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METHOD AND APPARATUS FOR CASTING CONCRETE
BODIES WITH CAVITIES THEREIN

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2 SHEETS—SHEET 1

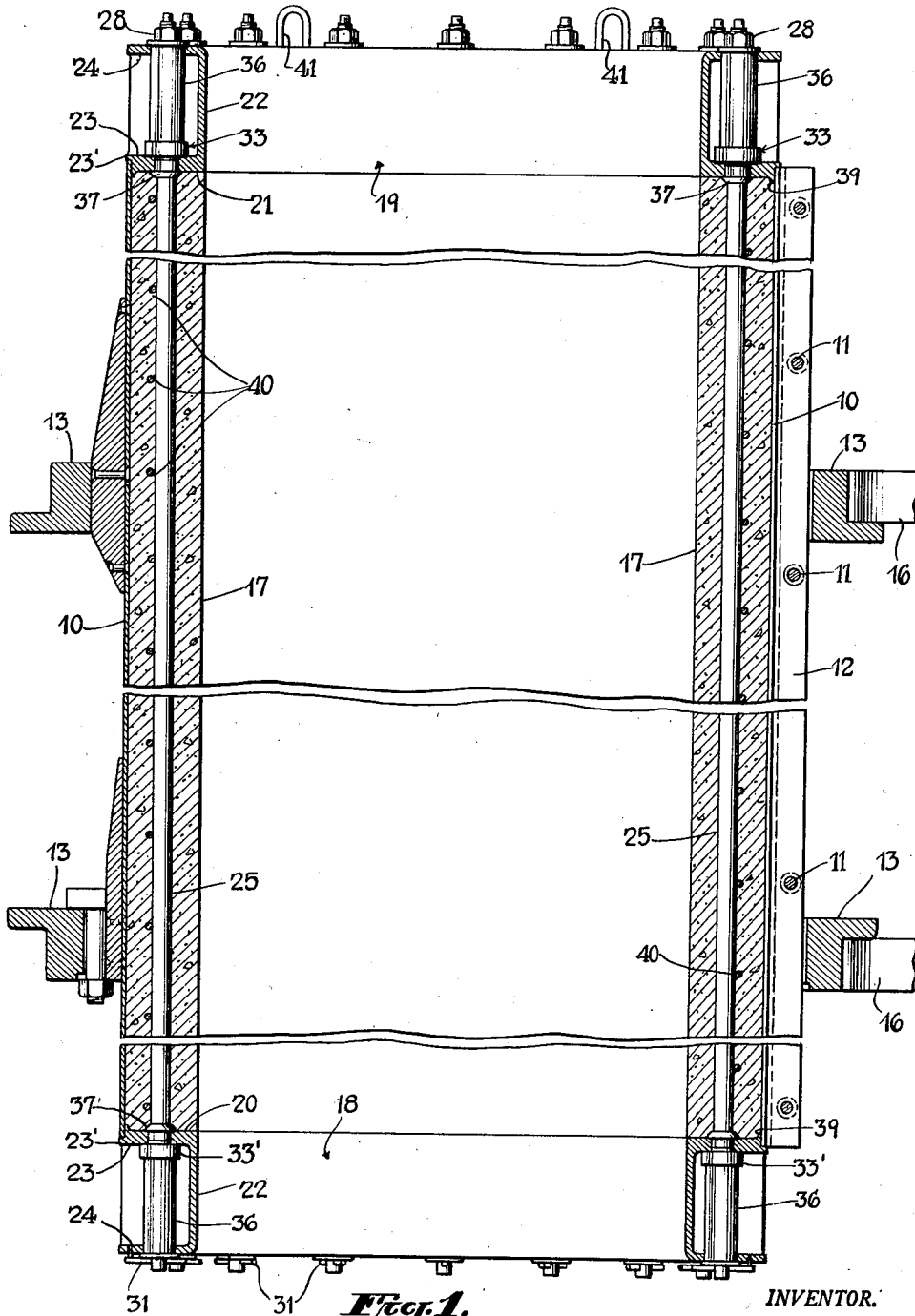


Fig. 1.

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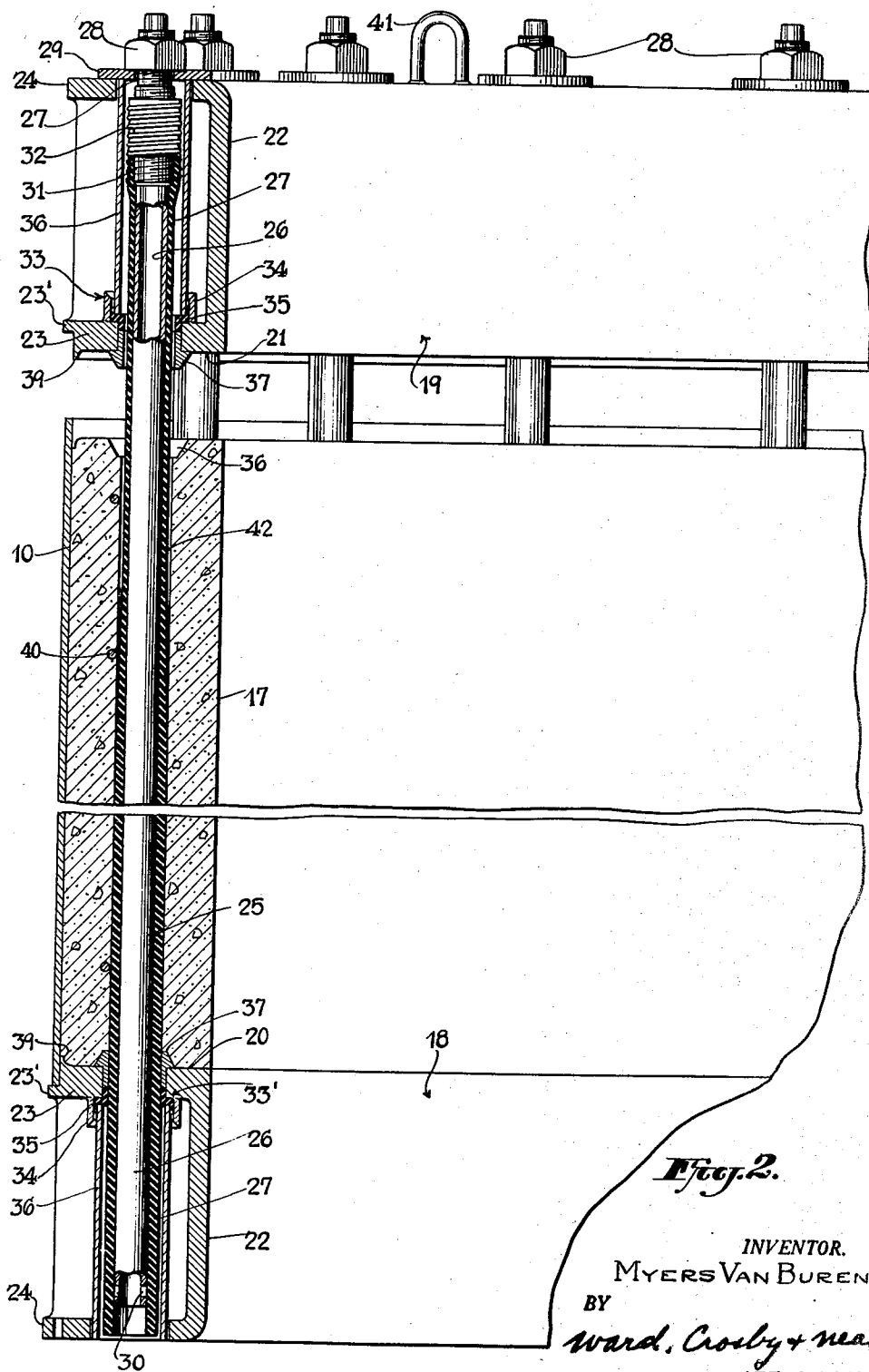


Fig. 2.

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METHOD AND APPARATUS FOR CASTING
CONCRETE BODIES WITH CAVITIES
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6 Claims. (Cl. 25—30)

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This invention relates to methods and apparatus for molding concrete and the like by spinning operations, the invention being particularly adapted, among other possibilities, for the manufacture of tubular concrete sections having in the walls thereof circumferentially spaced cavities extending longitudinally of the axis of the tubular member.

Tubular concrete sections or members of the type indicated are well adapted for use in end-to-end relation for forming continuous lengths of concrete pipe and certain types of piles or tubular columns, with the above-mentioned cavities in succeeding sections positioned in alignment whereby wires or other reinforcing means may be threaded therethrough and subjected to heavy tension for longitudinally prestressing the assembly of tubular sections and to hold same tightly together end-to-end with sealing means therebetween if desired, under heavy pressure. There are well known advantages in the method of forming tubular concrete members by spinning a mass of concrete in a rotatable molding apparatus, but the forming of longitudinal cavities in the walls of such members accurately, uniformly and economically in connection with such spinning operations involves difficulties which, so far as is known have not heretofore been satisfactorily overcome.

If such cavities are to be used to contain reinforcements under heavy tension for prestressing purposes, it is important that they be accurately formed and positioned, and free of any curvatures against which the prestressing cables or the like might bear and cause unpredictable transverse stresses in the completed assembly of sections when in use. Yet if a simple form of mandrel is used in the rapidly rotating molding apparatus to define such a cavity, the centrifugal force acting on the unsupported portions of such a mandrel will tend to cause it to deflect objectionably, thereby producing a somewhat curved cavity. Further problems arise in providing suitable supporting structure for the mandrels whereby they may be quickly and easily inserted in the mold and easily withdrawn from the set concrete, and at the same time so arranged as to prevent the wet concrete mixture from escaping about the ends of the mandrels or their supports.

The present invention provides novel methods and combinations of features for obviating these difficulties in a way permitting highly economical production of tubular concrete members having cavities in their walls as above referred to, and which will be uniform and accurate.

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Various further and more specific objects, features and advantages of the invention will appear from the description given below taken in connection with the accompanying drawing forming a part of this specification and illustrating by way of example a preferred embodiment of the invention.

In the drawings:

Fig. 1 is a horizontal sectional view of a preferred form of apparatus for carrying out the invention and involving the novel features thereof and showing the parts of the apparatus in the positions which they occupy during the operation of molding a tubular concrete member with cavities in the walls thereof such as above referred to;

Fig. 2 is a similar view, partly broken away but showing the positions of the parts when the mandrels are partially removed from the molded concrete member.

Referring to the drawings in further detail, the molding apparatus generally includes a tubular chamber portion or drum 10, the same being cylindrical in the form shown, although other shapes might be used depending on the desired cross-sectional shape of the concrete member to be molded therein. The drum 10 is preferably formed of an area of sheet metal, so shaped that two longitudinal edges thereof are brought together and removably held in place as by bolts 11 which pass through two angle bars as at 12 welded or otherwise secured respectively to such longitudinal edges in a manner which will be readily understood from Fig. 1. Two annular tracks as at 13 are provided around the exterior of this drum and are adapted to roll on rollers as indicated at 16 to permit spinning of the drum (by a suitable source of power, not shown) about its longitudinal axis, with a mass of concrete therein, and so that the centrifugal force of the spinning will cause the concrete to distribute itself over the inside surfaces of the drum to form a tubular concrete member as at 17.

Removable end pieces or barrier members as at 18 or 19 of like construction are provided at each end of the drum, the inner surfaces of these members as at 20, 21 serving to define the end surfaces of the concrete member 17 being molded. Each of these barrier members preferably comprises a cylindrical or annular web portion as at 22 which is cast integral with or is welded to annular flange portions as at 23, 24, said surfaces 20, 21 being formed on the flange portions as at 23, which are also preferably so shaped as to protrude slightly into the end of the sheet metal

drum to an extent limited by the small annular lip portions as at 23'.

A plurality of removable mandrel means as at 25 are provided, the same being of the shape and position of the desired cavities to be formed in the concrete body 17, viz. in the particular example shown such cavities are to be cylindrical in form, to extend longitudinally of the concrete member 17 at circumferentially spaced positions around within the walls of the member.

As shown in Fig. 2, each of such mandrel means preferably comprises an inner rigid core member 26 preferably of metal, surrounded by a sheath of readily stretchable rubber as at 27. Natural rubber may be used for this purpose, or if preferred, various suitable well-known types of synthetic rubber or rubber-like stretchable materials are available for the purpose.

The core 26 will usually be hollowed out, that is, in the form of a metal tube, although in some cases, particularly if a light metal is used, the core may comprise a solid rod. But in any event, the mandrel means is preferably so designed as to have an "over-all specific gravity" the same as, or approximating the specific gravity of the concrete as molded to form the member 17. The expression "over-all specific gravity" as used herein and in the appended claims, has reference to the specific gravity which each complete cross-sectional portion of the mandrel means will have, taking into account the specific gravities of the sheath and core materials and the space within the core, if any (ordinarily filled with air). It will be apparent that such "over-all specific gravity" approximating that of the concrete may be readily obtained by proper selection of the materials used and their relative dimensions, taking into account the specific gravity of each of the two materials and considering the space, if any, provided within the core.

The purpose and advantage of designing the mandrel means in this way is to obviate the deflections or distortions which would otherwise occur in the mandrel means under the powerful centrifugal force to which it is subjected during spinning of the apparatus. That is, since the mandrel means is supported rigidly at its respective ends by means such as hereinafter described, and it will be apparent that the metal portions particularly of each mandrel necessarily have considerable weight, the latter will, upon being subjected to centrifugal force during the spinning operation, be deflected outwardly in the event the concrete mixture is lighter than the mandrel means, or inwardly in the event the concrete mixture is heavier. Since during the setting of the concrete, the drum will ordinarily be subjected to a spinning motion with a circumferential speed for example as high as 3000 feet per minute, it will be apparent that such deflections will be substantial, if there is a substantial difference between the specific gravities of the concrete and the mandrel means. The cavities being formed in the concrete would then be curved or distorted in shape, giving rise to the objections above explained.

Commonly used concrete mixtures have a specific gravity in the neighborhood of 2.4. Hence, with such mixtures the mandrel means should be so designed as to have substantially the same over-all specific gravity. However, it will be appreciated that the specific gravity of concrete may vary considerably depending upon the characteristics of strength, weight, etc. desired in the finished structure, but usually if the mandrel

means is designed to have a specific gravity somewhere between about 2 and 2.8, this will satisfy the requirements for use with concretes of different weights within the ordinarily practical range, and still enable the mandrel means to be adequately supported and retained by the concrete against prohibitive deflections. In case the mixture has an unusually low specific gravity, as in the case of certain foam-like mixtures for example, then the mandrel means should be designed to have an equally low specific gravity.

As hereinafter explained, the mandrel cores, while in use, are preferably placed under substantial longitudinal tension which will be effective in further preventing deflections of the mandrels in the event their over-all specific gravity differs within reasonable limits from that of the concrete.

Since both end portions of the mandrels will ordinarily be rigidly supported, it is of course not important that such end portions, as distinguished from the middle portions, be designed to have a particular specific gravity, yet for simplicity, and as shown in Fig. 2, it will ordinarily be convenient to form both the core and the rubber sheath portions with uniform cross-sectional dimensions substantially throughout their lengths.

The supporting and tensioning means for the ends of the mandrels will now be described with reference to Fig. 2. One end of each mandrel core member, as shown, is provided with a threaded plug 27 adapted to receive a nut as at 28 to bear against a washer 29, which in turn bears against a flange portion on an end piece 18 or 19. The other end of the mandrel core is formed with a transverse slot or slots 30 through which key means as at 31 (Fig. 1) are adapted to be inserted to retain such end against movement when the nuts as at 28 are tightened to the extent desired for tensioning the mandrels and also to retain the end pieces or barrier members 18 and 19 tightly in position against the ends of the drum 10.

The end of the mandrel core which has the threaded plug 27 is also preferably formed with an external threaded portion 31, which is embraced by the corresponding end of the rubber sheath, the latter being securely retained on the threaded portion 31 as by tightly wrapping same with a helix of wire as at 32, so that the rubber is depressed into the threads at 31 and held against longitudinal displacement with respect thereto.

The flange portions 23, 24 are formed with aligned apertures for receiving the end portions of the mandrels. To prevent escape of the concrete mixture or water therefrom along the mandrels through the apertures in the flanges 23, such apertures are provided with stuffing box means as at 33, 33'. These may be formed by providing an annular collar as at 34 welded to the flange portion 23 and adapted to receive a gasket shaped with a cross-section as indicated at 35 and held in place by a thimble member 36. The latter member extends up into engagement with the washer 29 so that when the nut 28 is tightened, the lower end of the thimble member is crowded down against the gasket and the latter is forced into firm engagement around its periphery with the collar 34 and into tightly fitting embracing relation with the rubber sheath 27.

If the tubular concrete members 17 are to be used in prestressed end-to-end relationship as hereinabove explained, it will be desirable to

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provide an enlargement as at 36 at each end of each longitudinal cavity formed by the mandrel means, such enlargement providing space for grout to seal the prestressing wires at the abutting ends of the concrete sections. Such enlargements may be formed by providing a suitably shaped thimble-like member as at 37 fitted into the aperture in the flange portion 23 and having a portion adapted to protrude into the mass of concrete to the extent indicated at 36. Also it is desirable that the concrete member 17 be so formed that the outer peripheral edges of the end surfaces will be rounded. To accomplish this, the flange portions 23 may be formed with inwardly extending annular ridges as at 39.

In using the apparatus, the mandrel parts are first designed or selected so as to provide approximately the proper specific gravity as above explained, and these are inserted in the end pieces and assembled in the manner indicated in Fig. 1, the nuts 28 being tightened with the keys 31 in place whereby the mandrel cores will be longitudinally tensioned and the drum end pieces will be securely held in place. Then with the drum in horizontal position resting on the rollers 16, it is rotated by power driven means at a rate such that its peripheral speed will be several hundred feet per minute. During this time, a mass of the concrete is introduced through either or both ends of the drum structure, and after sufficient concrete is introduced, the spinning speed is increased and maintained for example at about 3000 feet per minute, until the concrete has become set to a degree permitting its removal from the apparatus. Usually some reinforcing means will also be provided in the concrete to facilitate its handling at this stage without breakage. For example, as indicated in Fig. 1, a length of wire may be provided for this purpose, shaped in the form of a helix, the cross-sections of its turns being indicated at 40, and same being located in positions to surround all of the mandrel means.

In order to remove the mandrel means, the drum structure is preferably moved to a vertical position and then the nuts 28 are loosened and the keys 31 are removed. Thereupon derrick means may be connected to the lifting eyelet members 41 on the end piece 19, whereupon this member is slowly lifted along with all of the several mandrel means as a unitary assembly. While the rubber sheaths will tend to remain adhered to the concrete, they will stretch first at the upper portions and then progressively further down as at 42, with the result that the successive portions of the rubber will readily become released from the concrete in the cavities as the cores are elevated. That is, the rubber will be released not only because of the upward pulling and stretching, but also because of the consequent reduction in diameter of the sheaths. The exterior surfaces of the core members may be lubricated if necessary to facilitate easy sliding thereof upwardly within such portions of the sheaths as have not been stretched and released at any stage of the operation of withdrawing the mandrels. It will be noted that the loosening of the nuts 28 will serve to release the pressure of the stuffing boxes against the rubber sheaths so that the stuffing boxes will not interfere with the upward stretching and withdrawal of the sheaths.

After the mandrels and end pieces of the assembly are removed, the concrete body 17 may be readily removed upon loosening the bolts 11

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along the side of the drum to permit the drum to expand to partially open condition.

After the concrete body has been removed, it will be apparent that all of the parts may be re-assembled and re-used in the manner shown in Fig. 1.

Although certain particular embodiments of the invention are herein disclosed for purposes of explanation, various further modifications thereof, after study of this specification, will be apparent to those skilled in the art to which the invention pertains. Reference should accordingly be had to the appended claims in determining the scope of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. In apparatus for molding tubular concrete members having longitudinal cavities at circumferentially spaced positions within the walls, the combination comprising a rotatable tubular chamber, removable barrier means at the ends of said chamber for defining the ends of the concrete members, a plurality of mandrels each passing through said chamber and through apertures in said barrier means and having the shape and positions of the desired cavities, sealing gaskets embracing the mandrels at said apertures, releasable means at the mandrel ends for longitudinally tensioning same, and elements interposed between the latter means and said gaskets to apply pressure from such tensioning means to said gaskets when the mandrels are tensioned.

2. In combination with rotatable molding apparatus adapted for the formation therein of tubular concrete members by spinning, longitudinally removable mandrel means supported adjacent its ends in the apparatus in a position to extend generally longitudinally within the wall of the concrete member being formed, to form a cavity therein, said mandrel means comprising a relatively rigid core surrounded by a readily stretchable covering, releasable threaded means at an end of said core for tensioning same during use in the apparatus, and stuffing box means embracing said covering and against which such tensioning means exerts pressure when in use, to tighten said stuffing box means.

3. In apparatus for molding tubular concrete members having longitudinal cavities at circumferentially spaced positions within the walls thereof, the combination comprising a rotatable tubular chamber, barrier means at an end of said chamber, a plurality of mandrels each passing through said chamber and having the shape and positions of the desired cavities, said barrier means including two interconnected flanges with aligned apertures through which the mandrels pass, the first of said flanges defining an end of the chamber space, the second of said flanges being spaced outwardly of the chamber from the first, gasket means embracing the mandrels at said first flange and means at the second of said flanges for longitudinally tensioning the mandrels, and elements interposed between said tensioning means and said gaskets for applying sealing pressure to the gaskets from such tensioning means.

4. In the molding of concrete in a rapidly rotating chamber having mandrel means supported therein in an off-center relation to the axis of rotation to form a cavity in the concrete, the method of avoiding substantial deflection of such mandrel means due to the action of the centrifugal force of the rotation, which method com-

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prises introducing into the chamber a mass of a concrete mixture having approximately the same specific gravity as the overall specific gravity of at least that portion of the mandrel means used which is spaced from its points of support, and rapidly rotating the chamber with such concrete mixture therein until the mixture has set, the amount of such mixture introduced being sufficient, when distributed around in the chamber by centrifugal force, to cover the mandrel means.

5. In the molding of concrete in a rotating chamber having mandrel means supported therein at the end walls of the chamber and extending along in spaced relation to the axis of rotation to form a cavity in the concrete, the method of avoiding substantial deflection of such mandrel means due to the action of the centrifugal force of the rotation, which method comprises introducing into the chamber a mass of a concrete mixture having approximately the same specific gravity as the overall specific gravity of at least that portion of the mandrel means used which is spaced from its points of support, and, while maintaining the mandrel means under a substantial longitudinal tensioning force reacting inwardly on the end walls of the chamber, rapidly rotating the chamber with such concrete mixture therein until the mixture has set, the amount of such mixture introduced being sufficient, when distributed around in the chamber by centrifugal force, to cover the mandrel means.

6. In the molding of concrete in a rapidly rotating chamber having mandrel means comprising a relatively rigid core covered by a readily stretchable sheath supported in the chamber

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and extending along the direction of, but in spaced relation to the axis of rotation to form a cavity in the concrete, the method of avoiding substantial deflection of such mandrel means due to gravity and the action of the centrifugal force of the rotation, which method comprises introducing into the chamber a mass of a concrete mixture having approximately the same specific gravity as the overall specific gravity of at least that portion of the mandrel means used which is spaced from its points of support, and, while maintaining the core of the mandrel means under substantial longitudinal tension, rapidly rotating the chamber with such concrete mixture therein until the mixture has set, the amount of such mixture introduced being sufficient to cover the mandrel means during such rotation.

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