Aug. 15, 1944. W. G. LAIRD 2,355,874

ART OF CONSTRUCTING METAL LIQUID STORAGE TANKS

Filed June 13, 1940

Fig. 1.

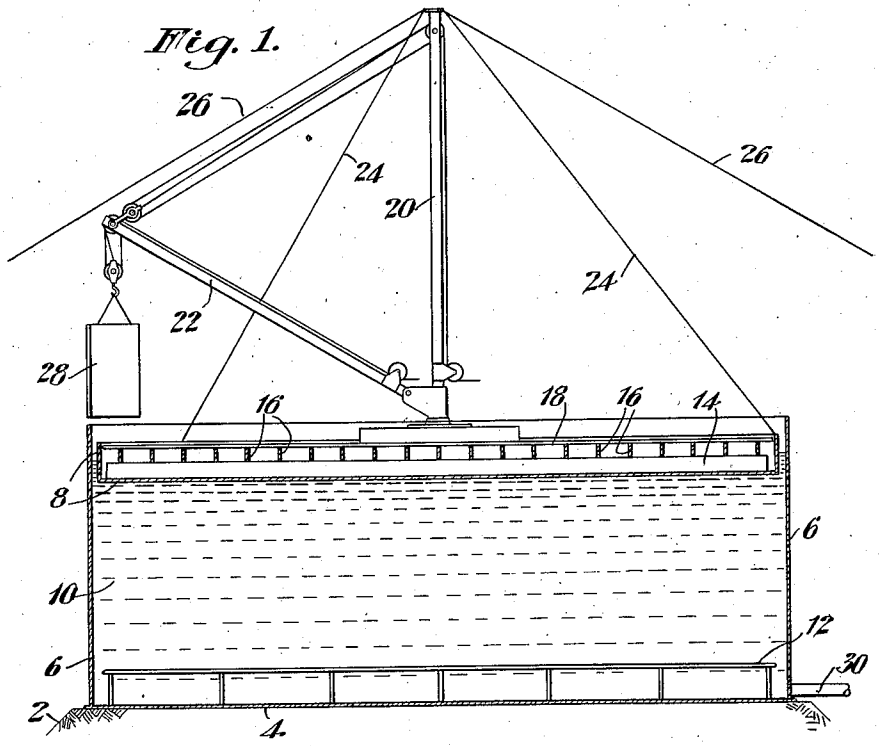
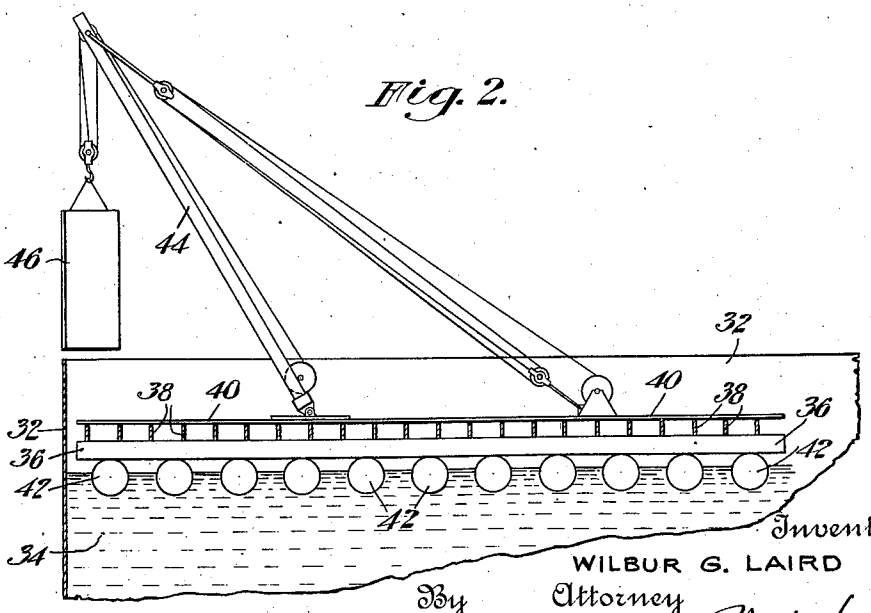


Fig. 2.



Inventor
WILBUR G. LAIRD
By Attorney
Arnold R. Workman

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ART OF CONSTRUCTING METAL LIQUID STORAGE TANKS

Wilbur G. Laird, Pleasantville, N. Y.

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7 Claims. (Cl. 29—148.2)

This invention relates to the art of constructing tanks for liquids and more particularly to the construction of sheet metal tanks of relatively large size which are erected in the field by the riveting or welding together of many plates to form the desired size and type of tank or container for liquids.

Since the present invention relates to a method of tank construction which is particularly adapted to the construction of tanks of the size and type employed by the petroleum industry, the method will be described in connection with certain types of oil storage tanks although its use is not limited in any way to oil storage tank construction.

The petroleum industry as a whole presents a huge problem in liquid storage; the volume of crude oil to be stored together with the volumes of finished and partly finished products results in a liquid tankage demand that probably is the largest of any single industry. While run-down and work tanks around a refinery are relatively small, many of the field storage tanks are among the largest employed by industry. For example, tanks having a diameter of approximately 120 feet and a heighth of approximately 48 feet, are common for storage purposes, although many larger tanks are in use. For refinery operations, many smaller tanks are employed although even these usually are large in comparison with those deemed large in other industries.

The riveted type of construction employed for many years has been largely replaced by the advent of more economical and efficient welding methods so that the oil storage tanks of today are largely constructed of mill-shipped plates welded together in the field to form the required size of container. Conical roofs for mere protection from the elements and some reduction of evaporation losses and fire hazards have largely given way to roofs of better construction and capable of withstanding a limited degree of internal vapor pressure. Along with these gradual changes in construction has been the adoption of numerous floating roof tanks in which a so-called roof or deck floats on the liquid in the tank and serves to eliminate the vapor space normally existing between the liquid surface and the tank roof.

Oil storage tanks are usually designed and constructed in accordance with standard specifications. The recommendations of The American Petroleum Institute being largely followed and known as A. P. I. specifications.

In the welding together of the plates used in the construction of oil storage tanks certain strains and stresses are necessarily set up which are not readily stress-relieved, therefore certain erection procedure has been found advantageous in order to minimize strains and stresses and avoid distortion of the tank wall or bottom. One course of tank construction procedure is as follows: A suitable foundation having been provided, the bottom plates are lap-laid on the foundation and welded together to form large interior plate sections. The lower ring plates of the tank wall are welded together and then welded to the outer bottom plates. These latter plates are then welded together, and then welded to the interior sections which are then welded together. Additional rings for the tank wall are welded from plates and then welded to the ring below until the full tank heighth is obtained. A top curb together with roof and roof supporting structure (for roofed tanks) completes the unit except for the usual accessories and connections. After completion, it is customary to submit the tank to hydraulic test for evidence of faulty welds and leakage. The welding sequence described above is one method of minimizing some of the strains and stresses incidental to progressive welding of large plate areas but the size of the tank, the thickness of the plate, the type of welding equipment, and the experience of the erectors governs the exact welding sequence best suited for a particular installation.

It will be apparent from the foregoing that in the erection of oil tanks of even ordinary size a very extensive amount of well braced scaffolding with working platform levels, necessarily must be started and extended to the very top of the tank. Furthermore, suitable wind bracing must be maintained until the top curb is attached because of the lightness of the upper rings, the large area exposed to wind effect, and the slight curvature of the walls of even ordinary sized tanks. Scaffolding not only must be maintained and extended with a minimum interference with the metal workers, but must be safe under all conditions of loading, and all inside scaffolding must be removed before the hydraulic test is applied. Faulty welds and seepages disclosed under test must be corrected and suitable working platforms provided to make the repairs. Long welding leads are necessitated when the customary electric welding method is used and add to the welding cost. It will be apparent to those skilled in the art that there are many handicaps to be overcome in the methods of tank construction now commonly employed, and that much

of the cost of present tank construction lies in the temporary and costly equipment now considered essential in obtaining a satisfactory finished tank. The construction of a floating roof tank entails practically the same procedure as that described above; the top curb is usually somewhat heavier, and the usual roof and roof supports are omitted. The floating roof itself is somewhat smaller in diameter than the tank, and is commonly constructed on permanent supports which prevent it from lying directly on the bottom of the tank. The supports provide a clean-out space between the floating roof and the bottom of the tank when emptied.

Having in mind the procedure now employed in the erection of storage tanks for liquids, the primary purpose of the present invention is to provide an improved method of tank erection which will materially reduce the cost of construction.

Another object of the invention is to provide an improved method of construction which will increase the comfort and safety of the workers and avoid the usual hazards involved in working from scaffolding.

A further object of the invention is to provide an improved method of construction in which the tank shell is simultaneously erected and tested for defects in seams and for leakage.

Another object of the invention is to provide an improved method of construction which will eliminate the necessity of using scaffolding and the expense involved in scaffolding equipment and its erection.

Another object of the invention is to provide an improved method of constructing liquid storage tanks of large diameter in which the use of bracing for the tank shell to prevent collapse during construction is entirely eliminated.

A further object of the invention is to provide a method of construction which will materially simplify the erection equipment required as for example in permitting the use of smaller erection derricks and shorter welding leads.

Another object of the invention is to provide an improved method for erecting floating roof storage tanks for liquids in which the floating roof is floated on water or other liquid and used in the erection process.

A further object of the invention is to provide an improved method for constructing liquid storage tanks which will materially cut down the losses of time during construction, and actually reduce the construction time.

A still further object of the invention is to provide an improved method for erecting liquid storage tanks which will avoid the fire hazard involved in the use of scaffolding.

Accordingly, the present invention comprises certain improvements in the art of constructing storage tanks for liquids, for example, in sheet metal storage tanks for liquids, in which sheet metal rings composed of a plurality of metal plates are erected in series one upon the other and secured together to make a tank of desired heighth. The improvements comprise the steps of providing a floatable member such as a floating deck or roof or raft of substantial size with suitable erection equipment thereon within the area to be surrounded by the tank wall, and which is adapted to float on a liquid to be introduced into the lower portion of the tank after that portion is erected, erecting the lowermost or first ring or rings of the tank in a liquid-tight manner around said floatable member as by attachment to a sheet metal bottom, introducing liquid into the erected ring or rings to float said floatable member therein and bring it to the desired heighth for use as a platform from which to work in the assembly and erection of the next ring or rings of the tank, and repeating the operation of introducing liquid to elevate the floatable member after the erection of each successive ring or rings in liquid-tight manner to the next lower ring, until a tank wall or shell of desired heighth has been obtained.

The floatable member used inside the tank may, in the case of a tank to be provided with a floating roof, actually be the floating roof itself which is intended to be left in the tank and which is usually only slightly smaller in diameter than the inside diameter of the tank. In other cases, the floatable member may be one or more suitably sized rafts or floats which can be used as a platform, to carry suitable erection equipment, materials and workers. The improvements of the present invention also include the testing of the tank structure for leaks and other possible defects as the successive rings are added.

Other objects and advantages of the improvements of the present invention will be apparent to those skilled in the art from the following more detailed description thereof, taken in connection with the accompanying drawing in which:

Fig. 1 is a diagrammatic vertical sectional view of a liquid storage tank being constructed in accordance with the improvements of the present invention, showing an intermediate stage of construction aided by the use of a floating roof or deck as the floatable member.

Fig. 2 is a diagrammatic broken vertical sectional view somewhat similar to that of Fig. 1, but with the floatable member illustrated as a pontoon float or raft, from which certain erecting operations may be carried on.

Referring now to the drawing: Fig. 1 is illustrative of one form of application of the improved method of constructing tanks for liquids. The illustration shows a tank of the floating deck type in process of construction and in which 2 is the foundation, 4 is the bottom of the tank, 6 is the tank wall or shell partially erected, and 8 the floating pan or deck floating on liquid 10 within the erected portion of the tank. The deck 8 is intended to remain within the tank as a floating roof or deck after the work of tank construction is completed.

The deck 8 is indicated as of light simple construction with temporary timbers and joist reinforcing to provide for suitable flooring where necessary and to distribute such concentrated loads as it may be desirable to carry. Metal sheets for the upper rings of the tank may be utilized for portions of the flooring if desired.

Since a welding sequence for large tanks of this character already has been described, the procedure for utilizing the floating deck 8 as a construction platform may be described as follows: After the bottom 4 has been placed on the foundation 2 the construction of the floating deck is preferably started. Usually this deck is supported above the bottom of the tank so as to provide working space for clean-cut purposes during the life of the tank. Such a support for the deck is illustrated at 12. After the deck 8 is ready, the temporary platform is provided, unless, of course, the deck is of such construction as to make temporary reinforcement unneces-

sary. Reinforcing stringers 14, joists 16 and a floor 18 are shown by way of illustration. After the deck is prepared as a suitable platform a single mast 20 and boom 22 may be erected in the center of the deck as shown. The mast 20 preferably is guyed both to the deck and to the ground by guys 24 and 26 respectively, the latter guys being slacked off when and as the deck is raised. A tank wall sheet 28 is shown suspended over the wall 6 from the boom 22 by means of suitable block and tackle equipment shown by way of illustration.

The next step in the erection method after providing the deck 8 and suitable equipment thereon, is the placing of the first or lower ring plates and the welding of the vertical seams. This is followed by welding the first ring to the bottom plates and the sequence welding together of the bottom plates themselves to complete the bottom and first ring section of the tank. Usually, and unless the tank plates are narrow or the deck supports unusually high, the next step will be to elevate the deck to the desired position for the placing of the next tank ring, by introducing water or other suitable liquid into the erected portion of the tank through a pipe 30. This introduction of water serves two purposes, it floats the deck, derrick and working platform to a convenient level for placing and welding the next tank ring; and it also tests for leakage all bottom and curb welds together with a portion of all vertical seams. Any observed faults or seepages may be corrected by lowering the water level at any stage as desired.

Fig. 2 is illustrative of another form of application of the improved method of constructing tanks for liquids. The illustration indicates an ordinary tank in process of construction and in which 32 is the erected portion of the tank wall.

A floating platform member is shown as supported by liquid 34. This floating member which provides a working platform during the tank erection is illustrated as comprising stringers 36, floor joists 38 and a floor 40, all of which are supported partially or wholly by pontoons 42 which may be of any type found most suitable and economical, such for instance as oil drums or other readily available buoyant units. On the working platform is illustrated a familiar form of A-frame derrick with the usual tackle for raising and lowering both load and the frame 44. A tank wall sheet 46 is shown suspended above the erected portion of the wall 32, by way of illustration. One or more working platforms may be used in a tank, and rotated or moved to the desired working position.

The erection sequence followed and illustrated by Fig. 2 is much the same as that described for Fig. 1, except that the working platform of Fig. 2 is illustrated as temporary and is intended to be completely removed from the finished tank. Therefore, no bottom frame work or raised support is necessary; the platform being constructed on the tank bottom before the admission of liquid and dismantled when the tank is emptied.

After the tank wall has been completed in accordance with the method illustrated by Fig. 2, the working platform or platforms may be used in the placing of the roof supporting columns (not shown), the placing of the roof girders, and the completion of the roof itself, if desired.

It will be understood by those skilled in the art of steel tank construction that the means shown in Figs. 1 and 2 are intended to be merely illustrative, and that the method is not limited to the use of any particular type of apparatus or exact arrangement. For example, the type of derrick illustrated in Fig. 1 may be satisfactory for the construction of certain sizes of tanks, but may be found too cumbersome for practical use in tanks of very large diameter; in which case derricks of the type illustrated by Fig. 2 may be employed, or, the derrick or derricks may be portable or movable on tracks laid on the deck 8. Similarly, the arrangement illustrated by Fig. 2 may be varied through a wide variety of suitable floating platforms. The hoisting and handling equipment may be of the mast and boom type, single or multiple A-frames, portable units, etc., and the platform or platforms may be equipped with grappling hooks (not shown) for holding them steady and in the position desired relative to the erected portion of the tank wall. The floating roof or platform may be fastened to the walls of the tank as it rises so that there will be no danger from tilting.

Additional equipment (not shown) carried on the platforms, may include generators for all welding, oxy-acetylene equipment, rivet heaters and rivets (when rivets are used), all kinds of necessary tools and erection equipment, etc., together with such tank material as may be desired. By way of illustration, it may be noted that if the platform being employed is similar to that illustrated by Fig. 1 and is 100 ft. in diameter, it will displace 7854 cu. ft. of liquid per foot of depth. This, with water displacement, is equivalent to approximately 490,000 lbs. gross, which is greater than the total weight of the usual tank of that diameter. It will be understood, therefore, that very heavy loads of material and equipment may be safely carried on the deck if desired, without exceeding a reasonable depth of liquid displacement.

From the foregoing description of the improved method of liquid storage tank construction, it will be apparent that the method will greatly reduce the cost of construction as well as the time usually required for erecting the tank, because the use of the floating work platform provides ample work space, avoids the use of inside and outside scaffolding, and the necessity of bracing. The floating deck or platform also permits the use of greatly simplified erection equipment such as the use of small erection derricks, and welding leads which are considerably shorter than are necessary in the usual practice. In the present instance, the electric generators may be carried directly on the floating roof or deck, and carried along as the tank wall is raised.

The improved method of erecting liquid storage tanks results in a considerable saving because the tank is automatically and continuously tested for defects in welding and for leakage as the erection proceeds. Furthermore, the presence of liquid in the tank shell from the beginning avoids the necessity of any bracing whatever and eventually produces a tank which is more accurately shaped, because the hydraulic head of liquid maintains it round and stabilizes the structure on the foundation in the course of its erection and avoids the strains often created in tank shells by present construction practices.

Other advantages and improvements of the herein claimed method of constructing sheet metal tanks for liquids are as follows:

1. Reduction of the hazard to workmen.

2. Allows an increased number of men to work on a tank and with much greater comfort.

3. Eliminates the fire hazard from wooden scaffolding.

4. Permits large quantities of materials to be carried along with the erection crew for convenient use.

5. Prevents wind vibration and blowing in of tank shell during erection.

6. Permits the painting of the outside of the tank as it is erected since it is tested as the erection proceeds.

7. Permits dismantling and repair of tanks as well as their erection without the use of scaffolding.

8. Avoids the cost of and hauling of scaffolding for field erection of oil storage and other tanks.

The procedure described above may be employed in the erection of any type of tank in which a floating member may be conveniently used for erecting the tank wall. The procedure for example may be applied to the erection of sheet metal pressure storage tanks such as the spherical, spheroidal or vertical tanks with hemispherical bottom and top now in use.

From the foregoing description it is apparent that various modifications may be made in the procedure and in the equipment used but such is to be understood as included in the scope of the appended claims.

Having thus described the invention in its preferred form, what is claimed as new is:

1. The method of simultaneously constructing and testing a floating roof storage tank for liquids, which comprises constructing a floating roof member of slightly smaller diameter than the internal diameter of the tank to be built and within the area to be surrounded by the tank shell, providing suitable erection equipment on said floating roof, erecting the lowermost ring or rings of the tank shell around said floating roof to form the lower portion of the tank in such a manner that it will hold liquid, introducing a liquid into the lower portion of the tank to float said floating roof and the equipment thereon and elevate it to the desired heighth to work from in the erection of a succeeding ring of the tank shell, erecting a succeeding ring of the tank shell by the aid of said floating roof and securing said ring to the upper portion of the next lower ring, introducing additional liquid into the lower portion of the tank to raise the level to a point slightly above the joint between the upper-most rings and thereby testing the liquid tightness of the joint, introducing further quantities of liquid into the erected portion of the tank structure to raise the level of the floating roof to the desired heighth for the erection of the next ring, and repeating the procedure of testing and erection until the tank shell has been raised to the desired heighth.

2. The method of building a sheet metal tank for liquids provided with a floating roof of slightly smaller diameter than the internal diameter of the tank in which a series of superposed sheet metal rings each composed of a plurality of sheet metal plates are successively erected with the plates of each ring secured together and to the next lower ring, comprising the steps of providing a floating roof within the area to be surrounded by the tank shell and adapted to float on a liquid, erecting the lower portion of the tank shell by assembling a plurality of sheet metal plates and securing them together and in fluid-tight engagement with a tank bottom, introducing a liquid into said erected lower portion to float said floating roof to a heighth suitable to work from in the erection of succeeding portions of the tank shell, providing suitable erection equipment on said floating roof for the erection of the tank shell, and erecting the succeeding portions by aid of said floating roof supported at the desired heighth by liquid introduced into the lower portion of the tank shell.

3. In the manufacture of a tank for holding oils and other liquids having an upwardly extending sheet metal shell composed of a plurality of individual sheet metal plates secured together in liquid-tight manner and supported on a permanent foundation, the steps of erecting the lower portion of the tank shell which is conveniently erected from the ground on the supporting foundation for the tank in liquid-tight manner, providing a floatable member of substantial size and displacement within the lower portion of the tank area, said member being adapted to float on a liquid and to be used as an erection platform in the tank, introducing a liquid into the lower portion of the tank to float said member and bring it to the desired heighth to work from in the erection of higher portions of the tank shell, utilizing said member in erecting higher portions of the tank shell in which said member is employed as a working platform, and repeating the operations of introducing liquid to raise the liquid level and said floating member and using the floating member in erecting additional superposed portions of the tank shell.

4. In the art of building sheet metal tanks for liquids in which sheet metal rings composed of a plurality of metal plates are erected in series one upon the other and secured together and to a metal bottom to make a liquid-tight tank of desired heighth, the improvement which comprises providing a member of substantial size within the tank area, said member being adapted to float on a liquid to be introduced into the tank and to be used as an erection platform in the tank as it is erected, providing a bottom for the tank and erecting the lowermost ring or rings of said tank in liquid-tight manner around said member on a supporting foundation, introducing liquid into the erected portion of the tank to test the liquid-tighteners of the erected portion of the tank and to float said member and bring it to the desired heighth to work from in the erection of a succeeding ring of the tank wall, erecting such ring of the tank wall by aid of said member and securing it in liquid-tight manner to the upper portion of the next lower ring, introducing additional liquid into the tank to further raise the liquid level to test the liquid-tightness of the last erected ring and to raise the level of said member to the desired heighth for the erection of a further ring, and repeating the procedure until the tank wall has been raised to the desired heighth.

5. In the manufacture of a tank for holding oils and other liquids having an upwardly extending sheet metal shell composed of a plurality of individual sheet metal plates secured together in liquid-tight manner, the steps of erecting the lower portion of the tank shell which is conveniently erected from the ground or other supporting foundation for the tank in liquid-tight manner on a supporting foundation, providing a floatable member of substantial size and displacement within the lower portion of the area, said member being adapted to float on a liquid and to be used as an erection platform in the tank, providing means on said floatable member

for lifting plates for the tank shell, introducing a liquid into the lower portion of the tank to float said member and bring it to the desired heighth to work from in the erection of higher portions of the tank shell, utilizing said member in erecting higher portions of the tank shell in which said member is employed as a working platform by using said lifting means thereon for raising plates for the shell into position on the previously erected portion of the tank shell, and repeating the operations of introducing liquid to raise said floating member and using it in erecting additional superposed portions of the tank shell.

6. The method of assembling sheet metal tanks for liquids constructed from sheet metal plates, comprising the steps of constructing a relatively shallow lower portion of the tank wall on a suitable foundation by securing a plurality of sheet metal plates together in fluid tight manner to form a ring-section on said foundation, thereafter introducing liquid into said lower constructed portion to float and elevate a buoyant working platform provided within the area surrounded by said constructed portion of the tank wall, assembling a plurality of sheet metal plates on the constructed portion of said wall by the aid of said working platform to form a ring-section of the wall secured in fluid-tight manner to said lower portion of the tank wall, introducing additional liquid into the assembled portion of the tank to raise the liquid level in the tank and elevate said platform, and assembling another ring-section of said tank wall from said elevated platform.

7. The method of building a sheet metal tank and providing a floating roof therefor, which comprises constructing a floating roof for the tank within the area to be surrounded by the tank shell, said roof being of only slightly smaller diameter than that of the tank and being adapted to float on a liquid, constructing a lower ring-portion of the tank shell by assembling a plurality of sheet metal plates and securing them together and to a previously constructed bottom for the tank, introducing a liquid into the constructed lower ring-portion of the tank shell in sufficient quantity to float and elevate said floating roof to a level suitable to work from in the construction of a further portion of said tank shell, constructing said further portion of the tank shell by using said roof as a working platform, and repeating the steps of introducing liquid to elevate the roof and using the floating roof as a working platform until a tank shell of desired heighth has been constructed.

WILBUR G. LAIRD.

DISCLAIMER

2,355,874.—*Wilbur G. Laird*, Pleasantville, N. Y. ART OF CONSTRUCTING METAL LIQUID STORAGE TANKS. Patent dated Aug. 15, 1944. Disclaimer filed Dec. 4, 1945, by the inventor.

Hereby enters this disclaimer to claims 3, 4, 5, and 6 of said patent.

[*Official Gazette January 15, 1946.*]