **15** by means of a pin and slot arrangement. A bracket **30** is attached to the lower portion of the roof having a vertical slot **31**, the sides of the slot being engaged by a pin **32** attached to the lower end of the member **29**. The shoe supporting member is pivotally connected to the lever **23** at **33**.

The roof and tank shell are insulated from each other in the vapor space **18** by eliminating direct metal contact between them through the hanger and pusher members. Thus, supporting member **29** is formed in two parts **34** and **35** separated from each other by gap **36**; the parts however are connected by insulating material **37** fastened securely to each part. The downwardly extending portion **24** is also provided with insulating material **37** to prevent metal contact with the shoe. One or more shunts **38** are secured at one end to the edge of the roof and at the other end to the shoes.

A lightning stroke may terminate on the floating roof, on the tank shell or at some location near the tank, and as a result the bound charge on the floating roof is released. This suddenly creates a voltage difference between the floating roof and the tank shell. The voltage drop between the floating roof and the tank shell depends upon the number of shunts provided. A larger number of shunts will result in a smaller voltage drop. The changes of voltage occur over extremely short intervals of time resulting in rapidly increasing surges of current which the shunts must accommodate. Hence it is important that the shunts be designed to have low inductance. Low inductance is accomplished by shunts across the shortest and most direct path and by shunts having large surface area. The preferred form of shunts is therefore a flat strip of metal attached between the edge of the roof and the shoes; abrupt changes in direction or alignment of the shunts is to be avoided. The shunts may be attached by bolting at each end without materially increasing the inductance. High resistance at the bolted connections or between the shoes and the tank shell is relatively unimportant because sparks can occur at these locations without danger of ignition.

With an adequate number of low inductance shunts, the maximum voltage drop between the floating roof and the shoes or tank shell is reduced. It is then practical to insulate the hanger and pusher mechanism to accommodate that maximum voltage without spark-over. Hence none of the current will be carried through the hanger

and pusher mechanism and no spark can occur in the mechanism or its attachments. This eliminates the possibility of ignition in the rim space between the roof edge and the tank wall.

In Figs. 2 and 3, there is a main hanger in the form of a lever **39** having its upper end pivoted at **40** to the side **15** of the floating roof, and extending downwardly from the point of attachment to the roof to curved area **41** and a further portion **42** extending inwardly from the curved area. Shoe supporting member **43** is pivoted to the lever **39** at **44** and to the upper portion of the shoe at **45**. It is preferred to construct the members **39** and **43** of parallel bars of steel to give increased strength and stability as shown in Fig. 3. Cross-braces **46** help to keep the unit rigid. Insulating material **37** is used in supporting member **43** as well as on lever **39** at the angle **41** where it pushes the shoe against the shell to prevent electrical conductance through the roof and tank shell. Shunt **47** communicates with the metal of the roof and shoe to ground electrical charges on the roof; such shunts are disposed around the roof in spaced relationship to each other.

Figs. 4 and 5 illustrate the upper part of a shoe supporting member **50** which may be used instead of member **29** in Fig. 1 or member **43** in Figs. 2 and 3. The shoes are insulated from the roof with member **50** by insulating barrier **51** which is a sleeve that fits over rod **52** connected as by welding to the upper end of the lower part **53** of the shoe supporting member **50**. Tube or pipe **54** fits over the insulating sleeve **51**. The lower end of the insulating sleeve extends outside of the lower end of the pipe **54** to deter electrical charges from jumping from rod **52** to the pipe. Inside pipe **54** is inserted plug **55** of insulating material. The plug bears against the end of rod **52** and contacts the end of insulating sleeve **51** to seal the rod **52** from pipe **54**. Metal disc **56** is inserted in the pipe **54** so that it bears against plug **55**. Disc **56** and pipe **54** are secured together by welding or screw means to prevent independent movement of each with respect to the other. The upper part **57** of the shoe supporting member **50** is connected as by welding to the disc **56**, and hole **58** is provided for pivotally joining it to a shoe, such as at **28** in Fig. 1.

Although any suitable insulating material may be used, it is generally advisable to select a material for use in a specific insulated shoe supporting structure so that the structure will remain stable and not lose its supporting ability in case of a fire.

Repair of a fire damaged floating roof is more readily achieved with the shoe in place than where the supporting members collapse and the shoe sinks to the bottom of the tank.

Furthermore, experience has shown that as long as the shoes maintain their normal position against the tank shell, the destruction of the seal material **17** will generally be localized, and the fire will also be local and relatively easily controlled. If the shoes were permitted to sink or pull away from the shell, the entire rim space would be opened and the fire would spread around the entire periphery of the floating roof.

Accordingly, with the structures shown in Figs. 1–3, it is advisable that at least insulating material **37** be fire resistant and not melt so that if a fire results from any cause the shoe will continue to be supported in its proper position and not sink to the bottom of, or pull away from, the tank.

In the structure shown in Figs. 4 and 5, electrical insulating material may be used that is either fire resistant or not fire resistant. Destruction of the insulating material in this form of insulated shoe hanger would not destroy its shoe supporting capacity because rod **52** would bear against pipe **54** and disc **56** since it is a compression joint as used in the floating roof tank. Of course, the insulating material, if destroyed, would have to be replaced after a fire to again provide the desired electrical insulation.

While there are shown and described certain embodiments of the invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims.

What is claimed is:

1. A liquid storage tank having a floating roof, a plurality of rigid metal shoes adapted to slidably contact the inner side walls of the tank, metal members for supporting and pressing each shoe against the side walls, said members being connected to and in contact with the roof and shoes, a flexible seal above the shoe supporting members and covering the space between the roof and tank side walls, said members having electrical insulators to prevent flow of electrical current from the roof to the tank side walls through the members, and a plurality of low inductance electrical shunts positioned above the flexible seal connected to the roof and shoe as an electrical bond to permit flow of lightning induced electric current to the tank side walls and thus to the ground.

2. The tank of claim 1 in which the insulators are fire resistant.

3. The tank of claim 1 in which the insulators are not fire resistant but the members are compositely constructed with insulators separating the metal components of the members, and the members can support the shoes without the insulators.

4. In a liquid storage tank having a oating roof, one or more rigid metal shoes adapted to slidably contact the inner side walls of the tank, means for supporting the shoes against the side walls including a lever swingably attached to the roof, said lever having a curved portion, a portion extending downwardly in the space between the roof and the tank from the point of attachment of the roof to the curved portion and a portion extending inwardly from said curved portion, and a rigid metallic shoe supporting member having one end pivotally connected to the shoe and having the other end connected to the roof, said shoe supporting member being pivotally connected intermediate its ends to the downwardly extending portion of the lever, and a flexible seal above the shoe supporting means covering the space between the roof and shoes, the improvement which comprises electrical insulation interposed on the lever and shoe supporting member between the roof and shoes to prevent metal to metal contact, and thereby the flow of electrical current, between the roof and shoes through the lever and shoe supporting member, and a plurality of low inductance electrical shunts connecting the roof and shoes above the flexible seal thereby providing an electrical bond between the roof and shoes.

5. In a liquid storage tank having a floating roof, rigid metal shoes adapted to slidably contact the inner side wall of the tank, metal levers attached to the roof which extend downwardly between the roof and side walls and curve inwardly beneath the roof, curved portions of the levers pressing the shoes against the side wall and a flexible seal above the space and levers between the roof and shoes, the improvement which comprises electrical insulation on the levers positioned to sever the metal-to-metal contact between the shoes and roof to prevent the flow of electrical current from the roof through the levers to the shoes and side wall, and a plurality of electrical shunts of low inductance above the flexible seal connecting the roof and shoes to provide an electrical bond between the floating roof and the tank wall.

6. In a liquid storage tank having a floating roof, shoes adapted to slidably contact the inner side walls of the tank, and members for supporting and pressing the shoes against the side walls, said members being connected to and in contact with the roof and shoes, and a flexible seal above the members and covering the space between

the roof and tank side walls, the improvement which comprises a plurality of electrical shunts of low inductance above the flexible seal connected to the roof and shoes to provide an electrical bond therebetween to carry an electrical current produced by lightning, and electrical insulators in the support members to prevent the flow of lightning-produced current from the roof through the members and then to the shoes and tank side walls.

7. In a liquid storage tank having a floating roof, rigid metal shoes adapted to slidably contact the inner side walls of the tank, metal members for supporting and pressing the shoes against the side walls, said members being connected to and in contact with the roof and shoes, and a flexible seal above the members and covering the space between the roof and tank side walls, the improvement which comprises a plurality of electrical shunts of low inductance comprising flat flexible metal strips of large surface area electrically bonded at opposing ends to the roof and shoes, said shunts being disposed around the roof in spaced relationship to each other thereby facilitating flow of lightning-induced electric current from the roof to the shoes and thus to the tank side walls and then to the ground.

8. In a liquid storage tank having a floating roof, rigid

metal shoes adapted to slidably contact the inner side walls of the tank, metal members for supporting and pressing the shoes against the side walls, said members being connected to and in contact with the roof and shoes, and a flexible seal above the members covering the space between the roof and tank side walls, the improvement which comprises insulation interposed in the members to prevent flow of electrical current from the roof to the tank side walls through the members, and a plurality of electrical shunts of low inductance comprising flat flexible metal strips of large surface area electrically bonded above the flexible seal at opposing ends to the roof and shoes, said shunts being disposed around the roof in spaced relationship to each other, thereby facilitating flow of lightning-induced electric current from the roof to the shoes and thus to the tank side walls and then to the ground.

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UNITED STATES PATENT OFFICE

CERTIFICATION OF CORRECTION

Patent No. 2,936,925 May 17, 1960

Frederick D. Moyer et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 31, for "oating" read -- floating --; column 6, list of references cited, after line 25, insert:

OTHER REFERENCES

"The Water Tower" Vol. 43, No. 1, published Sept., 1956 by the Chicago Bridge and Iron Co., Chicago, Ill., the article on page 7 dealing with insulated hanger for floating roofs.

Signed and sealed this 2nd day of May 1961.

(SEAL)
Attest:

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