

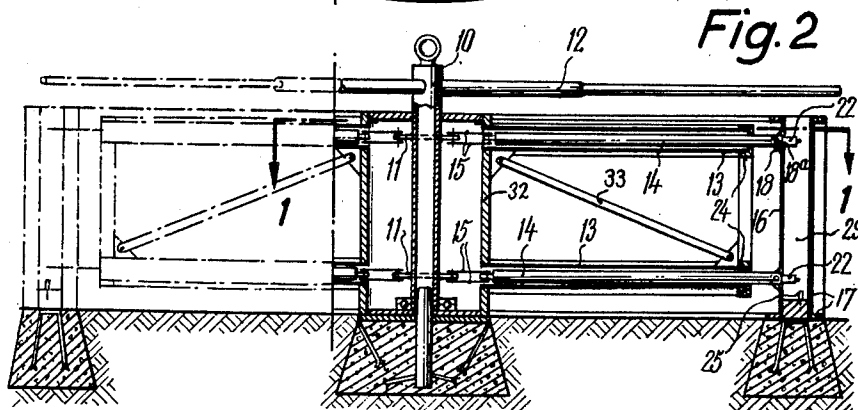
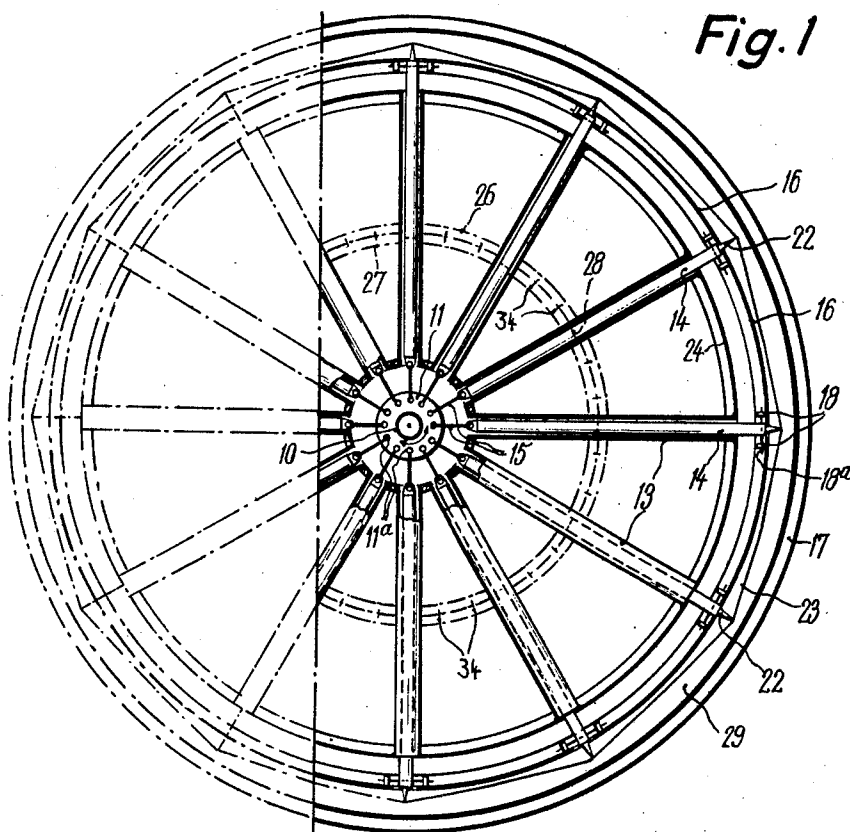
April 27, 1965

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FORMWORK FOR MANUFACTURING PRESTRESSED
HOLLOW CONCRETE BODIES

3,180,000

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2 Sheets-Sheet 1



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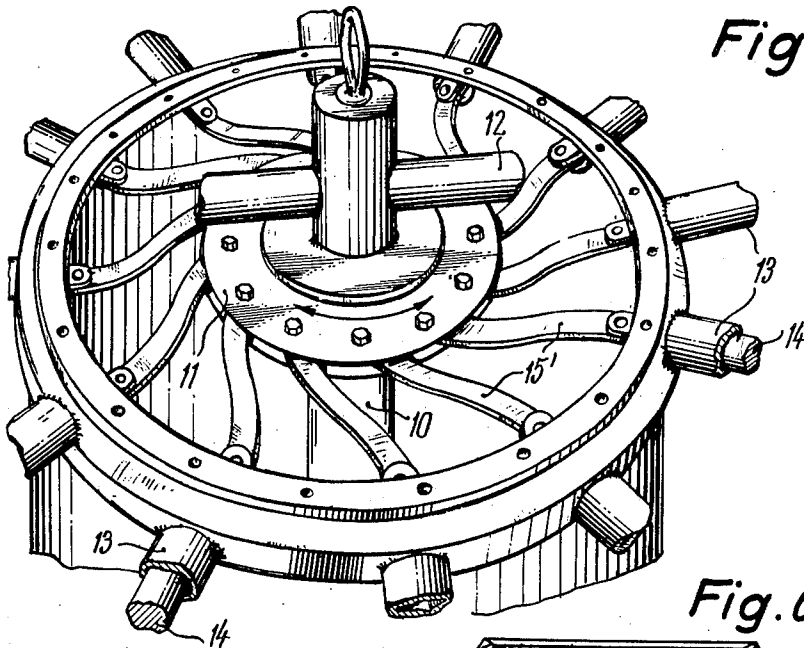


Fig. 5

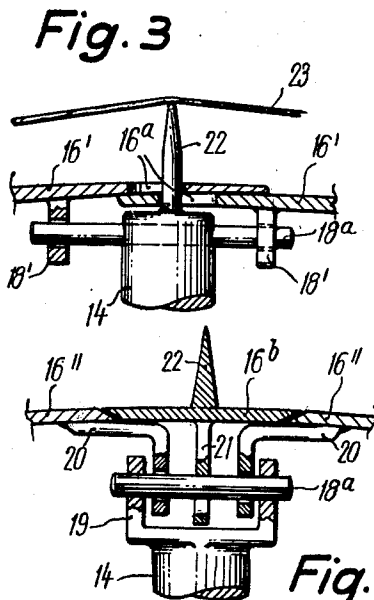


Fig. 3

Fig. 4

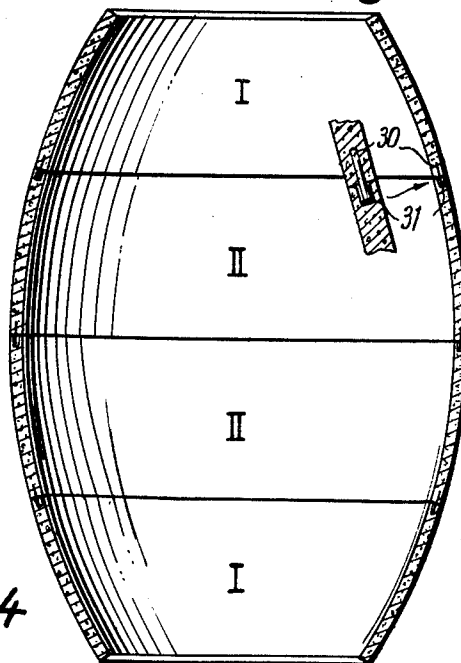


Fig. 6

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FORMWORK FOR MANUFACTURING PRE-STRESSED HOLLOW CONCRETE BODIES

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1 Claim. (Cl. 25—130)

This invention relates to a formwork for manufacturing cylindrical or cylinder-like hollow bodies of concrete.

Concrete containers have previously been made either by casting in a formwork which defines a cavity of a shape corresponding to that of the finished container or by means of a sliding or climbing formwork. Whereas the first-mentioned process requires a large expenditure of time and material for constructing the formwork, the second process involves a large expenditure because the formwork must be raised in increments and because the liquid concrete must be lifted to progressively increasing heights as the container is being built up.

It has not been possible before to manufacture relatively large containers by assembling prefabricated hollow-cylindrical or hollow cylinder-like concrete elements because an economically efficient manufacture of these elements is possible only up to a diameter of about three meters.

It is an object of the invention to provide a formwork which enables a rapid and economical manufacture of hollow-cylindrical or hollow cylinder-like bodies of concrete even with diameters exceeding 3 meters.

A formwork for manufacturing cylindrical or cylinder-like hollow bodies of concrete which comprises a stationary outer formwork wall and an inner formwork wall is designed according to the invention to permit of a radial expansion and contraction of the inner formwork wall. The inner formwork wall comprises preferably a plurality of sections consisting of sectors of a hollow cylinder, which are suspended from radially displaceable rams so as to be tangentially displaceable. Prestressing teeth are provided, extending through openings in the inner formwork wall, which teeth hold prestressing wires disposed in the mold cavity defined between the respective formwork walls. When concrete is poured between the inner and outer formwork walls, the prestressing wires, which are stressed rectilinearly between the adjacent teeth, insure the manufacture of a prestressed hollow concrete body.

Containers are manufactured from such hollow bodies by superimposing the cylindrical or cylinder-like hollow bodies of concrete which have been manufactured with the formwork according to the invention and connecting said bodies by suitable means.

Further advantages and details of the invention will be apparent from the subsequent description of an illustrative embodiment shown on the accompanying drawings, in which

FIG. 1 is a top plan view of the formwork according to the invention partly in section taken on line 1—1 of FIG. 2.

FIG. 2 is a vertical sectional view taken through the center of FIG. 1 and through the axis of a ram shown in FIG. 1.

FIG. 3 shows an embodiment of the joint between two sections of the inner formwork wall with prestressing teeth and prestressing wire on an enlarged scale.

FIG. 4 shows another embodiment of the joint between two sections of the inner formwork wall with prestressing teeth also on an enlarged scale.

FIG. 5 is an enlarged perspective view showing the upper turntable of the formwork according to the invention in an intermediate position and

FIG. 6 is a transverse sectional view showing a container manufactured by the process according to the invention.

As shown in FIGS. 1 and 2 and in FIG. 5, the formwork according to the invention comprises two circular turntables 11, which have twelve holes 11a spaced around a circle. These turntables are firmly connected one to the other and to one or more lever arms 12 by a hollow shaft 10. The hollow shaft 10 is mounted in a ball bearing at its lower end and is centered by a pin, which is embedded in the concrete foundation of the formwork. Twelve connecting-rods 15 are pivoted by means of pins to the turntables 11 and at their other ends are connected to radially outwardly extending rams 14, which are slidably mounted in radially extending guide tubes 13.

A pivotal movement of the lever arm 12 will cause a radial displacement of the rams 14.

The guide tubes 13 are connected at their outer ends by bar-section iron rings 24 extending around the formwork. To afford a firm mounting for the rams 14, the guide tubes are connected to each other by cross-members 33 and are secured at their inner ends to a metal cylinder 32 screw-connected to the foundation.

The inner formwork wall or skin, which is preferably cylindrical and consists of a plurality of sections 16, is suspended from the ends of the rams 14. Liquid concrete is poured between this expanded inner skin and a stationary outer formwork wall or skin 17. To enable the lifting of the set concrete body out of the formwork, the inner skin is drawn inwardly by a suitable operation of the lever arm 12. Because the shrinkage of the concrete has caused the concrete body to detach also from the outer skin, the body can now be lifted out of the formwork with the aid of hoists engaging hooks or the like embedded in the concrete.

Special means are required for mounting the inner skin on the rams 14 because the periphery of the inner skin varies when the rams are retracted or extended. For this reason, the skin consists of separate sections 16, which are suspended from the rams in such a manner that the sections 16 can be tangentially displaced to some extent.

In one embodiment, shown in FIG. 3, the skin is assembled from separate sections 16', which overlap at the joints, to allow for an increase in its circumference when the skin is being expanded. Close to their ends, the skin sections 16' have welded eyelets 18', with which they are slidably suspended from pins 18a tangentially protruding from both sides of the rams 14.

In the embodiment shown in FIG. 4, the end of the rams 14 is forked (19). The two prongs of the fork are interconnected by a pin 18a, on which two angle members 20 are slidably mounted. Each of said angle members is welded to one skin section 16'. In this embodiment a gap is defined between two sections 16'' of the expanded skin and a cover strip 16b is inserted between the two sections 16'' to prevent a leakage of liquid concrete out of the formwork. The cover strip 16b may be omitted, however, if a covering of V2A sheet steel is laid around the expanded inner skin to form a lining of the finished concrete body, as is desirable in many cases. FIGS. 3 and 4 show the joint between two sections of the expanded skin.

A special advantage of the formwork according to the invention resides in that it facilitates the manufacture of cylindrical hollow bodies of prestressed concrete. For this purpose, prestressing teeth 22 (FIGS. 1, 2, 3, 4) are provided, which are either secured to the ends of the rams 14 and extend through appropriately shaped slots 16a in the sections 16' of the inner skin (FIG. 3) or are mounted on the cover strips 16b (FIG. 4), each cover

strip being supported against the pins 18a by connecting members 21. Prestressing wires can be extended in a polygonal configuration around all prestressing teeth 22 while the formwork is retracted. An expansion of the formwork will then subject the prestressing wires 23 to a strong tension. Concrete is now poured into the space 29 between the skins 16 and 17. When the concrete has set, the prestressing teeth may be removed from the concrete or may remain embedded in the same if they were only loosely mounted on the rams or cover strips.

This process of manufacturing hollow cylindrical or hollow cylinder-like bodies of reinforced concrete has the advantage that the prestressing wires are extended in a polygonal rather than circular configuration, in which they would tend to cut into the concrete. This is avoided by the arrangement according to the invention.

It is obvious that more than two prestressing wires may be extended if appropriate connections are provided between the ends of upper and lower rams.

In a preferred embodiment, the guide tubes 13 have a joint as at 28 in FIG. 1. In this case, the guide tubes on both sides of the joint are interconnected by bar-section iron rings 26 and 27. These two rings are detachably interconnected by bolts 34.

This enables the combination of that part of the formwork which consists of the turntables 11, the shaft 10, the lever arm 12, the connecting rods 15 and the inner part of the guide tubes 13 with outer parts and skins of various sizes. The rams 14 have a screw-threaded joint at 28, to enable a replacement of their outer parts, or the entire rams are replaced when another skin is to be attached to them.

The upper rams and guide tubes may be longer than the lower ones and the skin may be curved when seen in the section shown in FIG. 2 to enable the manufacture of cylinder-like hollow bodies, e.g., of conical or barrel shape.

The rams 14 and guide tubes 13 disposed in one plane may also differ in length to enable the manufacture of hollow bodies having a non-circular, e.g., oval cross-section.

The connecting-rods 15 are shown in FIG. 1 as straight links but consist preferably of S-shaped links 15' (FIG. 5), which can interleave more easily when the skin is retracted and which enable a better transmission of the pushing force. FIG. 5 shows the turntable 11 in an intermediate position. The arrows indicate the directions of rotation which are possible.

To assemble a container, e.g., a silo, a plurality of hollow concrete bodies made with the formwork according to the invention are superimposed. The movable hoists now available are capable of lifting loads of up to 40 tons. This is approximately the weight of a cylindrical concrete building element made with the formwork according to the invention and having a diameter of 25 meters. Portal cranes, which can carry even heavier weights, enable the construction of containers having even larger diameters.

The alignment of the superimposed hollow-cylindrical or hollow cylinder-like concrete elements may be insured, e.g., by pins 30 and tubular members 31 embedded in the concrete (FIG. 6). Core elements 25 (FIG. 2) are secured to the formwork to insure that the recesses required for aligning will be formed in the concrete. It is obvious that the alignment can also be achieved with the aid of stepped rims or similar provisions.

A container or silo shown in FIG. 6 is manufactured as follows: A formwork for making the elements I in FIG. 6 is first constructed by the mounting of appropriate rams and guide tube parts at 28 (FIG. 1), suspending appropriate skin sections and providing an outer skin.

This formwork is used to make two concrete elements having the shape I or a plurality thereof, when a plurality of containers are to be constructed. The central part of the formwork is then separated at 28 in FIG. 1 and is assembled with another outer part, which is suitable for the shape II in FIG. 6. Two prefabricated concrete elements having the shape II are now made for each container. When all parts have been made, they are superimposed as shown in FIG. 6 and connected by suitable means.

It may be pointed out that the transmission of torque to the turntable 11 may be effected by a reducer gear unit or by a motor. In a practical embodiment, it has been found, however, that the lever arrangement shown in FIG. 2 can easily be operated by two men.

This process, which serves preferably for the manufacture of exactly cylindrical containers or silos or for making containers of a different shape, e.g., that shown in FIG. 6, permits of erecting containers at much smaller costs and within much shorter times than with known formworks for manufacturing containers.

I claim:

A formwork for manufacturing prestressed hollow concrete bodies, comprising:

- (a) a stationary outer mold shell;
- (b) an inner mold shell consisting of a plurality of shell sections having tapered, overlapping edge portions separated by intermediate gaps;
- (c) vertically extending cover strips covering the gaps between the edge portions of said shell sections;
- (d) prestressing teeth mounted on said cover strips and extending into the mold to hold prestressing wires surrounding said inner mold shell;
- (e) a plurality of radially extending stationary guide tubes having rams slidably supported therein, each of said rams being connected with its outer end to the ends of two adjacent shell sections and to one of the cover strips so that the shell sections can slightly displace tangentially and the cover strips can slightly displace radially relative to said ram;
- (f) connecting rods having outer ends individually secured to the inner ends of said rams;
- (g) a pivotable disc disposed centrally of the formwork and being pivotally connected to the inner ends of said connecting rods; and
- (h) an operating means for turning said disc and effecting expansion or contraction of said shell sections, the operating means automatically stressing the prestressing wires when actuated to effect expansion of said rams and of said shell sections.

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