Feb. 2, 1926. 1,571,484

H. M. KNIGHT

TANK

Filed August 10, 1921 2 Sheets-Sheet 1

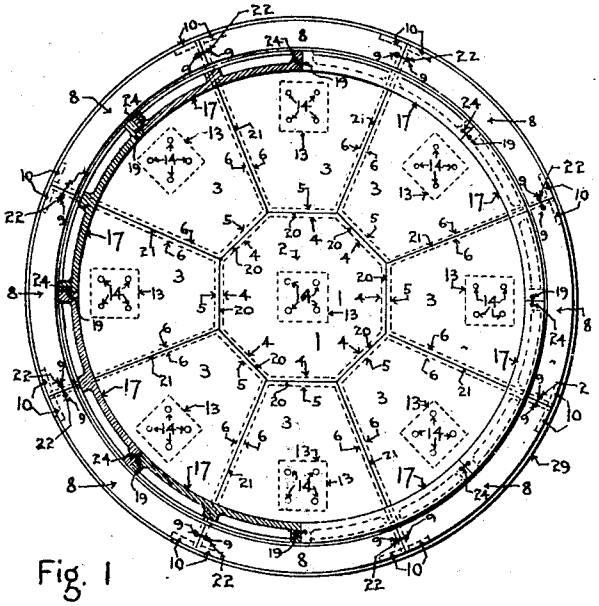

Fig. 1

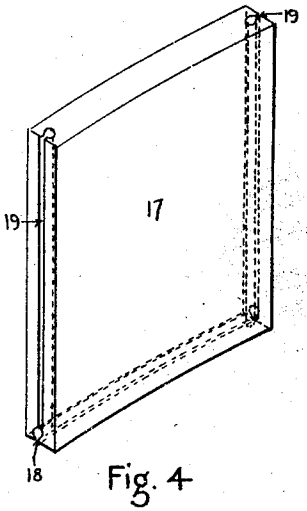

Fig. 4

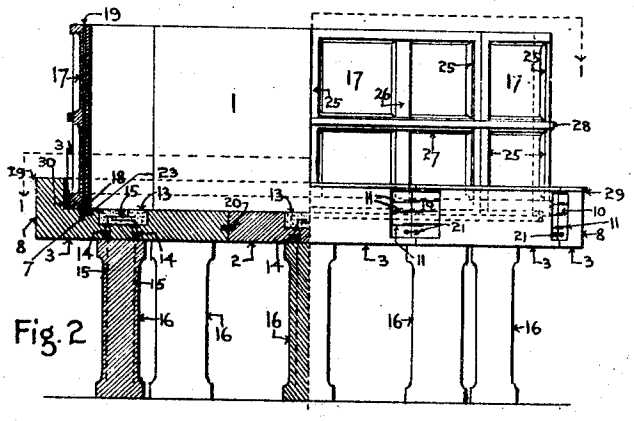

Fig. 2

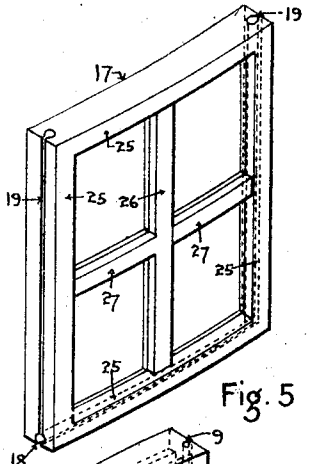

Fig. 5

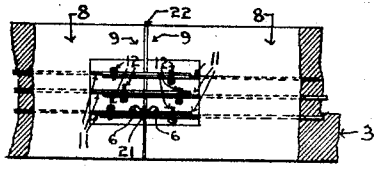

Fig. 3

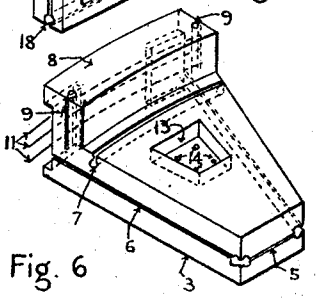

Fig. 6

Herbert M. Knight INVENTOR

BY

ATTORNEY

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H. M. KNIGHT

TANK

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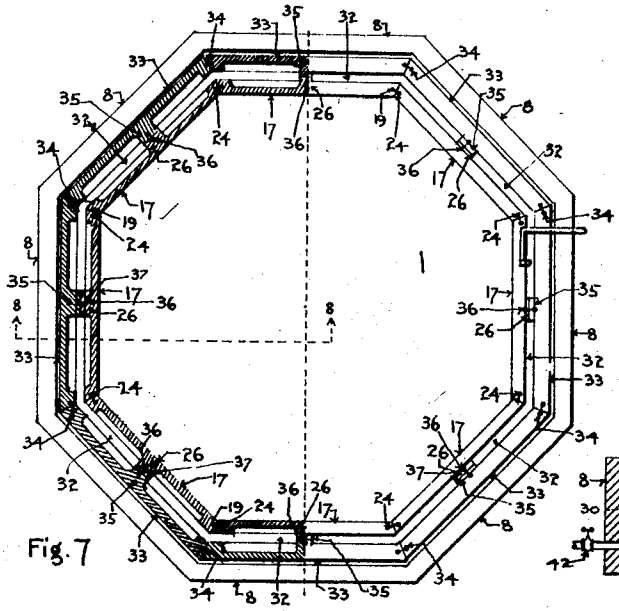

Fig. 7

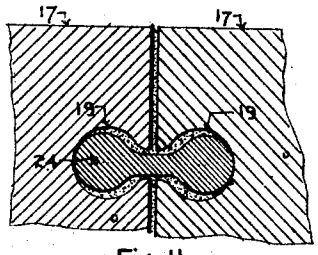

Fig. 11

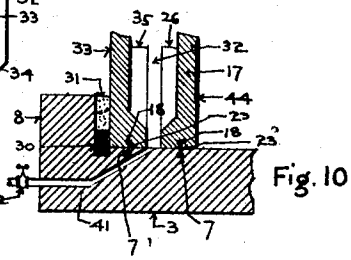

Fig. 10

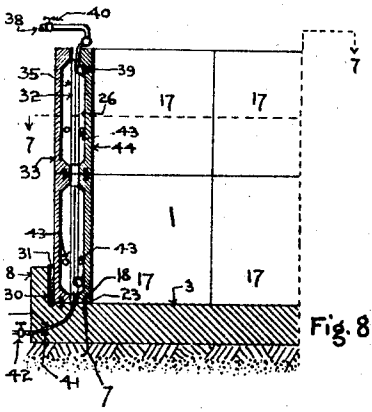

Fig. 8

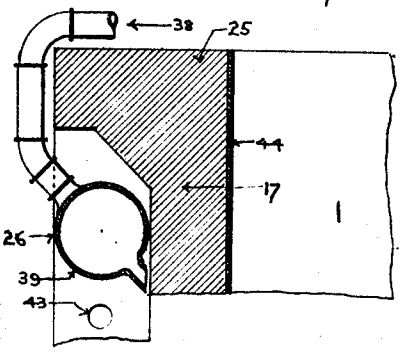

Fig. 9

Herbert M. Knight INVENTOR

BY

ATTORNEYS

Patented Feb. 2, 1926. 1,571,484

# UNITED STATES PATENT OFFICE.

HERBERT M. KNIGHT, OF MONTCLAIR, NEW JERSEY.

## TANK.

Application filed August 10, 1921. Serial No. 491,229.

*To all whom it may concern:*

Be it known that I, HERBERT M. KNIGHT, a citizen of the United States, and resident of Montclair, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Tanks, of which the following is a specification.

This invention relates to tanks and has special application to tanks of which the component material is concrete.

One of the objects of my invention is to produce a tank which can be constructed of pre-cast concrete units. Another object of my invention is to produce a tank composed of pre-cast concrete units in which the several units composing similar parts shall be similar and interchangeable. Another object of the invention is to produce a tank composed of connected pre-cast concrete units in which the units shall be connected together by keys. A further object of the invention is to produce a tank composed of connected pre-cast concrete units in which the joints between the several units shall be protected against leakage. Another object of the invention is to produce a tank composed of connected pre-cast concrete units which shall be integrally anchored to a previously erected base. Another object of the invention is to produce a tank composed of connected pre-cast concrete units so designed as to eliminate continuous transverse stresses throughout the floor of the tank. Another object of the invention is to produce a tank composed of connected pre-cast concrete units in which the peripheral reinforcement of the units composing the base can be overlapped and made to act together. Another object of the invention is to produce a tank composed of connected pre-cast concrete units of a cellular type. Still another object of the invention is to produce a tank composed of connected pre-cast concrete units in a cellular arrangement and means to prevent the percolation of liquids outwardly through the walls of the tank. Other objects of the invention will appear from the following description and from the accompanying drawings.

The accompanying drawings Figs. 1 to 11 inclusive indicate the usual and preferred embodiment of the invention. They are however illustrative only and are not to be considered as inclusive of all forms in which the invention may be embodied nor as exclusive of other forms than that indicated.

I illustrate my invention by the accompanying drawings, in which Fig. 1 is a partial horizontal cross-section and plan of a tank on the line 1—1 of Fig. 2; Fig. 2 is a partial vertical cross-section and elevation on the line 2—2 of Fig. 1; Fig. 3 is an elevation of the exterior of a portion of the base showing the lapping of the peripheral reinforcement; Fig. 4 is an isometric view of a wall unit view from the interior of the tank; Fig. 5 is an isometric view of a wall unit viewed from the exterior; Fig. 6 is an isometric view of a base sector; Fig. 7 is a partial horizontal cross-section and plan of a cellular tank; Fig. 8 is a vertical cross-section of one half of a cellular tank on the line 8—8 of Fig. 7; Fig. 9 is a partial cross-section of the top of a cellular tank showing a sprayer; Fig. 10 is a cross-section at the bottom of a cellular tank and Fig. 11 is section of the joint and key employed in such a tank composed of pre-cast connected units.

Referring to the drawings in which similar numbers refer to similar parts, 1 is a tank in which the bottom is made up of a central portion 2 surrounded by interchangeable circumferential units 3. Peripheral re-entrant grooves 4 are cast in the edges of the central portion and similar re-entrant grooves 5 adapted to aline with the re-entrant grooves 4 are cast in the inner edges of the circumferential units. Re-entrant grooves 6 are cast in the radial edges of the circumferential units. A re-entrant groove 7 is cast in the upper face of the circumferential unit. An abutment 8 is cast normally upon the outer perimeter of the circumferential unit and vertical re-entrant grooves 9 are cast in the edges of said abutment. Pockets 10 are left in the outer face of said abutment and circumferential reinforcement 11 exposed therein, adapted to receive means 12 for fastening overlapping reinforcing members. Pockets 13 are left in the upper faces of the central and circumferential units and perforations 14 pass through the bottom of said pockets adapted to receive the reinforcing members 15 of posts 16 supporting said tank. Wall units 17 rest upon the circumferential bottom units and a re-entrant groove 18 in the bot-

tom of said wall units is adapted to register with the re-entrant groove 7 in the upper face of the circumferential bottom unit. Re-entrant grooves 19 are cast in the vertical edges of the wall plates. Keys 20 are inserted and cemented into the juxtaposed re-entrant grooves 4 and 5. Keys 21 are inserted and cemented into the juxtaposed radial re-entrant grooves 6. Keys 22 are inserted and cemented into the juxtaposed vertical re-entrant grooves 9. Keys 23 are inserted and cemented into the juxtaposed re-entrant grooves 7 and 18 and keys 24 are inserted and cemented into the juxtaposed re-entrant grooves 19 of adjacent wall units. Thickened edges 25 surround the edges of the wall units and vertical ribs 26 and horizontal ribs 27 are cast upon the backs of the said wall units. Bands 28 are placed around the assembled wall units and bands 29 around the abutments of the assembled circumferential bottom units. Calking material 30 is placed between the wall plates and the abutments and a superficial concrete filling seals the calking material in place. An annular space 32 is created by the assembling of an outer wall of units 33 having keys 34 joining adjacent units. Vertical ribs 35 register with the ribs 26 of the inner wall and keys 36 are inserted and cemented into alined re-entrant grooves 37. A source of liquid supply 38 terminates in a sprayer 39 the said liquid supply being provided with a regulative means 40. A draw-off 41 provided with a regulating means 42 is located at the bottom of said annular space. Communicating holes 43 through the ribs connect the several annular spaces. An indestructible lining 44 covers the interior faces of the units.

The usual course pursued in constructing tanks of reinforced concrete for the purpose of containing liquids, is to erect an interior and exterior forming of boards, or other temporary holding means, and then to pour mass concrete inside the narrow annular space between the forms. This is a long tedious and expensive process both because of the time and expense involved in the erection and removal of the temporary forms employed and because of the difficulties and delays incident to the placing of the reinforcement in the narrow and confined space represented by the tank walls. This invention seeks to overcome these defects by substituting pre-cast concrete units for the mass concrete usually employed. Again certain liquids, particularly mineral oils, are subject to rapid percolation through the walls of unlined concrete tanks, such walls being very pervious, resulting in the loss of the liquid content of the tank. This loss through percolation can be overcome if the tank walls are completely saturated with a different liquid of a slightly greater specific gravity than that of the liquid which it is desired to retain in the tank.

In the invention illustrated and described, a floor of pre-cast units is employed, consisting of a central portion resting upon a central pier and connected thereto by means of the reinforcing medium employed in said pier, or other means, said reinforcing medium or other means passing through perforations in the said bottom plates. A registering re-entrant groove is cast in the peripheral edge of the central unit and similar and alined re-entrant grooves are cast in the abutting edges of the pre-cast units of the floor exterior to the central unit and keys, of a form adaped to enter and lock together the central and surrounding bottom units, either by insertion or automatically, are cemented into the said grooves. At the same time these keys create a dam or bulkhead, preventing leakage through the joint.

The pre-cast bottom units, circumferential to the central unit, are supported upon posts positioned beneath the loaded centre of gravity of the said unit, such reinforcing medium, or bolts, as are embedded in said posts being extended upwardly passing through holes in the said bottom units and meshing with the reinforcement of said units.

It is at once apparent, as a result of the separation and subdivision of the bottom of the tank into the several units, and of the further fact that each bottom unit is supported at its centre of gravity, that no beam action of the bottom, as a whole, results, the maximum bending moments are reduced, the thickness of the slab is decreased and economy results without attending loss of strength. The determination of stresses is made positive and the structure can therefore be designed with accuracy and with a maximum of economy. The radial edges of the circumferential bottom units have re-entrant grooves cast therein adapted to aline with similar re-entrant grooves in the edges of adjacent circumferential units and to permit of the insertion and cementing of a key, by means of which the several circumferential units are connected and immovably fastened together. Other re-entrant grooves are formed in the upper surface of the circumferential bottom units adapted to aline with similar re-entrant grooves in the lower edges of the wall units, and to permit of the insertion, either in advance of or subsequent to the assembling of the said units of keys adapted to enter said grooves and to be cemented therein thereby fastening the said bottom and wall units securely and permanently together.

The outer portion of the circumferential floor unit is raised above the level of the tank bottom and acts as an abutment to re-

ceive the pressure from the base of the wall units. This abutment is heavily reinforced against such pressure, the reinforcing medium being extended beyond the radial edges of the units and exposed in a pocket left in the outer face of the circumferential unit. The reinforcement of all circumferential units having been similarly extended and projecting, results in the overlapping of the reinforcing medium, which are securely fastened together within the pocket and the pocket sealed with concrete, thereby causing the entire floor system of pre-cast and assembled units to act together in resisting outward pressure from the contained liquid.

The wall plates which are similar and interchangeable, are ribbed along the edges, and, where necessary, on account of the size of the wall unit required, intermediate of the edges, in order to strengthen the wall unit without undue addition in weight or material. It is evident that by the introduction of vertical and horizontal ribs, reinforced to meet the stresses, that a very thin section of wall plate can be used between the ribs, the ribs serving largely to sustain and transmit the stresses. Less material is thereby employed and the weight of the tank correspondingly reduced. The peripheral edges of the wall units have cast therein re-entrant grooves adapted to interchangeably aline, and to admit of the insertion of a key therein, the insertion and cementing of which key securely and permanently fastens the several wall units together.

Bands, adapted to resist the bursting pressure of the contained liquid surround the assembled wall units in contact with the horizontal ribs upon the exterior surface thereof, or, in the case of cellular walls, in contact with exterior surface of the assembled units direct. Leakage beneath the assembled wall units is prevented by means of a calking compound introduced into the annular groove between the exterior of the wall units and the interior face of the abutment of the circumferential bottom units, the space above said calking being filled with concrete in order to convey the pressure at the bottom of the tank wall to the abutment of the bottom.

Cellular tanks are constructed similarly to a single wall tank, except that, for the purpose of preventing the percolation through the tank walls of the liquid within the tank, means are introduced for saturating the tank wall, and, if need be, of filling the annular space between the interior and exterior shells with a liquid of such character and specific gravity as will prevent the loss of the contained liquid of the tank. This liquid for saturation purposes is conducted from some source exterior to the tank, through a pipe or pipes, as indicated, discharging the fluid into a sprayer, through regulating means, said sprayer being parallel with the tank walls and in contact therewith, the amount of liquid being regulated to the point of saturation required in order to close the pores of the tank walls against filtration from within. Means are provided to secure the intercommunication of the various cells of which the walls are composed, so that, in the event that it is desirable or necessary to completely or partially fill the cellular space with the fluid, it may flow through the several cells from one point of supply. For the purpose of clarity a single source of supply and a single sprayer are indicated, as also a single drain for the purpose of clearing the annular space of its liquid content, whereas, in practice, such and so many supply pipes, sprayers and drains will be employed as are necessary or desirable.

As a further means of protection against the outward percolation of the contained liquid and as a protection against the disintegration of the concrete by the action of the liquid content upon the tank walls, an interior lining coat, preferably but not necessarily, applied in situ, of a nature and composition immune to the action of the confined liquid, is shown. This interior lining is shown as a separate and distinct layer of some material such as enamelled iron, which has been introduced into the forms during the casting of the units before they are assembled to make up the tank walls, but such indication is not intended to exclude an enamelled, or similar coating, applied in situ, either with or without the application of heat, to secure the results of immunity and imperviousness desired.

What I claim is:—

1. In a tank composed of pre-cast units, a bottom comprising a central unit having re-entrant grooves around its peripheral edge, circumferential units having re-entrant grooves in alinement with the grooves of the central unit, re-entrant grooves in the radial edges of the circumferential units alined with the radial re-entrant grooves in the abutting edges of adjacent circumferential units and keys in all of the said grooves.

2. In a tank bottom composed of pre-cast units, circumferential units with an abutment cast thereon and depressed pockets in the exterior face of said abutment.

3. In a tank bottom composed of pre-cast units, circumferential units with an abutment cast thereon, depressed pockets in the exterior face of said abutment said pockets extending from the radial edges of said circumferential units.

4. In a tank bottom composed of pre-cast units, circumferential units with an abutment cast thereon, depressed pockets in the exterior face of said abutment extending

from the radial edge of said circumferential unit and reinforcing members exposed in said pockets.

5. In a tank bottom composed of pre-cast units, circumferential units with an abutment cast thereon, depressed pockets in the exterior face of said abutments said pockets extending from the radial edges of said circumferential units and reinforcing members exposed in said pockets and extending circumferentially beyond the radial edges of said circumferential unit.

6. In a tank bottom composed of pre-cast units, abutting circumferential units with abutments cast thereon, depressed pockets in the exterior face of said abutments said pockets extending from the radial edges of said circumferential units and reinforcing members exposed in said pockets and extending circumferentially beyond the radial edges of said circumferential units, said reinforcing members of adjacent units overlapping within said pockets.

7. In a tank composed of pre-cast units, a bottom, comprising a central unit surrounded by circumferential units, each independently supported by a post.

8. In a tank composed of pre-cast units, a bottom, comprising a central unit surrounded by circumferential units, each independently supported, said points of support being located beneath the centres of gravity of the several units.

9. In a tank composed of pre-cast units, a bottom, comprising a central unit surrounded by circumferential units, each independently supported by a post, the reinforcing members of said post entering said units through perforations therein.

10. In a tank composed of a multiple of pre-cast units, bottom units comprising a central unit, other bottom units circumferentially disposed relative to said central unit, wall units superimposed upon said circumferential units, grooves in the upper surface of said circumferential units, grooves in the bottoms of said wall units, said grooves in said circumferential units and said grooves in said wall units being in alinement and keys in said alined grooves.

11. In a tank composed of a multiple of pre-cast units, bottom units comprising a central unit, other bottom units circumferentially disposed relative to said central unit, wall units superimposed upon said circumferential units, re-entrant grooves in the upper surface of said circumferential units, re-entrant grooves in the bottom edges of said wall units, said grooves in said circumferential units and said grooves in said wall units being in alinement and keys in said alined grooves.

12. In a tank composed of a multiple of pre-cast units, the combination of bottom units, comprising a central unit, circumferential units, grooves in the periphery of the central unit, grooves in the edges of said circumferential units which abut the periphery of the said central unit, said grooves in said central unit and said grooves in said circumferential units being in alinement, keys in said grooves, grooves in the radial edges of said circumferential units, said grooves in said edges of adjacent circumferential units being in alinement, keys in said alined grooves, abutments on the outer edges of said circumferential units, wall units superimposed upon said circumferential units, grooves in the upper surface of said circumferential units, grooves in the bottom edges of said wall units, said grooves in said circumferential units and said grooves in said wall units being in alinement, keys in said alined grooves, grooves in the vertical edges of said wall units, said grooves in adjacent wall units being in alinement and keys in said alined grooves.

13. In a tank composed of a multiple of pre-cast units, the combination of bottom units, comprising a central unit, circumferential units, re-entrant grooves in the periphery of the central unit, re-entrant grooves in the edges of said circumferential units which abut the periphery of said central unit, said grooves in said central unit and said grooves in said circumferential units being in alinement, keys in said alined grooves, re-entrant grooves in the radial edges of said circumferential units, said grooves in said edges of adjacent circumferential units being in alinement, keys in said alined grooves, abutments on the outer edges of said circumferential units, wall units superimposed upon said circumferential units, re-entrant grooves in the upper surface of said circumferential units, re-entrant grooves in the bottom edges of said wall units, said grooves in said circumferential units and said grooves in said wall units being in alinement, keys in said alined grooves, re-entrant grooves in the vertical edges of said wall units, said grooves in adjacent wall units being in alinement and keys in said alined grooves.

14. In a tank composed of pre-cast units, the combination of bottom units, comprising a central unit, circumferential units, grooves in the periphery of the central unit alined with grooves in the abutting edges of the circumferential units keys in said grooves, alined grooves in the abutting radial edges of the circumferential units, keys in said grooves, abutments on the outer edges of said circumferential units, pockets in the outer faces of said abutments, lapped and connected reinforcement members in said pockets, wall units, calking and contact means between said wall units and said abutments, grooves in the upper faces of said circumferential units, alined grooves in the

lower edges of said wall units, keys in said grooves, alined grooves in the abutting vertical edges of said wall units, keys in said grooves, ribs on said wall units, means for resisting bursting pressures, means for preventing leakage through the wall units, and independent supporting means to said bottom units, substantially as, and for the purpose described.

15. In a tank composed of pre-cast units, the combination of bottom units, comprising a central unit and circumferential units, re-entrant grooves in the periphery of the central unit alined with re-entrant grooves in the abutting edges of the circumferential units, keys in said grooves, alined re-entrant grooves in the abutting radial edges of the circumferential units, keys in said grooves, abutments on the outer edges of said circumferential units, pockets in the outer faces of said abutments, lapped and connected reinforcement members in said pockets, wall units, calking and contact means between said wall units and said abutments, re-entrant grooves in the upper faces of said circumferential units, alined re-entrant grooves in the lower edges of said wall units, keys in said grooves, alined re-entrant grooves in the abutting vertical edges of said wall units, keys in said grooves, ribs on said wall units, means for resisting bursting pressures, means for preventing leakage through the wall units, and independent supporting means to said bottom units, substantially as, and for the purpose described.

16. In a tank composed of a multiple of pre-cast units, the combination of bottom units, comprising a central unit, circumferential units, grooves in the periphery of the central unit, grooves in the edges of said circumferential units which abut the periphery of the said central unit, said grooves in said central unit and said grooves in said circumferential units being in alinement, keys in said grooves, grooves in the radial edges of said circumferential units, said grooves in said edges of adjacent circumferential units being in alinement, keys in said alined grooves, abutments on the outer edges of said circumferential units, inner wall units superimposed upon said circumferential units, grooves in the upper surface of said circumferential units, grooves in the bottom edges of said inner wall units, said grooves in said circumferential units and said grooves in said inner wall units being in alinement, keys in said alined grooves, grooves in the vertical edges of said inner wall units, said grooves in adjacent inner wall units being in alinement, keys in said alined grooves, outer wall units superimposed upon said circumferential units, grooves in the upper surface of said circumferential units, grooves in the bottom edges of said outer wall units, said grooves in said circumferential units and said grooves in said outer wall units being in alinement, keys in said alined grooves, grooves in the vertical edges of said outer wall units, said grooves in adjacent outer wall units being in alinement, keys in said alined grooves, ribs on the inner face of said outer wall units, grooves in said ribs, ribs on the outer face of said inner wall units, said grooves in said ribs of adjacent inner and outer wall units being in alinement and keys in said alined grooves.

17. In a tank composed of a multiple of pre-cast units, the combination of bottom units, inner wall units, outer wall units, means tying said inner wall units to said bottom units, means tying said outer wall units to said bottom units, means tying said outer wall units to said inner wall units, said inner wall units and said outer wall units being separated by an annular space, means for supplying liquid to said space between said inner and outer wall units and other means for withdrawing said liquid.

Signed at New York in the county of New York and State of New York this ninth day of August A. D. 1921.

HERBERT M. KNIGHT.