Nov. 16, 1965 J. J. CLOSNER 3,217,451

PRESTRESSED CONCRETE STRUCTURES

Filed Jan. 27, 1961 2 Sheets-Sheet 1

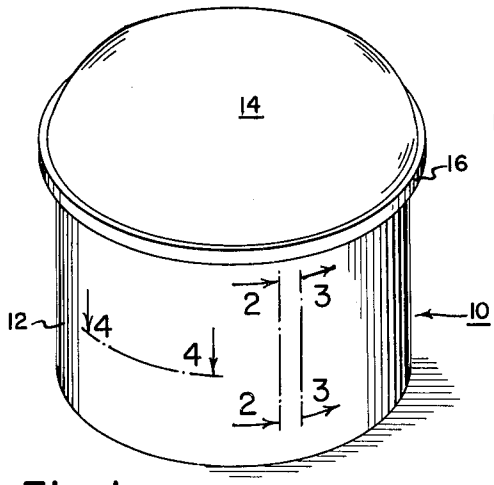


Fig. 1

Fig. 2

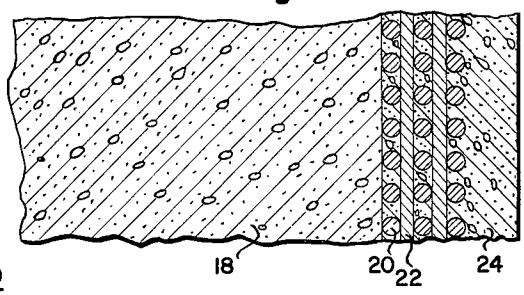
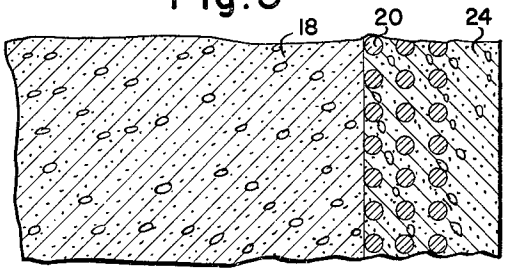


Fig. 3



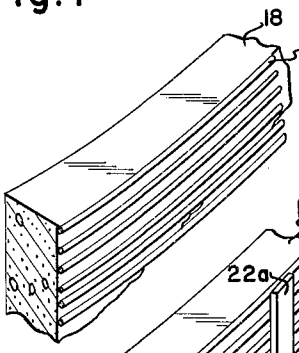


Fig. 5

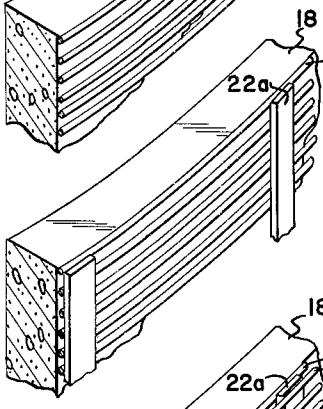


Fig. 6

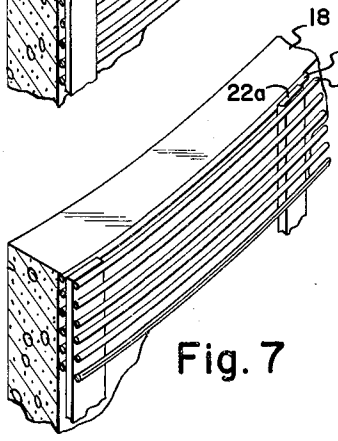


Fig. 7

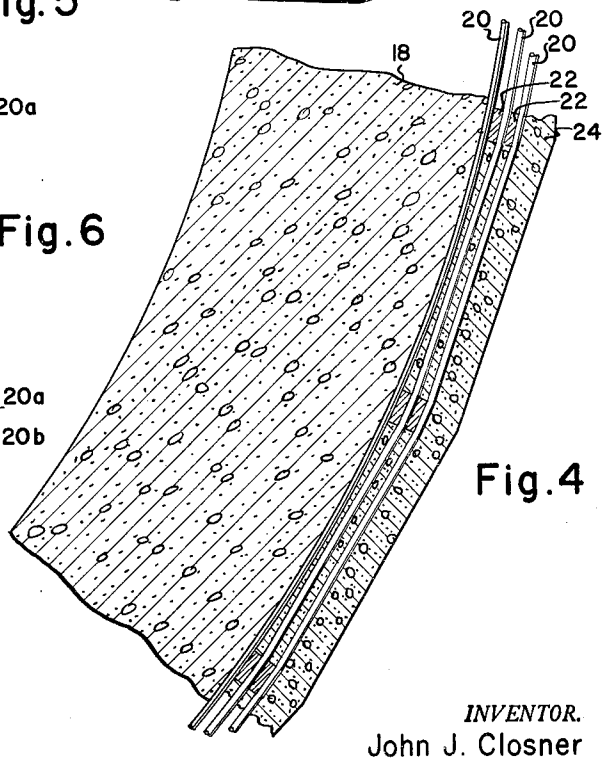


Fig. 4

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Fig. 8

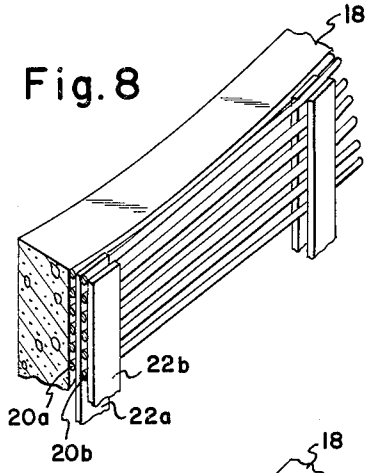


Fig. 9

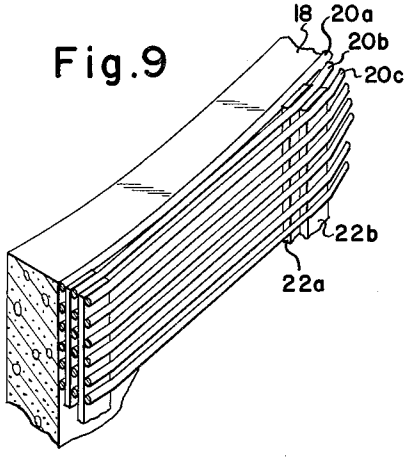


Fig. 12

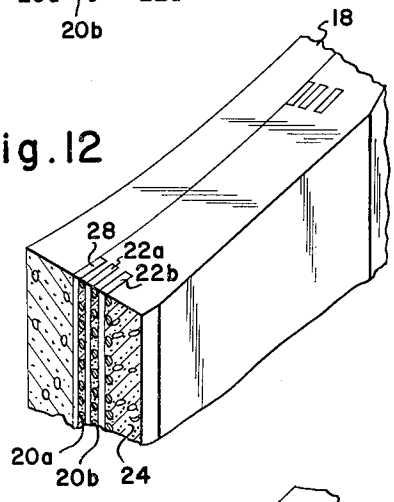


Fig. 10

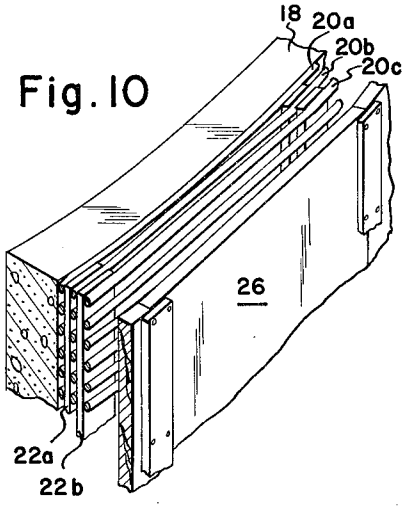
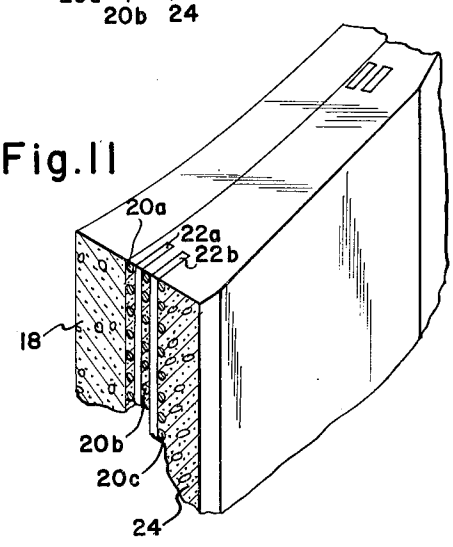


Fig. 11



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PRESTRESSED CONCRETE STRUCTURES

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7 Claims. (Cl. 52—224)

This invention relates to prestressed structures of concrete such as tanks, domes, and the like, as well as the method of constucting the same; and, in particular, to structures wherein the tensioned tendons are properly positioned and covered by a protective coating.

Heretofore, the principal technique for prestressing concrete structures has been to wrap and tension tendons, usually several layers of high tensile strength steel wires, strand or cable, about the outside surface of the structure and to cover each tendon layer with a protective coating of mortar to prevent corrosion. The application of an individual mortar coat over each tendon layer is not only an expensive operation but also a time consuming one. Before the present invention when several layers of tendons were used, it was necessary to apply one tendon layer, cover coat this layer with mortar and let the mortar set and harden before applying the next tendon layer. In addition to the time lost by waiting for the mortar to set, other slowdowns also result from inclement weather conditions since mortar cannot be readily applied in very cold or wet weather.

A further shortcoming of prior technique is that the successive coats of mortar (which must be applied over each tendon layer) are usually not evenly finished due to the nature of the material and the methods of applying it. Therefore, since each mortar coat does not present an even and true bearing surface for the succeeding tendon layer, sand or air pockets may form between the tendon and the previous mortar coat when the tendon layer is coated. These sand or air pockets act as reservoirs for moisture and may cause corrosion of the steel tendons. Such corrosion is a very serious problem and the maintenance required to overcome it often dissuades against the use of prestressed reinforced concrete structures.

Accordingly, it is an object of the present invention to overcome such difficulties by providing a structure and method of construction which insures proper spacing of the various layers of tendons and which permits the application of all the layers of tendons to be completed before any protective coating is applied.

It is a further object to provide a structure and method which is simple, more economical to use than the prior art methods and structures, and which helps to reduce maintenance problems relating to the corrosion of the tendons.

Although in the accompanying drawings a preferred embodiment of the present invention is shown and described in this specification, it is to be understood that this is not intended to be exhaustive and limiting of the invention, but, on the contrary, it is chosen for the purpose of illustrating the invention in order that others skilled in the art may so fully understand the invention, its principals and the application thereof, that they may embody it and adapt it in numerous forms, each as may be best suited to the requirements of the particular use.

In the drawings:

FIGURE 1 is a perspective view of a completed prestressed reinforced concrete tank in accordance with the present invention.

FIGURE 2 is a vertical sectional view through a portion of the wall of the completed tank showing the spacing of the various layers of prestressing tendons.

FIGURE 3 is similar to FIGURE 2 but taken along the lines 3—3 of FIGURE 1 and

FIGURE 4 is a sectional view of a section of the wall taken along lines 4—4 of FIGURE 1.

FIGURE 5 is a fragmentary perspective view of a section of the wall with the first tendon layer tensioned thereon.

FIGURE 6 is a view similar to FIGURE 5 with the first row of separators added.

FIGURE 7 is a view similar to FIGURE 6 with the second tendon layer added.

FIGURE 8 is a view similar to FIGURE 7 with the second row of separators in place.

FIGURE 9 is a view similar to FIGURE 8 with the third tendon layer applied.

FIGURE 10 is a view similar to FIGURE 9 with a form in place prior to pouring a protective coating about the tendon layers and separators.

FIGURE 11 is a view similar to FIGURE 10 with the protective coating in place.

FIGURE 12 is a view similar to FIGURE 11 but of an embodiment wherein a row of separators are inserted between the wall and the first tendon layer.

Referring to the drawings, and to FIGURE 1 in particular, a reinforced concrete tank **10**, is shown, which has sidewalls **12**, a dome top **14**, and a dome ring **16** for prestressing and supporting the dome. The sidewalls **12** and the dome ring **16** have been wound with a series of high tensile strength prestressing steel tendons over which has been applied a protective coating of mortar.

The tendon and coating combination may best be understood by referring to FIGURES 2, 3, and 4. As shown therein, the sidewalls **12** are comprised of a concrete core wall **18**, a series of layers of high tensile strength prestressing tendons **20**, upright separator bars **22** and a protective cover coating **24**.

In constructing the tank **10**, the core wall **18** is first formed and set in place on a suitable foundation by means which are well known in the art. With the core wall **18** constructed, the first layer of prestressing tendons **20** are applied. These may be applied by wire winding apparatus such as shown in U.S. Patent Nos. 2,372,060 and 2,364,696 or by any other suitable means which are known to the art.

It is to be understood that "tendon layer" as used in this specification does not require the tendons to be in intimate contact with each other.

After the first tendon layer was in place, the practice heretofore has been to apply a protective coating of mortar over this layer. The mortar was usually applied by spraying it with a mechanical coating apparatus. This first layer of mortar had to set and harden before the next layer of wire could be applied. It was also necessary that the proper climatic conditions exist before applying the mortar coating. In very cold weather or in rain or snow it was not possible to apply the mortar coating satisfactorily.

In distinction with the prior art methods the present invention does not require that the first tendon layer be coated with the mortar before the next tendon layer is applied. As shown in FIGURES 5–11, all prestressing tendons are applied before cover coating. In carrying out the present invention in accordance with the illustrated embodiment of FIGURES 5–11, a row of upright separator bars **22***a* are spaced circumferentially about the first tendon layer **20***a* which is tensioned about the core wall **18**. In actual practice, when using a high tensile strength ¼ inch diameter steel wire as the prestressing tendon, separator bars one inch wide and ¼ inch thick have been found satisfactory. The second tendon layer **20***b* is applied to the tank and prestressed over the first row of separator bars **22** before a mortar coat is applied.

With the second tendon layer **20***b* in place, a second set of upright separator bars **22***b* are spaced over the second layer **20***b* and arranged on the same radial line with the

respective separators of the first row of bars 22*a*. A third tendon layer 20*c* is then applied over the second row of bars 22*b*. Additional alternate rows of bars 22 and tendon layers 20 are applied as required with each succeeding row of separators radially aligned with the respective separators of the preceding rows. This radial alignment concentrates the bearing load of each tendon layer 20 at each of the pressure points formed by the radial stack of separators. Thus, better design and construction control is possible.

It is to be understood that the number of tendon layers and the corresponding number of rows of separators will be determined as a matter of design.

The circumferential spacing of the separators is dependent upon the radius of the tank wall. Each stack of separators may advantageously be spaced so that the second tendon layer is no more than tangential to the first layer midway between separators, thus insuring proper load bearing as well as permitting good protective coating of all the tendons.

After all the tendon layers and rows of separators are in place, the protective coating 24 is preferably applied by placing a form 26 (as shown in FIGURE 10) and pouring the coating 24 about the tendons. Where the number of tendon layers is small and the spacing permits, mechanical spraying may be used.

Also with dome rings and the like, it will often be found to be more economical and easier to obtain full coverage of the tendons by preparing a form and pouring the cover coating.

While the cover coating will usually be a cement mortar, it is also within the scope of the present invention to use other plastic materials.

In many cases, the finish of the core wall 18 is uneven and rough. Accordingly, as shown in FIGURE 12, in actual practice it usually is desirable to place a row of separators 28 directly against the wall 18 before the first tendon layer is applied and tensioned. Such an arrangement insures that the bearing and point load on the wall will be fully concentrated at the separators. In addition, it is a further safeguard against sand or air pockets possibly forming between the core wall 18 and the first tendon layer when the protective coating is applied.

The use of a row of separators 28 directly against the core wall serves to transfer the prestress tensile force of the series of tendon layers uniformly through the vertical extent of the first row of separators 28. This arrangement has the particular advantage of preventing a "sawing" cutting, or crushing of the concrete in the core wall.

In constructing a wall using the row of separators 28, the same method as described hereinbefore except that as an initial step the row of separators 28 is first positioned about the core wall before the first tendon layer 20*a* is applied.

I claim:

1. The method of prestressing a substantially cylindrical concrete tank structure which comprises applying a first layer of a prestressing tendon about the structure, placing a first row of upright separators circumferentially spaced about the structure and adjacent to the first tendon layer, applying at least two additional layers of prestressing tendons to the structure with another row of upright separators positioned between each two additional layers of prestressing tendons, the separators in each row being radially aligned with the respective separators in each other row, and applying a cover coat of protective material over the tendons and the upright separators.

2. A substantially cylindrical concrete tank structure comprising an annular core wall prestressed with a first layer of a high tensile strength tendon, a first row of upright separators circumferentially spaced about the wall and contacting the first tendon layer, a second layer of prestressing tendon tensioned about the wall and over the first row of separators, additional alternate rows of separators and tendon layers, said separators in each row being in radial alignment with the respective separators in each other row, and a protective cover coating over the layers of prestressing tendons and the upright separators.

3. The method of prestressing a substantially cylindrical concrete tank structure which comprises applying a row of upright separators circumferentially spaced about the structure, tensioning a first layer of a prestressing tendon about the structure and over the first row of separators to achieve a desired elongation of said tendon layer, applying a second row of upright separators circumferentially spaced about the structure and over said first tendon layer and radially aligned with the respective separators of said first row of separators, tensioning a second tendon layer about the structure and over the second row of separators to achieve a desired elongation of said second tendon layer, and applying a cover coat of protective material over the tendon layers and the upright separators.

4. The method of claim 3 wherein the upright separators of the first row are spaced apart so that the chords formed by the first tendon layer are tangent to the concrete structure.

5. The method of claim 3 wherein the upright separators of the first row are spaced apart so that the chords formed by the first tendon layer are spaced from the concrete structure.

6. A substantially cylindrical concrete tank structure comprising an annular core prestressed with a first layer of a high tensile strength tendon tensioned to a desired elongation about the core, a first row of upright separators circumferentially spaced about the core and between the core and said first tendon layer, a second row of upright separators circumferentially spaced about the structure and over said first tendon layer and radially aligned with the respective separators of said first row, a second tendon layer tensioned about the core and over the second row of separators, a protective cover coat over the tendon layers and the separators.

7. A substantially cylindrical concrete tank structure as defined in claim 6 wherein the cover coat is a cementitious material.

References Cited by the Examiner

UNITED STATES PATENTS

2,031,057	2/1936	Mitchell	138—176
2,637,895	5/1953	Blaton	50—135
2,662,555	12/1953	Hirsh	138—176

FOREIGN PATENTS

1,222,543	1/1960	France.
367,743	2/1932	Great Britain.

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