Jan. 13, 1953 K. P. BILLNER 2,624,931

METHOD OF MOLDING CONCRETE STRUCTURES

Filed Feb. 28, 1951 2 SHEETS—SHEET 1

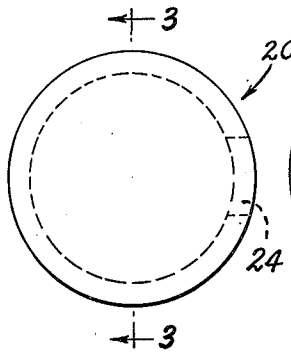


FIG. 1

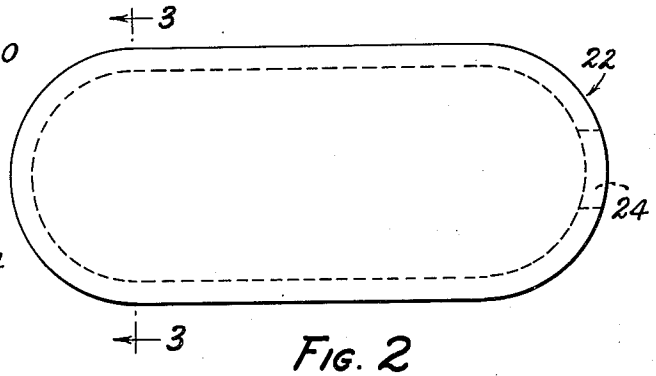


FIG. 2

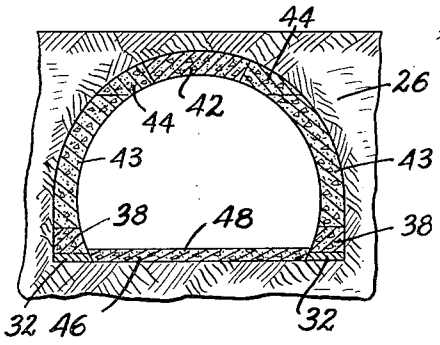


FIG. 3

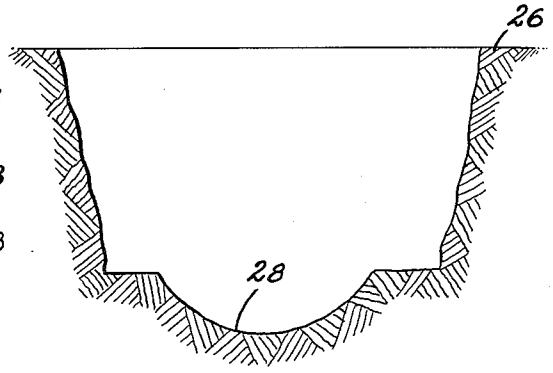


FIG. 4

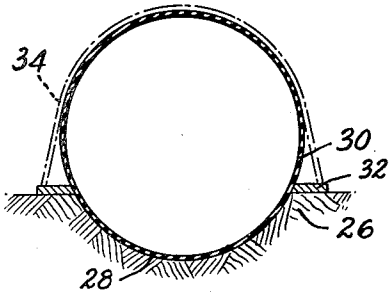


FIG. 5

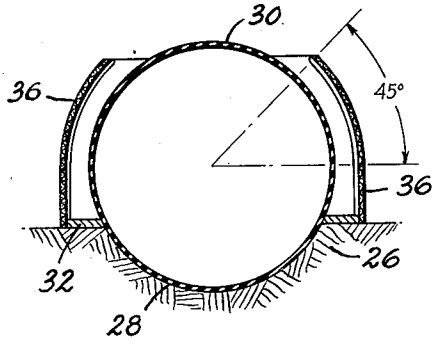


FIG. 6

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METHOD OF MOLDING CONCRETE STRUCTURES

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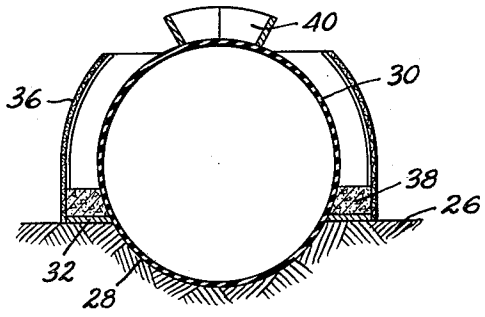


FIG. 7

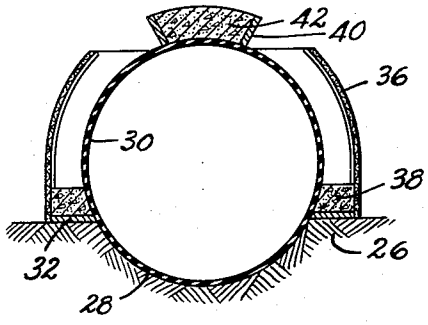


FIG. 8

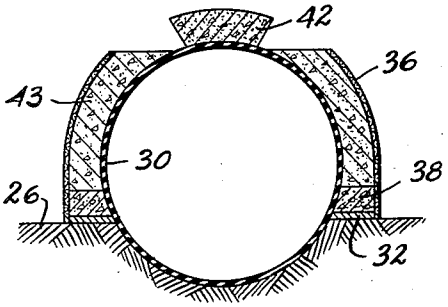


FIG. 9

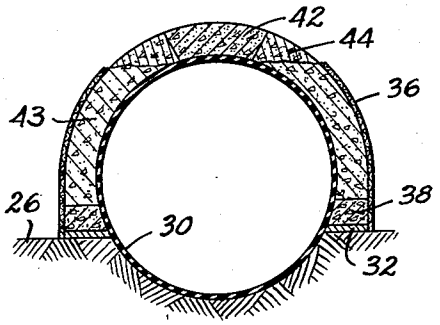


FIG. 10

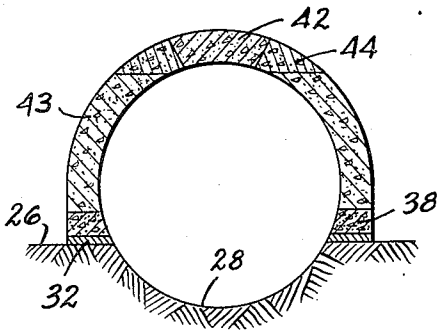


FIG. 11

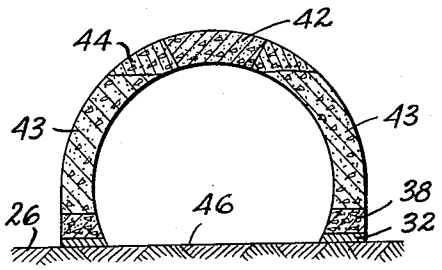


FIG. 12

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METHOD OF MOLDING CONCRETE STRUCTURES

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Application February 28, 1951, Serial No. 213,100

8 Claims. (Cl. 25—155)

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Ever since the time, many years ago, that the present inventor publicly demonstrated the use of inflatable flexible internal forms for the production of concrete structures, there have been many attempts by others to imitate and reproduce the methods and products. However, thus far, not one of these attempts has achieved a commercially acceptable method and product combining the primary requisites of rapid construction, economy and adequate strength.

By the present invention, the method has now been developed to a point that it becomes entirely feasible and highly desirable to use an inflatable internal form for the production of concrete structures and is eminently suited to the construction of such enclosures as bomb shelters and pill boxes where strength is a major criterion.

Since the present method contemplates prefabricated forms capable of repeated use, rapid construction is achieved. Inasmuch as the method minimizes the use of steel, economy is also realized. The fact that the method produces structures wherein substantially all portions are in compression, results in inherent strength. And other factors contributing to these primary requisites will become apparent to those skilled in the art.

It is among the objects of this invention to provide a method of producing a concrete structure comprising forming in the earth a depression having a cross section approximating a circular segment of predetermined radius, seating in the depression an inflatable flexible internal form having a substantially circular cross section of corresponding radius, providing an annular external form surrounding a portion of the internal form in spaced relationship, securing the forms against movement relative to the depression, introducing concrete between the forms and over exposed portions of the internal form to define a structure containing an opening, and removing the internal form after the concrete becomes self supporting. Inasmuch as the internal form is inflatable, it can be partially or completely deflated after the concrete becomes self supporting and removed through the opening defined in the structure which may be a door or window. The internal form may be restrained against movement by applying a force to an upper portion thereof, which may be the force of gravity acting on a mass of concrete applied to the upper portion of the form. In fact, it is contemplated that a frusto conical form be applied to the crown portion of the internal form and that concrete be poured in the hollow frusto conical form and

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allowed to harden therein, so that when the frusto conical form is removed, the concrete crown piece will be joined with the other portions of the concrete structure to produce what is in effect a monolithic construction.

The lower portions of the concrete construction may be produced in stages by a plurality of pours. This will be particularly beneficial where it is desired to produce a low wall for locating the forms and preventing relative movement thereof during the period that the major portion of the concrete is introduced between the forms. It will be understood of course, that unless precautions are taken to anchor the forms, hydrotatic pressure effects produced by the concrete in its plastic condition would tend to lift the forms from their desired positions. Ultimately, the space between unconnected bodies of concrete thus produced, will be filled with additional quantities of concrete to produce the desired structure, preferably containing an opening through which the internal form can be removed after it has been deflated.

The annular external form is preferably open at its top and of less height than the internal form so that concrete can be introduced through the open top of the external form in producing the contemplated structure.

A more complete understanding of the invention will follow from a detailed description of the accompanying drawings wherein:

Fig. 1 is a plan view of a structure of substantially spherical curvature;

Fig. 2 is a plan view of a structure of elongated form having end portions of substantially spherical curvature and intermediate portions of substantially cylindrical curvature;

Fig. 3 is a section taken along line 3—3 of either Fig. 1 or Fig. 2; and

Figs. 4 to 12 inclusive, are cross sections depicting progressive steps of the method which ultimately produces the structure depicted in Fig. 3.

The structures 20 and 22 depicted in Figs. 1 and 2 respectively, are substantially circular in cross section as depicted in Fig. 3, containing one or more door or window openings 24 providing access and also serving as an opening or openings through which the internal form can be removed.

Depicting the earth by reference character 26, an excavation is made as shown in Fig. 4, in the course of which a depression 23 having a cross section approximating a circular segment of predetermined radius is produced to complement

the external surface of an inflatable form 30 shown in Fig. 5 which may be composed of a rubber containing composition or such other suitable material as will be flexible, inflatable, and of sufficient strength to sustain the forces imposed upon it in use. One or more pallets 32 may be arranged about the depression 28 for use in anchoring the internal form 30 by means of rods 34 which, if desired, may extend over the top of the form with their ends secured to the pallet 32. Where such rods are used, they may be left in the completed structure to serve as reinforcement. However, their use under some circumstances will be optional even though in other cases, they may be important to sustain loads.

It will be understood that where the finished structure assumes the form of a portion of a sphere, the inflatable form 30 will be substantially spherical. If on the other hand, the finished structure is of the elongated type depicted in Fig. 2, then of course, the inflatable form 30 will be similarly elongated.

As shown in Fig. 6, an external form 36 of generally annular configuration open at its top is arranged about the internal form in spaced relationship with respect thereto and secured in a suitable manner to the one or more pallets 32 to prevent movement thereof when concrete is introduced between the forms. Since portability and ease of handling promote speed and economy, the external form is preferably as light in weight as will be consistent with its required strength. While various materials can be employed for the purpose, heavy canvas and metallic reinforcing rods have been combined to great advantage for the construction of these external forms. As shown in the drawings, the height of the external form is less than that of the internal form to facilitate the introduction of concrete between them.

As a matter of fact, as indicated by broken lines in Fig. 6, the upper edge of the external form terminates at a point approximating 45° from the horizontal extending through the center of the internal form. Fig. 7 depicts a body of concrete 38 introduced between the forms and superposed upon the pallet or pallets 32 serving to anchor or position the external form relative to the internal one, yet the height of this portion of the wall has been confined to a degree insuring against displacement of the forms due to hydrostatic pressure of the plastic concrete.

Fig. 7 also depicts a split hollow frusto conical form 40 with its smaller base superimposed upon the uppermost portion of the internal form to receive a body or crown of concrete 42, shown in Fig. 8, which serves to exert a force downwardly upon the internal form sufficient to prevent its displacement when concrete is introduced between the forms to complete the side wall portions of the structure. The split crown form 40 is removed after the outside form 36 has been filled with concrete 43, whereupon some of the concrete defining the crown at the top of the balloon form 30 may slump to some extent. Additional concrete 44 will then be filled in to complete the structure, the outline of which will have a configuration approximating that depicted in Fig. 10 wherein the external surface possesses a substantially smooth curvature after the concrete filling 44 has been introduced and becomes set. At this point, the external form 36 can be removed and the internal form 30 deflated and removed through an opening 24 so that the structure approximates a form such as that depicted in Fig. 11. Then, by suitable backfilling, the depression 28 can be filled producing a horizontal floor 46 such as that shown in Fig. 12. Then, as shown in Fig. 3, a concrete floor 48 can be poured on the horizontal floor 46 and if desired, the structure can be completely covered with earth so as to afford added protection against enemy forces or the elements.

An important aspect of the form of the invention just described in detail is the use of the depression 28 in conjunction with an inflatable form having a complementary external surface, since this permits the use of a form of circular section, taking advantage of the strongest type of construction for a minimum amount of material and preventing highly objectionable distortion of the type so common where inflatable forms of other shapes have been proposed.

Since the foregoing description relates to only one specific example of the manner of practicing the present invention, this illustration should not be construed as limiting beyond the scope of the appended claims.

I claim:

1. A method of producing a concrete structure comprising forming in the earth a depression having a vertical cross section approximating a circular segment of predetermined radius, seating in said depression an inflatable flexible internal form having a substantially circular vertical cross section of corresponding radius with a portion of said internal form extending above said depression, seating an annular external form on the earth at a higher elevation than the lowermost portion of said depression and surrounding a portion of said internal form in spaced relationship, securing said forms against movement relative to said depression, introducing concrete between said forms and over exposed portions of said internal form to define a structure containing an opening, and removing said internal form after said concrete becomes self supporting.

2. A method of producing a concrete structure comprising forming in the earth a depression having a vertical cross section approximating a circular segment of predetermined radius, seating in said depression an inflatable flexible internal form having a substantially circular vertical cross section of corresponding radius with a portion of said internal form extending above said depression, seating an annular external form on the earth at a higher elevation than the lowermost portion of said depression and surrounding a portion of said internal form in spaced relationship, securing said forms against movement relative to said depression, introducing concrete between said forms and over exposed portions of said internal form to define a structure containing an opening, and removing said internal form through said opening after said concrete becomes self supporting.

3. A method of producing a concrete structure comprising forming in the earth a depression having a vertical cross section approximating a circular segment of predetermined radius, seating in said depression an inflatable flexible internal form having a substantially circular vertical cross section of corresponding radius with a portion of said internal form extending above said depression, applying a restraining force to an upper portion of said form, seating an annular external form on the earth at a higher elevation than the lowermost portion of said depression and surrounding a portion of said internal form in spaced relationship, securing said external form against

movement relative to said internal form, introducing concrete between said forms and over exposed portions of said internal form to define a structure containing an opening, and removing said forms after said concrete becomes self supporting.

4. A method of producing a concrete structure comprising forming in the earth a depression having a vertical cross section approximating a circular segment of predetermined radius, seating in said depression an inflatable flexible internal form having a substantially circular vertical cross section of corresponding radius with a portion of said internal form extending above said depression, applying a concrete body to an upper portion of said form, seating an annular external form on the earth at a higher elevation than the lowermost portion of said depression and surrounding a portion of said internal form in spaced relationship, securing said external form against movement relative to said internal form, introducing concrete between said forms and over exposed portions of said internal form to define with said body a structure containing an opening, and removing said forms after said concrete becomes self supporting.

5. A method of producing a concrete structure comprising forming in the earth a depression having a vertical cross section approximatmg a circular segment of predetermined radius, seating in said depression an inflatable flexible internal form having a substantially circular vertical cross section of corresponding radius with a portion of said internal form extending above said depression, casting a concrete body on an upper portion of said form, seating an annular external form on the earth at a higher elevation than the lowermost portion of said depression and surrounding a portion of said internal form in spaced relationship, securing said external form against movement relative to said internal form, introducing concrete between said forms and over exposed portions of said internal form to define with said body a structure containing an opening, and removing said forms after said concrete becomes self supporting.

6. A method of producing a concrete structure comprising forming in the earth a depression having a vertical cross section approximating a circular segment of predetermined radius, seating in said depression an inflatable flexible internal form having a substantially circular vertical cross section of corresponding radius with a portion of said internal form extending above said depression, seating an annular external form on the earth at a higher elevation than the lowermost portion of said depression and surrounding a portion of said internal form in spaced relationship, applying spaced plastic bodies of concrete between a portion of the space defined by said forms and over an upper portion of said internal form to secure said forms against movement relative to said depression, and subsequently introducing concrete between said bodies to define a structure containing an opening, and removing said forms after said concrete becomes self supporting.

7. A method of producing a concrete structure comprising forming in the earth a depression having a vertical cross section approximating a circular segment of predetermined radius, seating in said depression an inflatable flexible internal form having a substantially circular vertical cross section of corresponding radius with a portion of said internal form extending above said depression, seating an annular external form on the earth at a higher elevation than the lowermost portion of said depression and surrounding a portion of said internal form in spaced relationship, securing said forms against movement relative to said depression, introducing concrete between said forms and over exposed portions of said internal form to define a structure containing an opening, deflating said internal form after said concrete becomes self supporting, removing said external form, and removing said internal form through said opening.

8. A method of producing a concrete structure comprising forming in the earth a depression having a vertical cross section approximating a circular segment of predetermined radius, seating in said depression an inflatable flexible internal form having a substantially circular vertical cross section of corresponding radius with a portion of said internal form extending above said depression, seating an open top annular external form of less height than said internal form on the earth at a higher elevation than the lowermost portion of said depression and surrounding a portion of said internal form in spaced relationship, securing said forms against movement relative to said depression, introducing concrete through the open top of said external form between said forms and over exposed portions of said internal form to define a structure containing an opening, and removing said internal form after said concrete becomes self supporting.

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