Aug. 19, 1958 J. F. MUMMERT ET AL 2,847,755

METHOD OF ERECTING FLOATING ROOFS AND APPARATUS THEREFOR

Filed March 8, 1954

3 Sheets-Sheet 1

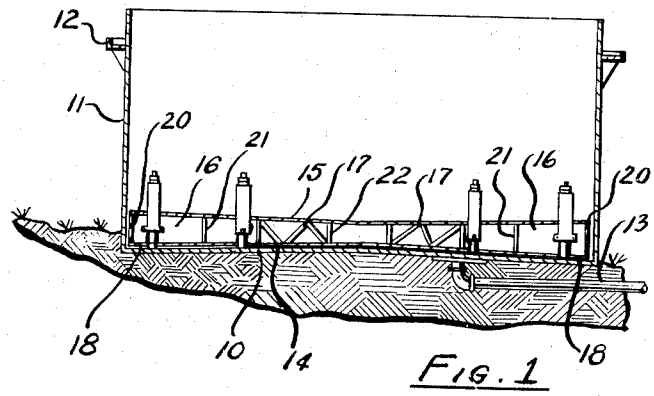


FIG. 1

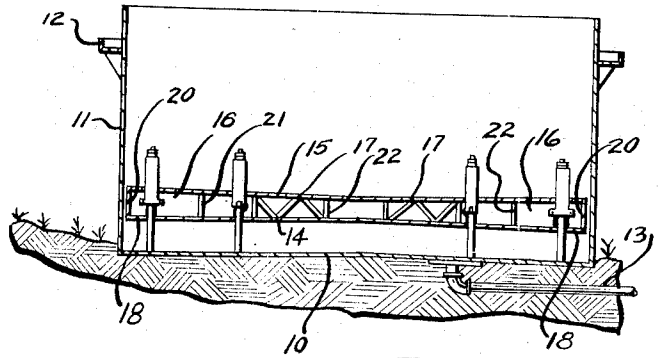


FIG. 2

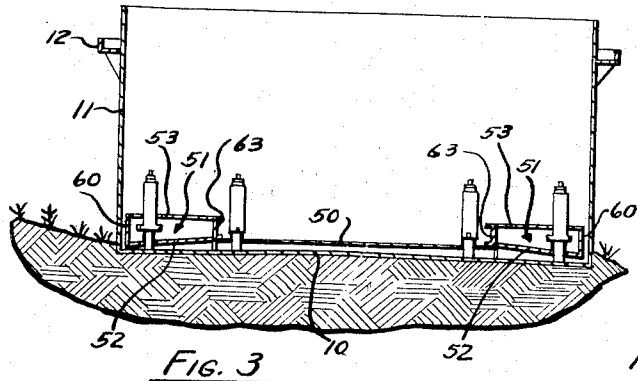


FIG. 3

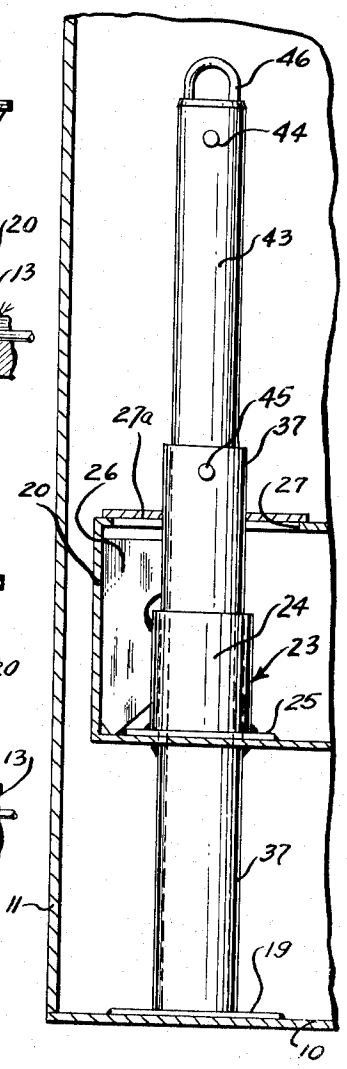


FIG. 4

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3 Sheets-Sheet 2

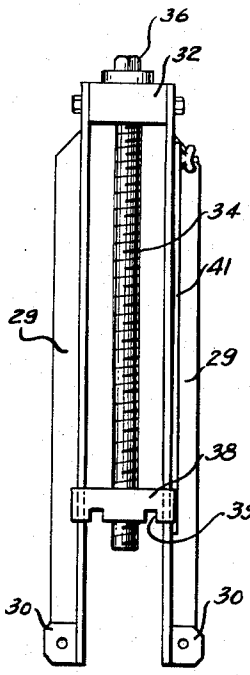


FIG. 7

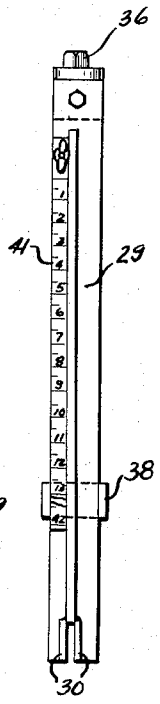


FIG. 8

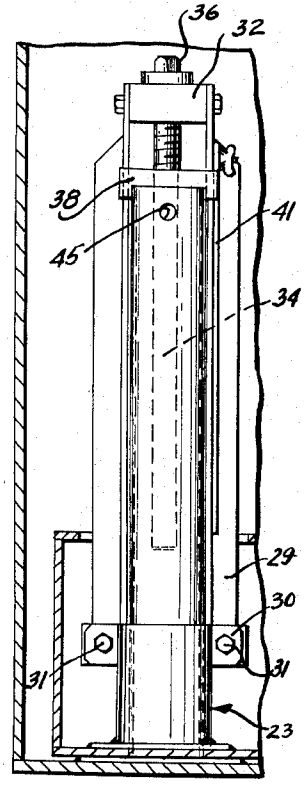


FIG. 5

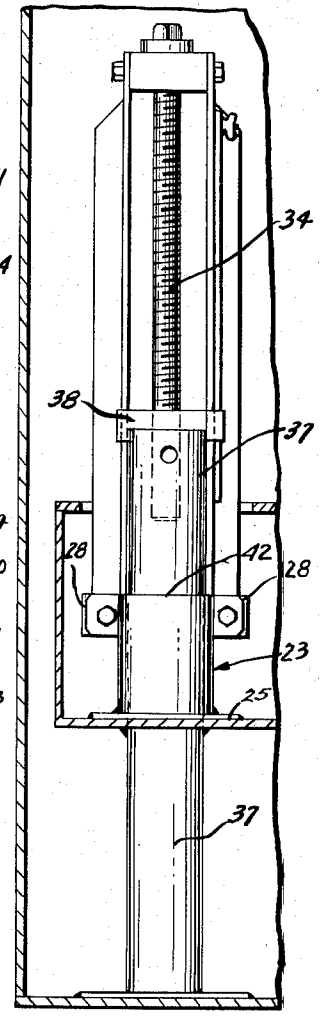


FIG. 6

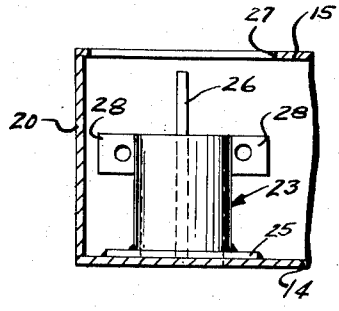


FIG. 9

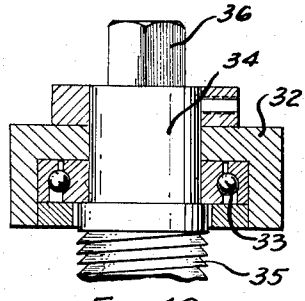


FIG. 10

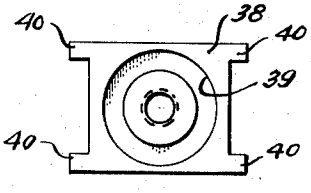


FIG. 11

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3 Sheets-Sheet 3

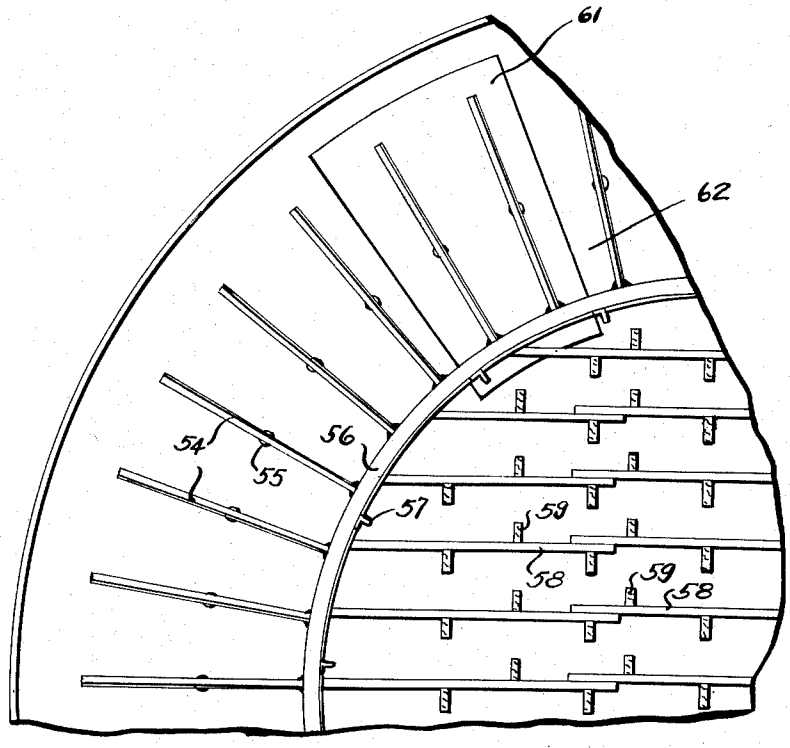


FIG. 12

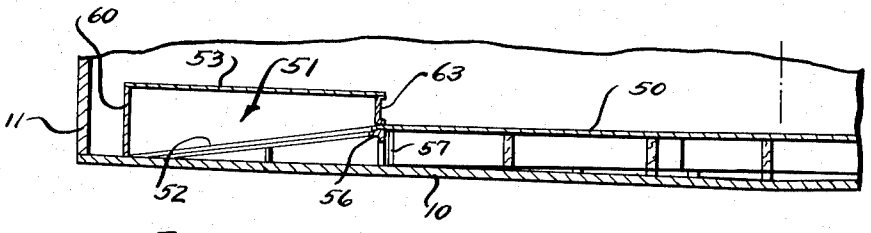


FIG. 13

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METHOD OF ERECTING FLOATING ROOFS AND APPARATUS THEREFOR

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Application March 8, 1954, Serial No. 414,778

9 Claims. (Cl. 29—429)

This invention relates to liquid storage tanks having floating roofs and more particularly to the method and apparatus used in connection with the construction of the floating roof in a field-erected liquid storage tank.

Crude oil, gasoline and other similar products as well as chemicals are often stored in quite large storage tanks which are erected out in the field. One fairly standard size of tank has a capacity of 80,000 barrels. With volatile products, there is the problem of loss due to evaporation and the problem of fire. For some years past, large storage tanks have been equipped with a floating cover generally referred to as a floating roof. Floating roofs as used in liquid storage tanks generally take on one of three basic forms. The simplest form is referred to as a pan-type roof and is similar to a pie pan in that it has a generally single thickness of plate deck joined at its periphery to an upstanding rim which provides the freeboard for the roof as it floats in the liquid. Another type of roof is one having part of its covering surface of single plate deck joined, however, to pontoons which provide the buoyancy. A third type of roof is one referred to as a double-deck roof in that it has a bottom plate deck and an upper plate deck which is spaced above the bottom deck. These decks are joined in appropriate manner so that they act in unison.

Floating roof tanks ordinarily have no weather cover or roof so that rain and snow can fall directly on the floating roof even when the roof is down near the bottom of the tank. This water must be drained either through the product or through appropriate pipes or hoses to the outside. These appurtenances are placed under the floating roof between the roof and the bottom of the tank. Other appurtenances are likewise situated in the bottom of the tank so that the roof itself cannot ordinarily be allowed to rest directly on the bottom when the tank is empty. The usual procedure is to provide the roof with a number of supporting posts which land the roof on the bottom of the tank but at an elevation above the bottom. This leaves room for all of the appurtenances that are usually placed in the tank bottom and insures that no damage will be done to them when the tank is emptied.

Construction procedure in the past has generally been to build the floating roof within the tank at its proper low service position. This position is perhaps three feet or a little more above the bottom of the tank and may vary considerably. The roofs are built of plate metal generally shaped in the shop and shipped to the site in flat condition. These plates have to be supported during the construction so that the welders may join them together to form the complete floating roof structure. The practice has been to use a considerable amount of temporary support within the tank itself to support the roof plates at low service elevation and to remove this material through a manhole in the side of the tank after the roof has been completed and placed on its own roof supports. The procedure is expensive in both material and labor and adds considerably to the construction time necessary,

which is a factor in the cost of the tank and floating roof structure itself.

The present invention presents a method of construction in which no temporary framing is required in certain instances and a very small amount of rather lightweight and easily handled framing is necessary in other instances. Ordinarily, the roof is constructed on the bottom of the tank itself and only sufficient framing is used to achieve the proper slope of the roof plates. Should the bottom of the tank have a slope corresponding to the slope desired in the bottom deck of the floating roof, the roof may be constructed directly on the tank bottom. In the past, there have been suggestions that such construction procedure would be desirable. There has been, however, the difficulty of getting the roof to its proper position after it is constructed on the tank bottom. It has been suggested that the roof should be floated but the shape of the roof when floating may be considerably different from its shape when supported on its post supports. A floating roof must have the proper drainage characteristics in order to withstand the climatic conditions under which it may be used. It is thus exceedingly important that the roof decks have a proper pitch and that the structure be made in such a way as to maintain that pitch when the tank is empty and when the roof is floating on the stored product.

The present invention also provides a method and apparatus for elevating the roof to its proper low service position and permitting securing the roof in that position. Once the tank is placed in service and the roof floated on the product, the tank may be emptied and the roof will return to land on its post supports in the low service position.

The invention will be illustrated and described in connection with the accompanying drawings in which:

Figure 1 is a small scale vertical section taken through a liquid storage tank and a floating roof therein ready to be elevated to its low service position;

Figure 2 is similar to Figure 1 and shows the roof raised to its proper low service position;

Figure 3 is similar to Figure 1 and illustrates a roof of the pontoon type;

Figure 4 is an enlarged fragmentary vertical sectional view taken through the tank and a portion of the roof showing one of the post supports for the roof;

Figure 5 is a fragmentary vertical sectional view through the tank and part of the roof showing the raising device in position in a floating roof which has been constructed directly on the bottom of the tank;

Figure 6 is a view similar to Figure 5 showing the roof after it has been elevated and fixed in low service position;

Figure 7 is a front elevation view of the hoisting mechanism;

Fig. 8 is a side elevational view of the mechanism illustrated in Figure 7;

Figure 9 is a fragmentary vertical sectional view through a section of a floating roof showing the sleeve member associated with the hoisting mechanism;

Figure 10 is an enlarged fragmentary sectional view through the upper end of the hoisting mechanism showing the top bearing support;

Figure 11 is a bottom plan view of the bearing member used with the hoisting mechanism;

Figure 12 is a fragmentary plan view toward the bottom of a tank showing temporary framing used in constructing a pontoon type floating roof; and

Figure 13 is a fragmentary vertical sectional view through a tank showing the temporary framing illustrated in Figure 12 with the pontoon type roof partially completed thereon.

The floating roof storage tanks are made in a variety

of sizes and the capacities, of course, depend upon the diameter and height of the tank. By way of example, a tank 120 ft. in diameter by 48 ft. high would have a capacity of about 96,000 barrels.

The tanks are constructed with a bottom **10** of plates joined to side wall plates **11** reinforced at the top by a wind girder **12** and provided with inlet and outlet pipe connections **13**. The tank is built on a prepared foundation which may include a concrete ring wall under the shell **11** of the tank and is ordinarily constructed on a sand base. The bottom plates **10** may often be given a slope from the shell of the tank upwardly toward a center in order that water might drain through the product to the outside rim of the tank. Tanks generally are of welded construction with the bottom plates being lap welded and the shells of the tanks being butt welded both on the horizontal and vertical joints. The inner surface of the tank sidewalls are generally smooth and any offset due to a difference in size of the courses of the plates being taken up on the outside of the tank rather than on the inside. This permits a fairly smooth surface for a sealing ring to slide upon with movement of the floating roof up and down within the tank.

In Figures 1 and 2, a floating roof is illustrated after completion in the tank bottom and in Fig. 2 it is elevated to the low position it will occupy during service. The roof is of the double-deck type. That is, it has a lower deck of plates **14** and an upper deck **15** enclosing an intervening space. The roof is built in annular sections for the most part, the outermost section **16** being untrussed whereas intermediate section **17** may be provided with trusses extending radially in the roof. It is generally known that the tanks and roofs are round, or substantially so, so that no illustration of the tank or roof in this regard has been made.

The procedure followed in erecting a floating roof structure of the double-deck type in accordance with the present invention permits the construction of the roof directly on the bottom. It will be noted in Figure 1 that the bottom of the tank has substantially the same slope as the bottom deck **14** of the floating roof. The first step in the construction is the placement of bottom deck sketch plates **18** which are those plates at the peripheral edge of the bottom deck next to the shell of the tank. Care is exercised to secure the proper placing of the sketch plates to insure that the plates form a true circle. If the shell of the tank is no more than ⅛ inch out of round, templates may be used placed against the shell to locate the sketch plates **18**. When these sketch plates have been welded together, a sealing ring is installed on the tank shell to be later attached to the roof for movement with it as it floats upon the stored product. This sealing ring forms no part of the present invention and therefore has not been illustrated.

Prior to, or simultaneously with, the placing of the sketch plates, a small pad plate is placed on and welded to the bottom of the tank whenever a roof support will bear on the bottom. In Figure 4, a pad **19** is illustrated as welded to the bottom **10** of the tank, and is generally a square or round plate larger than the post which will bear against it.

The outer rim **20** of the floating roof is next attached to the sketch plates, care being exercised to insure that the rim is plumb. The construction of the other parts of the roof then proceeds until the roof is finished as far as its bottom deck and bulkheads **21** and **22** are concerned. Before the upper deck **15** is placed in position, sleeve members **23**, having a barrel **24** and a pedestal **25**, are welded in position over openings in the lower deck. Care is taken to make sure that the barrel of the sleeve member is substantially vertically aligned and a shear plate **26** is inserted between the outer rim or bulkhead and the sleeve. The shear plate is welded to both to insure that the sleeve remains vertical. The position of these sleeves is chosen to be in the exact spot for a permanent roof support. Ordinarily, the sleeves are positioned in a ring about the tank with the inner ring of supports concentric within the outer rings.

The roof is then completed by the installation of the upper deck **15**. Holes **27** are burned in the upper deck over the sleeve member **23** so that the sleeve member will be accessible in raising the roof to its permanent low position. Each sleeve member is provided with a pair of apertured lugs **28** on diametrically opposite sides by which a jacking mechanism may be attached to raised the roof.

Following the completion of the roof to the extent set out above, a jack member is applied to each sleeve **23** in the roof for the purpose of raising the roof as a unit. The jack members utilize a pair of tension straps **29** having a bifurcated lug **30** at the lower end for fitting it over the apertured lug **28** on the sleeve member. A bolt **31** may be inserted to secure them together. A lug member **32** joins the upper ends of the tension straps and is more particularly set out in Figure 10. In this is a thrust bearing **33** against which a screw member **34** may thrust upward. This screw member has a thread **35** particularly adapted to bear considerable load. The top **36** of the screw is shaped so as to receive a turning crank.

To raise the roof, a supporting post **37** is inserted through the sleeve member. This post is hollow and may be a tube or pipe. A bearing lug **38** threadedly engaging screw **34** is provided with an annular groove **39** to fit over the top of the post **37**. Ears **40** fit about the tension straps **29** to guide the lug in its vertical travel. It may thus be seen that the turning of the screw **34** may travel the bearing lug **38** downwardly moving the post **37** through the sleeve and drawing the roof upwardly. In order that all parts of the roof be acting in unison, a scale **41** is provided on one of the tension straps so that the workmen may gauge the movement of the roof upwardly. The scales shown indicate movements from 1 inch to 42 inches. The procedure followed is to place a slight bit of tension on each jack and then sufficient men to man the jacks in unison to raise the roof under the direction of one person so that all parts of the rooof are raised in equal increments. A roof, even though weighing several hundred thousand pounds, may thus easily be raised into proper position.

When the roof has reached its upper position, a weld **42** is applied between the posts **37** and sleeve **23** to secure them together. The jack is removed and the shear plate **26** is also welded to the post **37**. Thereafter, the roof upon approaching the bottom will land on the posts and be held in its low position as illustrated in Figures 2 and 6. In some instances, it may be desirable to raise the roof to an even higher position. In such cases, an additional pipe **43** may be telescoped inside the post **37** and the lifting procedure repeated to raise the roof until an opening **44** reaches an opening **45** in the post **37** to receive a pin. A lifting ring **46** is applied to the top of the post after removal of the jack mechanism.

In the construction of some roofs, the bottom of the tank may not have the proper shape for the bottom of the roof. Figures 3, 12, and 13 illustrate one type of roof which has a bottom slope different from that of the bottom of the tank. In this instance, a pontoon type roof has a central single plate thickness deck **50** and an outer annular pontoon **51**. The bottom plates **52** of the pontoon slope upwardly while the upper plates **53** have a slight downward pitch toward the center of the roof in order to drain water toward the center. The construction procedure with such a roof varies from the procedure outlined above only in the initial steps. Sufficient temporary framing is used to support the bottom of the roof in its proper shape. The outer peripheral slope of the pontoon bottom deck **52** may be provided by radially aligned rods **54** temporarily supported by short posts **55**

and at their inner end by an angle iron **56** supported above the deck by small hangers **57**. The central single deck portion **50** may be supported on 2 by 6 boards **58** supported in place by blocks of wood **59**. Only a sufficient number of these boards need be placed in the tank to support the plates themselves which may be of the order of 18 ft. long and 5 or 6 ft. wide. The procedure for placing the bottom deck and the rim **60** of the roof is substantially the same as described above. The sketch plates **61** are first placed in position and then joined to other plates **62** which form the bottom of the pontoon and continue on to form the single deck **50**. The inner rim **63** of the pontoon is placed in proper position after the initial sleeves **23** are fixed in the pontoon.

It is ordinarily only necessary to lift a pontoon-type roof to its proper position by roof supports in the outer and next inner ring of supports. A double-deck roof is generally lifted over its entire area. On the larger sizes of single deck pan-type roofs or pontoon-type roofs, some lifting will also be carried on in the single deck area to prevent too much sagging in the plates.

It will be noted in Figure 4 that the roof support takes on substantially the same appearance after the jack is removed as such roof supports have in ordinary types of construction. The opening **27** which was cut in the top deck may be closed by cover plate **27***a* and the sleeve **23** initially placed in the roof is left in the roof although its function has generally ceased to exist after the jacking operation. The roof sleeves are welded securely in position so that any movement thereafter cannot occur. The roof is not only economically constructed but is raised to its proper position in a very easy and quick manner maintaining the proper slope of the roof when landed and not floating. Ordinarily sufficient manholes are provided in the roof to permit workmen to enter the space between the roof and tank bottom to place such appurtenances as are necessary in the tank and under the roof. At the same time, the men can check the elevation of all of the roof supports and in the event that the bottom of the tank has settled, compensation can be made at that time so that the correct slope of the roof is obtained when in its elevated position.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, for some modifications will be obvious to those skilled in the art.

We claim:

1. The method of constructing a floating roof in a field erected liquid storage tank which comprises, temporarily supporting all roof parts in the tank from the tank bottom and on blocking in areas where roof and tank bottom configuration differ, securing the roof parts together to substantially complete the roof in the tank in its temporarily supported position, placing upright roof supporting posts in the roof so as to bear downwardly on the tank bottom, then jacking the substantially completed roof from a plurality of points as a unit over said posts to proper low service position in the tank and securing the roof to the posts to thereafter limit downward travel of the roof in the tank to the low service position supported on said posts.

2. The method as specified in claim 1 wherein the peripheral portion of the floating roof is placed in direct contact with the tank bottom plates and the central portion of the roof is placed on shallow temporary framing to give the bottom of the roof a configuration different from that of the tank bottom.

3. The method of constructing a floating roof for a field erected storage tank, which comprises placing roof parts on the tank bottom in proper position to be welded into a substantially complete floating roof, securing the parts together, inserting roof support posts through the roof to bear on the tank bottom and then lifting the roof to proper position above the tank bottom by jacking the roof as a unit upwardly over said support posts.

4. The method of constructing a floating roof for a field erected storage tank, which comprises welding together roof parts properly positioned in the bottom of the tank to substantially complete the floating structure of the roof, supporting the roof parts during welding on the tank bottom so that the substantially completed roof is below its intended low service position, and then lifting the roof to low service position as a unit by jacking against roof support posts extending through the roof and bearing against the tank bottom.

5. The method of constructing a floating roof for a field erected liquid storage tank which comprises, fitting together preshaped plates to form the roof structure on the bottom of the tank, placing auxiliary sleeves within the roof over predetermined tank bottom areas, telescoping usual roof support members through the sleeves to bear against the tank bottom, raising the roof as a body by jacking said roof support members through the sleeves and then securing the sleeves and roof support members together to hold the roof in its proper elevated position above the tank bottom.

6. The method of constructing a floating roof for a liquid storage tank which comprises, securing roof support pads in predetermined locations on the tank bottom, locating roof bottom deck sketch plates relative to the tank shell to form the peripheral portion of the roof deck resting on the bottom of the tank, welding the positioned sketch plates to bottom deck plates also placed on the tank bottom, securing an outer roof rim plate in upstanding position to the bottom deck sketch plates and roof bulkheads to the bottom plates and rim plate, forming openings in the bottom deck over said support pads and securing sleeve members to the bottom deck over the openings, welding top deck plates to the bulkheads and rim plate substantially to complete the floating roof, inserting pipe support members through the sleeve members so as to bear against the support pads and extend above the roof, mounting weight lifting jacks on the pipe supports and sleeves, operating all of the jacks together to raise the roof from the bottom of the tank to final position, then welding the pipe supports and sleeve members together to maintain the roof in elevated position and then removing the jacks.

7. The method as specified in Claim 3 in which the roof is raised progressively by jacking on a plurality of spaced roof supports in the form of posts and securing the roof to the posts in permanent fashion after raising the roof to proper elevation in the tank.

8. Apparatus for raising a newly constructed floating roof from the bottom of a liquid storage tank to proper low service position above the bottom, comprising: a sleeve member having a barrel and a pedestal adapted to be secured to the roof so that the barrel extends substantially vertically over an opening in the deck of the roof; a pair of apertured lugs on opposite sides of the upper portion of the barrel; a post member telescoped through the sleeve member and extending downwardly to contact the bottom of the tank and upwardly to expose portion above the floating roof; a jack member including a bearing nut adapted to rest on top of the post member and threadedly receiving a rod extending downwardly within the post member; a pair of tension straps each secured to one of said apertured lugs and to the top of said threaded rod so that turning of the rod may force the post member downwardly through the sleeve to elevate the roof from bearing on the bottom of the tank to being supported on the post.

9. Apparatus for raising a new constructed floating roof from the bottom of a liquid storage tank to proper low service position above the bottom, comprising: a sleeve member secured to the roof and having a central passage extending substantially vertically over an opening in the roof deck; a post member telescoped through the sleeve member and extending downwardly through the opening in the roof deck to engage the tank bottom; a pair of tension straps secured at their lower end to

the sleeve member and secured together at their upper end; a screw member threadable idly in the top portion of said tension straps; a bearing member on the top of said post threadedly receiving the screw member whereby turning of the screw can lower the post through the sleeve and raise the roof from the tank bottom.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,847,755 August 19, 1958

John F. Mummert et al.

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

Column 3, line 57, for "whenever" read -- wherever --; column 4, line 10, for "raised" read -- raise --.

Signed and sealed this 25th day of November 1958.

(SEAL)
Attest:
KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents