May 1, 1945. D. ORDING ET AL 2,374,889

TOWER

Filed Nov. 16, 1942 2 Sheets-Sheet 1

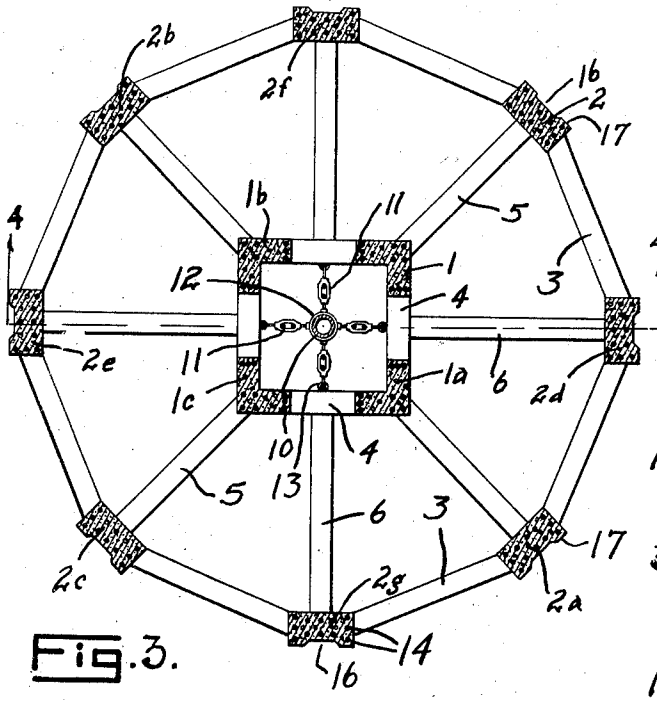


Fig. 3.

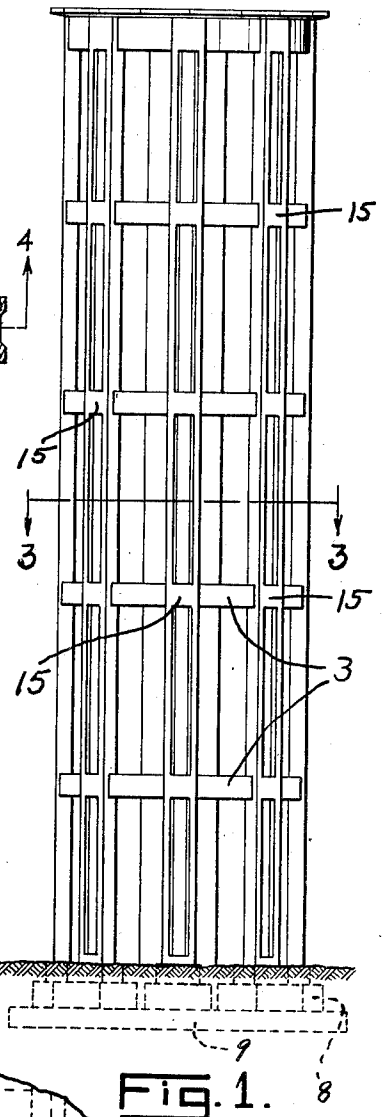


Fig. 1.

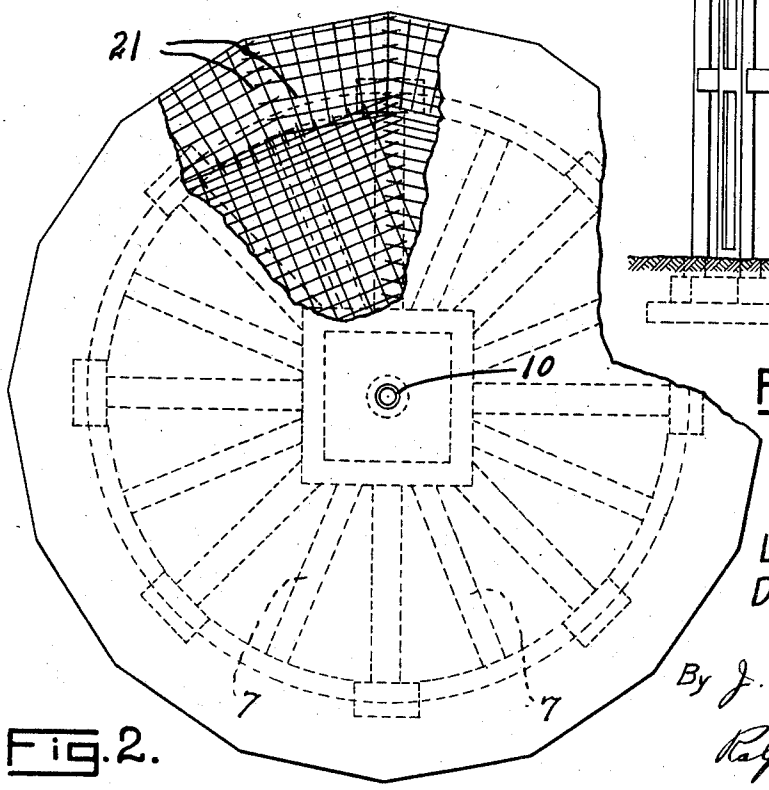


Fig. 2.

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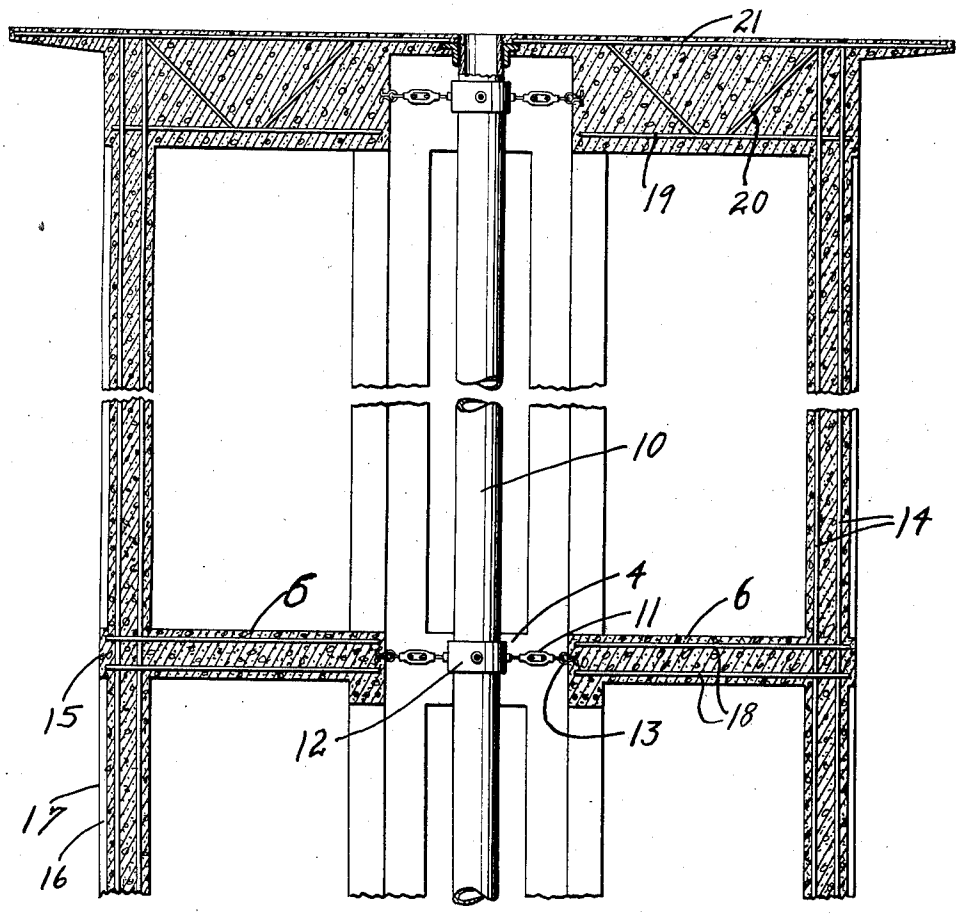


Fig. 4.

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UNITED STATES PATENT OFFICE

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TOWER

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4 Claims. (Cl. 72—85)

This invention relates to towers and more particularly has reference to towers of reinforced concrete construction for the purpose of supporting water tanks and other heavy structures.

Concrete towers, or at least tall concrete towers, have not heretofore been used because of the greater ease of assembling and building steel towers and of the lower first cost of steel towers. Now, however, when steel is out of the question for any structure that can be made without it, reinforced concrete is worthy of consideration. The fact is that even though the first cost of the concrete tower is greater by a sizable amount of money, the cost over a period of years is less because there is practically no upkeep to a concrete tower whereas a steel tower must be scraped and painted periodically to prevent its destruction by rust in most sections of the United States.

Another objection to the concrete tower has been the rather unsightly appearance of concrete unless plastered over on the outside. This is due primarily to the lines and irregularities appearing on the surface of the concrete structure by reason of the joints formed between the successive pourings of the concrete and by reason of the joints in the molding form into which the concrete is poured.

An object of this invention is to provide a concrete tower constructed to avoid the disadvantages pointed out hereinbefore.

Another object of this invention is to provide a tower of reinforced concrete construction which is of relatively high strength and which lacks the unsightly appearance of normally-constructed concrete structures.

A further object of this invention is to provide a concrete tower having an inner group of columns surrounded by an outer group of columns and having a plurality of horizontal beams connecting the columns of the inner group together, connecting the columns of the outer group together and extending between the inner and outer groups of columns and their connecting beams.

Still another object of this invention is to provide a concrete tower formed of a group of vertically extending columns connected by a plurality of vertically spaced groups of horizontally extending beams in which the outer surfaces of the columns are formed with a plurality of panels, the upper edges of which lie in planes containing the lower surfaces of the horizontal beams and the lower edges of which lie in planes containing the upper surfaces of the horizontal beams.

A still further object of this invention is to provide a concrete tower for supporting water tanks having a conduit depending from the center portion of the latter which tower comprises an inner group of vertical columns spaced about said conduit, an outer group of columns spaced about said conduit but more remote therefrom, a plurality of groups of horizontally extending beams connecting the columns of the inner group together, connecting the columns of the outer group together, and extending between the inner and outer groups of columns and the beams connecting the same, and means horizontally extending between said conduit and the inner group of columns and the beams connecting the same.

With these and other objects in view as will appear more fully hereinafter, the invention resides in the parts and combinations of the tower hereinafter described and illustrated in the drawings and in the method of constructing the same.

In the drawings:

Figure 1 is an elevational view of a tower constructed in accordance with the present invention.

Fig. 2 is a plan view partly in section of the tower illustrated in Fig. 1.

Fig. 3 is a horizontal sectional view taken on line 3—3 of Fig. 1.

Fig. 4 is a fragmentary sectional view taken on line 4—4 of Fig. 3.

As shown in the drawings, the concrete tower according to the present invention comprises a plurality of uprights or vertical columns which are interconnected by horizontal beams arranged at various regions throughout the height of the tower. The vertical columns are arranged in the form of an inner group of columns 1, 1a, 1b and 1c and an outer group of columns 2, 2a, 2b, 2c, 2d, 2e, 2f and 2g. In the specific embodiment illustrated, the group of inner columns 1 are of angular cross section and are arranged in the form of a square or rectangular enclosure, as is clearly shown in Fig. 3 of the drawings.

Columns 2 of the outer group of columns are equally spaced about the center of the enclosure formed by the inner group of columns 1 and are aligned with the diagonals of the square enclosure formed by the inner group of columns 1. For instance, columns 2a and 2b are aligned with columns 1a and 1b of the inner group and accordingly columns 2 and 2c are aligned with columns 1 and 1c respectively of the inner group of columns. The other columns 2 of the outer group are arranged in pairs which are aligned

with median planes passing through the sides of the square enclosure formed by the inner group of columns 1. For instance, outer columns 2*d* and 2*e* lie in a median plane passing through one side of the square enclosure formed by the inner columns 1 and outer columns 2*f* and 2*g* lie in the median plane passing through the other sides of the enclosure formed by said inner group of columns.

While for purposes of illustration the inner group of columns comprises four columns of angle cross section and the outer group of columns comprises eight columns of substantially rectangular cross section, it is within the concept of the present invention to employ various numbers of columns within the inner and outer groups of columns and various shapes within each of said groups.

The vertically extending columns are supported on footings 8 which in turn are supported upon a subfooting 9 which may comprise a concrete slab or other suitable foundation element.

At various levels throughout the height of the tower the vertical columns 1, 1*a*, 1*b*, 1*c* of the inner group and the vertical columns 2, 2*a*, 2*b*, 2*c*, 2*d*, 2*e*, 2*f*, 2*g* of the outer group are connected together by horizontal beams. The various columns of the outer group are connected together by horizontally extending beams 3 and the various columns of the inner group are connected together by a plurality of horizontally extending beams 4. In addition a plurality of beams 5 extend between the columns of the inner and outer groups. Since there are twice as many columns 2 in the outer group as there are columns 1 in the inner group, alternate columns of the outer group are connected by beams 6 with the connecting beams 4 of the inner group of columns. Fig. 3 of the drawings clearly shows the arrangement of the vertical columns and the several types of horizontal beams interconnecting the columns of each group, the columns of the two groups, and the connecting beams.

In addition to the radially extending beams 6 connecting the inner and outer groups of columns and interconnecting beams, there is a further group of beams 7 which extend in a substantially radial direction between the beams 4 of the inner group of columns and beams 3*a* of the outer group of columns. These additional radially extending beams 7 are desirable for providing an effective support for a floor to be constructed on the upper portion of the tower. By increasing the number of radially extending beams, the thickness of the floor on the upper portion of the tower may be maintained at a minimum and will provide a more useful and effective support for a load to be carried thereon.

Also the depth of the beams forming the support for the floor may be of minimum thickness.

By constructing the tower in accordance with the present invention with an inner and outer group of columns it is possible to mount the riser for the supply and discharge of water from a tank supported by the tower within the rectangular enclosure formed by the inner group of columns. As is clearly illustrated in the drawings, the tubular conduit 10 is shown positioned centrally of the tower and is supported in position by means of turnbuckles 11 which are connected to collars 12 mounted on the pipe or conduit 10 and extend between said collar and anchors 13 imbedded in the concrete beams 4 interconnecting the inner group of columns 1.

The arrangement of the pipe or conduit 10 centrally of the inner group of supporting columns is an important feature of the present invention. When a water tank is supported on a tower, it is desirable that the pipe leading to the tower be located in the center of the latter. It is important that this pipe be adequately supported and protected and such support and protection will be afforded by the several groups of columns in the center of which the pipe is mounted. Furthermore by constructing the tower so that the radially extending beams do not extend diametrically across the center of the tower, it is possible to locate the riser pipe at the true center of the tower rather than eccentrically as would be the case of a tower construction in which beams extended diametrically across the same.

In constructing a tower in accordance with the present invention, the footing is first poured and then the inner and outer columns for a height up to the lowest level of horizontal beams is poured in suitable forms provided for the purpose. Before pouring the concrete for forming the several columns reinforcing rods 14 are mounted in position. These rods may be positioned in accordance with the usual procedure employed in forming concrete columns.

After the lowermost group of inner and outer columns has been poured and hardened to a sufficient extent the forms are prepared for pouring the lowermost group of horizontally extending beams. In accordance with the present invention these beams are cast as a unit and the portions of the outer beams 3 extending over the tops of the outer columns 2 are shaped so as to have the appearance of being part of the outer columns. These portions of the horizontal beams 3 are indicated by reference character 15 in the drawings. This phase of construction of the tower in accordance with the present invention is important as it contributes greatly to the appearance of the finished tower.

In this connection it should be noted that the outermost faces of the tower group of columns 2 are formed with vertically extending recesses 16 so that the outer faces of said columns comprise two marginal portions 17 between which lies the recess 16. After the portions 15 of the beams 3 are cast on top of the columns 2, said portions 15 of the horizontal beams cooperate with the recesses 16 to give a paneled appearance to the outer surfaces of the vertical columns 2. From the showing in Fig. 1 of the drawings it will be observed that the panels 16 formed in the outer faces of the vertical columns 2 have their upper edges lying in the same plane as the lower surfaces of the horizontal beams 3 and that the lower edges of said panel-forming recesses lie in a plane containing the upper surfaces of said horizontal beams 3. There will be a slight line between the juncture of the outer surfaces 17 of the columns 2 and the portions 15 of the horizontal beams but due to the relatively narrow extent of the surfaces 17, said line will be practically invisible and the vertical columns 2 will have the appearance of being paneled as explained above.

After alternately pouring columns and horizontal beams and reaching the desired height of the tower, the final or uppermost group of horizontal beams are poured as shown in Fig. 2 of the drawings. In addition to providing the vertically extending reinforcements 14, the present

invention also provides the provision of reinforcing rods 18 in the horizontal beams.

The uppermost group of horizontal beams which will serve to support the floor are constructed of slightly greater depth than the beams at the intermediate levels and are reinforced in a somewhat different manner as indicated by the reinforcing elements 19 and 20. After pouring of the uppermost group of beams, reinforcing netting 21 as indicated in Fig. 2 may be placed in position to reinforce the floor which is poured in suitable forms so as to adhere to the uppermost group of beams. If desired, the uppermost group of beams and the floor may be formed with a single pouring.

The construction according to the present invention comprising the two groups of columns connected by the several groups of beams provides a strong practical tower. In addition to the inner group of columns housing and supporting the pipe, they give better support for the load to be carried by the tower.

Furthermore, if the columns on the outside were the only columns the size of the tank which could be supported by the tower would be definitely limited because of necessity for the tremendous depth of the beam in the floor of the tank at the top of the tower. This beam would of course, have to be very deep in order to take the load and span the distance between the outside columns and as the beam was increased in size to take this load, the columns would have to be increased in size until the structure would be a commercial impossibility.

By providing four (or any other desired number) of supporting columns adjacent but not at the center of the tower and spaced circumferentially about the center of the tower, we have avoided the necessity for extreme depth of the beam structure in the tank floor at the top of the tower because we have provided a support around the central portion of the tower, and therefore made the beam length less than half what it would be if it had to span the entire distance between outside columns. These inner columns are tied together with beams extending between adjacent columns but not extending across and the tie beams extending radially inwardly from the outside columns are tied to the inner columns and to the inner beams. This permits a beam extending from one outside column to be tied to the beams extending from all the other outside columns without any congestion of any reinforcing materials at the center of the structure. It also presents a structure in which the central portion is left free for positioning the riser pipe exactly at the center of the structure.

Furthermore, the riser pipe may be supported from the central columns and beams very easily by means of the turnbuckles at as many points as may be desired throughout its length. Thus, the central column and beam structure serves as a practical means of tying together the tie beams from the outside columns, it provides a protection and support and an open central portion for a riser pipe, and it provides a central support for the floor of a tank or the like at the top of the tower thus avoiding the massive beams that would otherwise be necessary. Also, with the structures shown the floor at the top of the tower may be readily laid without difficulties in placing the reinforcing bars whereas if no central support were provided some means would have to be arranged for extending the reinforcing bars substantially radially across the central portion of the floor and this would incur great congestion of reinforcing bars as well as other almost insurmountable constructional difficulties.

From the foregoing description, it will be realized that the present invention provides a tower structure which is effective for supporting heavy loads and which in addition lacks the disadvantage of prior art concrete constructions in that the disagreeable appearance of said prior art structures is eliminated.

Having described our invention, we claim:

1. A supporting tower comprising four vertical concrete columns of angle cross section each defining the corner of a rectangular enclosure and constituting an inner group, a plurality of columns of substantially rectangular cross section spaced about the exterior of said rectangular enclosure defined by the columns of angle cross section and constituting an outer group, said columns of the outer group being positioned in alignment with diagonally opposed columns of the inner group and in alignment with vertical median planes passing through said rectangular enclosure, horizontal beams connecting columns of the inner group, horizontal beams connecting the columns of the outer group, horizontal beams connecting the aligned columns of the inner and outer groups, and horizontal beams connecting the horizontal beams of the inner group of columns with the columns of the outer group lying in said median planes.

2. A supporting tower comprising four vertical concrete columns of angle cross section each defining the corner of a rectangular enclosure and constituting an inner group, a plurality of columns of substantially rectangular cross section spaced about the exterior of said rectangular enclosure defined by the columns of angle cross section and constituting an outer group, said columns of the outer group being positioned in alignment with diagonally opposed columns of the inner group and in alignment with vertical median planes passing through said rectangular enclosure, horizontal beams connecting the columns of the inner group, horizontal beams connecting the columns of the outer group, horizontal beams connecting the aligned columns of the inner and outer groups, and horizontal beams connecting the horizontal beams of the inner group of columns with the columns of the outer group lying in said median planes, said tower having a plurality of horizontal beams at a plurality of levels, the uppermost group of horizontal beams having additional horizontal beams extending between the horizontal beams connecting the columns of the respective groups.

3. A supporting tower comprising four vertical concrete columns of angle cross section each defining the corner of a rectangular enclosure and constituting an inner group, a plurality of columns of substantially rectangular cross section spaced about the exterior of said rectangular enclosure defined by the columns of angle cross section and constituting an outer group, said columns of the outer group being positioned in alignment with diagonally opposed columns of the inner group and in alignment with vertical median planes passing through said rectangular enclosure, horizontal beams connecting columns of the inner group, horizontal beams connecting the columns of the outer group, horizontal beams connecting the aligned columns of the inner and outer groups, horizontal beams connecting the horizontal beams of the inner group of columns

with the columns of the outer group lying in said median planes, said tower having a plurality of horizontal beams at a plurality of levels, the uppermost group of horizontal beams having additional horizontal beams extending between the horizontal beams connecting the columns of the respective groups, and a reinforced concrete floor molded on said horizontal beams at the top of the tower.

4. A supporting tower comprising four vertical concrete columns of angle cross section each defining the corner of a rectangular enclosure and constituting an inner group, a plurality of columns of substantially rectangular cross section spaced about the exterior of said rectangular enclosure defined by the columns of angle cross section and constituting an outer group, said columns of the outer group being positioned in alignment with diagonally opposed columns of the inner group and in alignment with vertical median planes passing through said rectangular enclosure, horizontal beams connecting columns of the inner group, horizontal beams connecting the columns of the outer group, horizontal beams connecting the aligned columns of the inner and outer groups, horizontal beams connecting the horizontal beams of the inner group of columns with the columns of the outer group lying in said median planes, said tower having a plurality of horizontal beams at a plurality of levels, a tubular member extending coaxially of the inner group of columns, and horizontal braces extending between the beams connecting the inner group of columns and said tubular member.

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