

Sept. 20, 1966

L. KESTING

3,274,306

METHOD FOR CASTING CONCRETE STRUCTURES

Filed Jan. 8, 1964

9 Sheets-Sheet 1

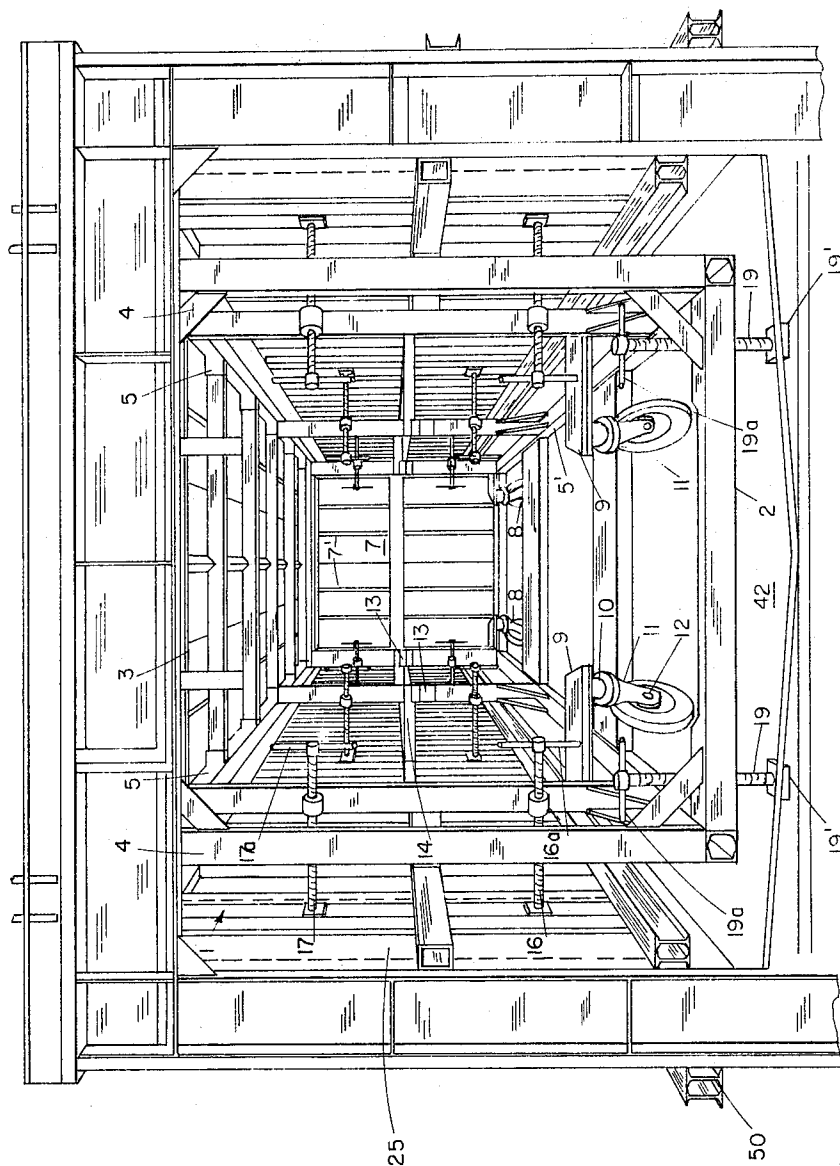


FIG. 1

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9 Sheets-Sheet 2

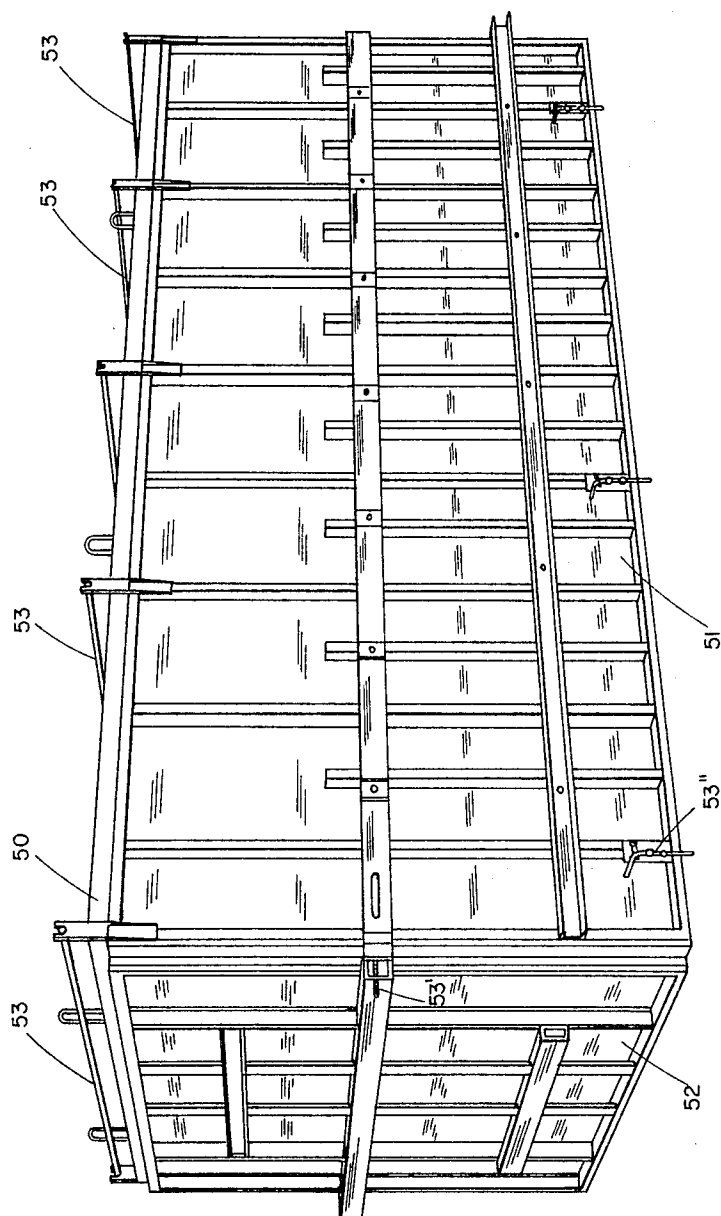


FIG. 2

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9 Sheets-Sheet 3

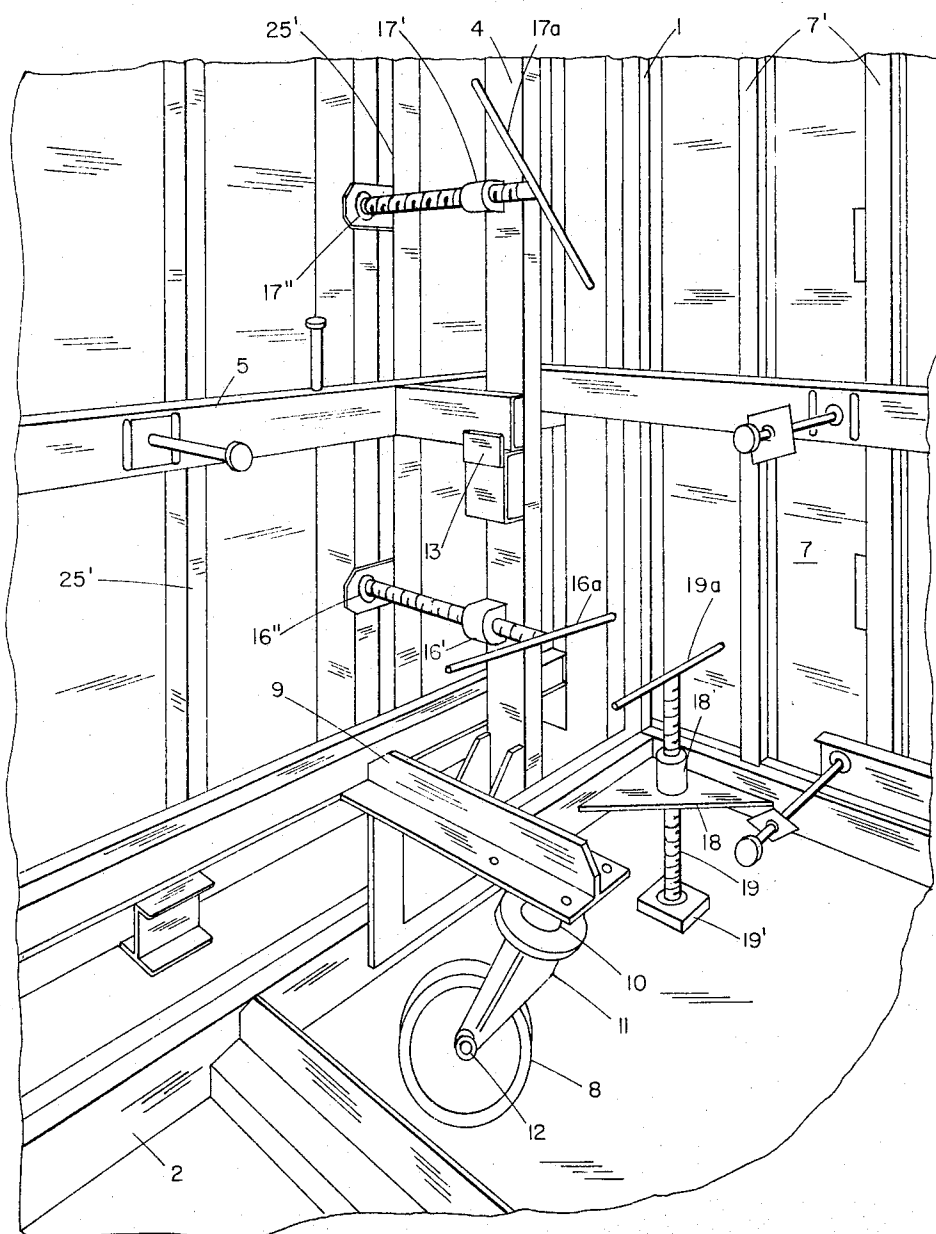


FIG. 3

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9 Sheets-Sheet 4

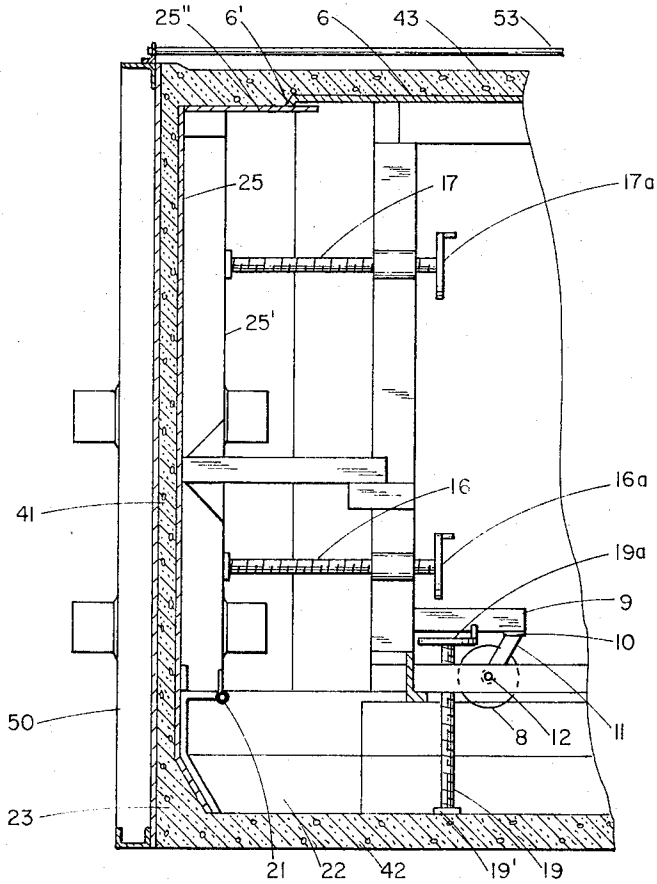


FIG. 4

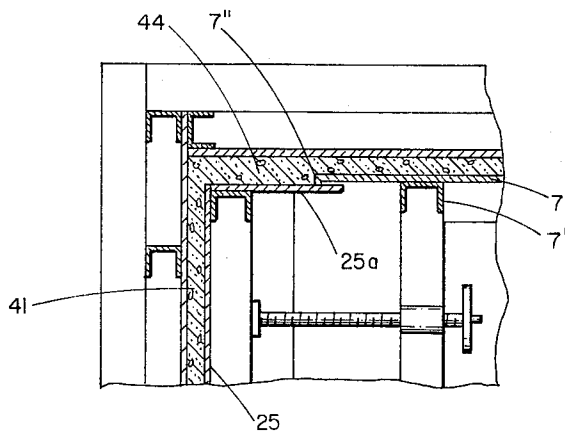


FIG. 5

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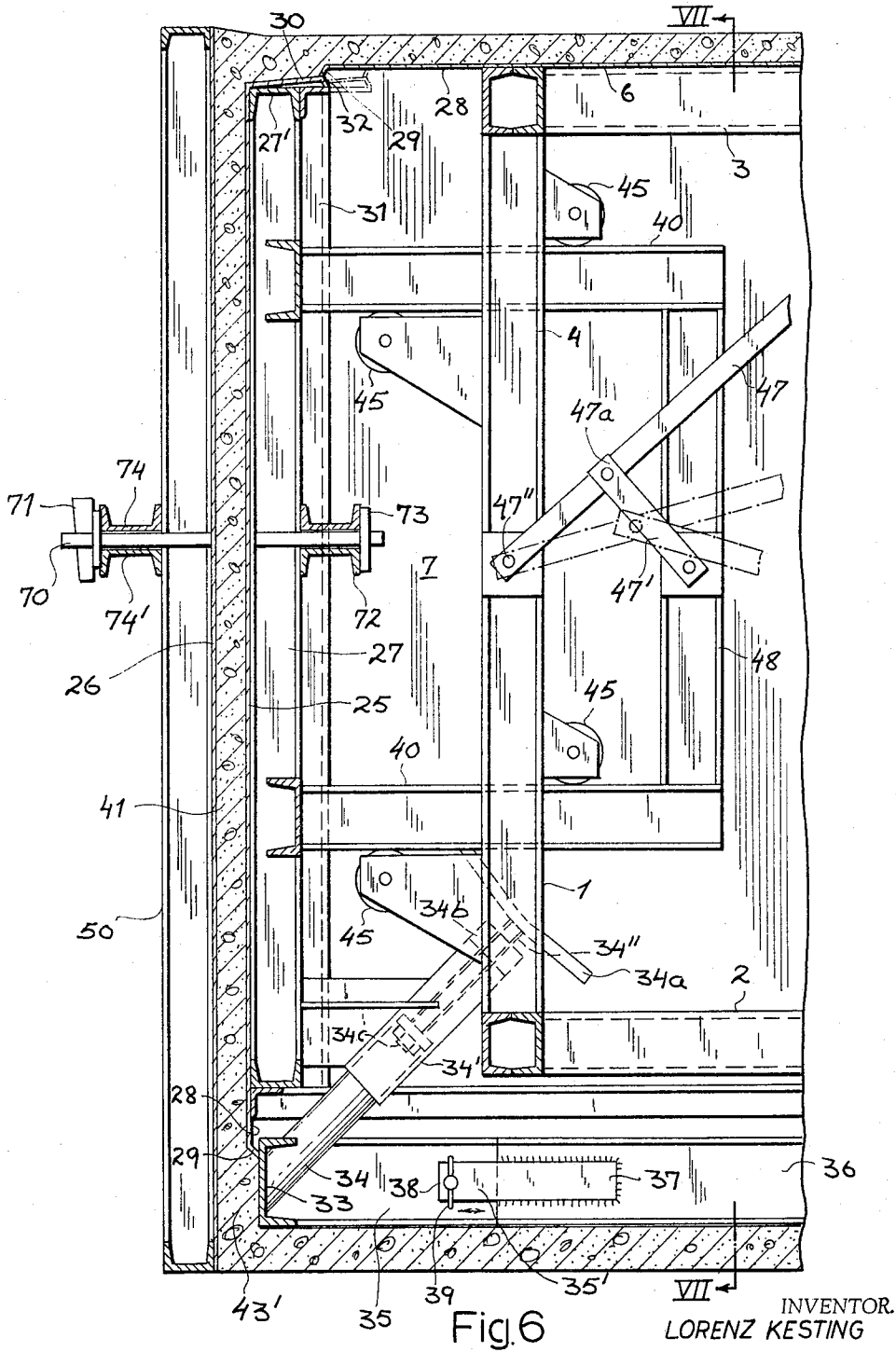
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**3,274,306**

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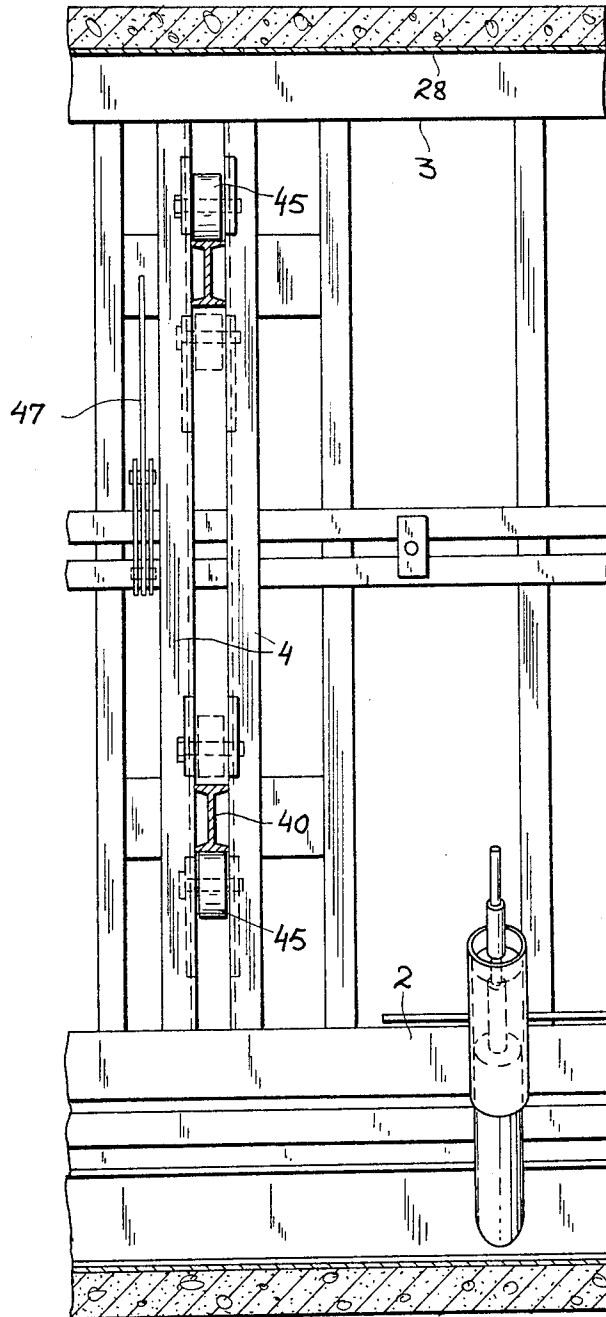


Fig. 7

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9 Sheets-Sheet 7

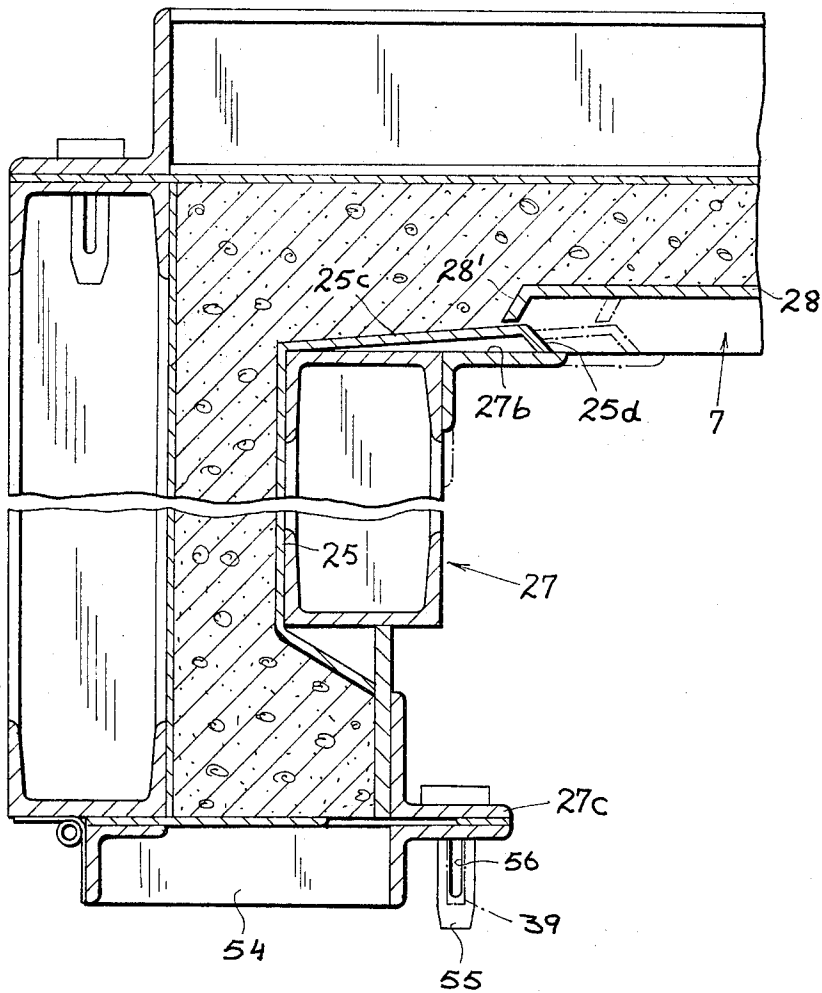


Fig. 8

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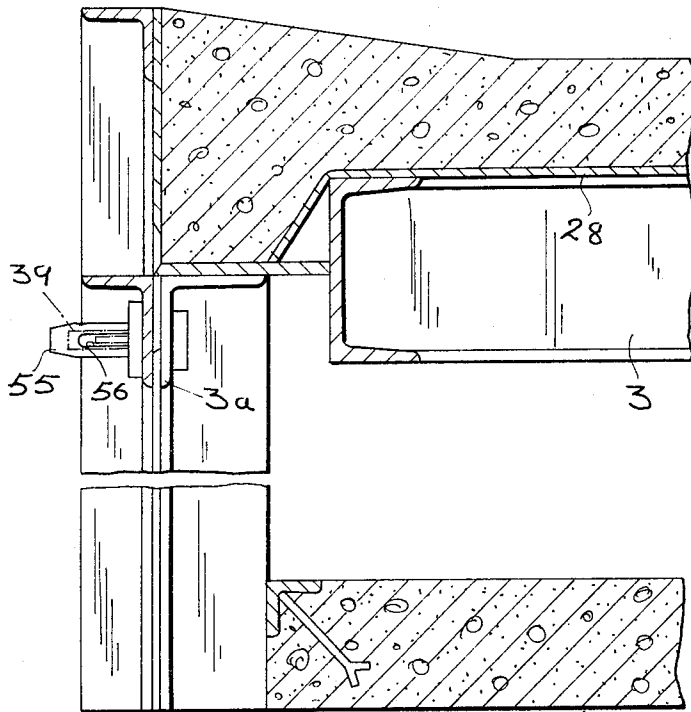


Fig. 9

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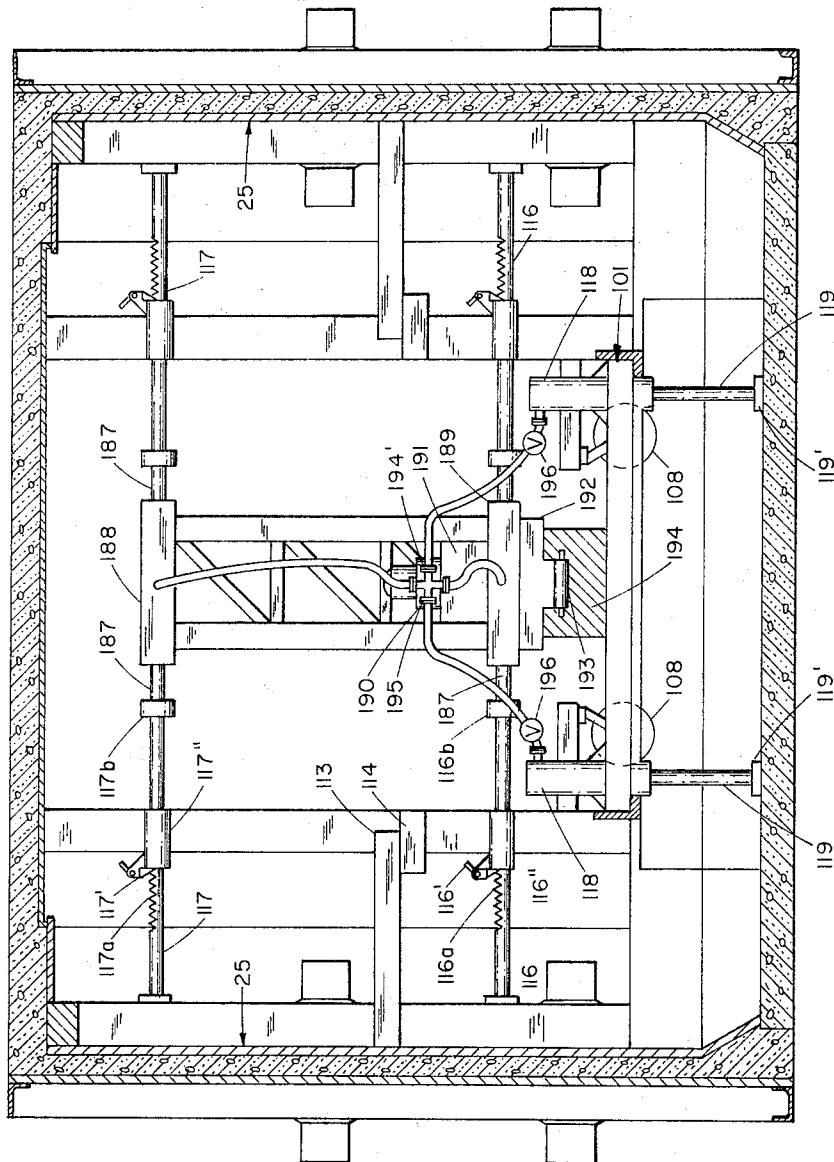


FIG. 10

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## 3,274,306 METHOD FOR CASTING CONCRETE STRUCTURES

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Claims priority, application Germany, Jan. 9, 1963,  
B 70,264

2 Claims. (Cl. 264—34)

My present invention relates to a method for the casting of concrete structures and, more particularly, to the formation of substantially monolithic concrete structures having one or more angularly adjoining walls.

The construction of large, space-enclosing structures from concrete has been carried out heretofore generally by the erection of inner and outer falsework from a multiplicity of mold boards and the like at the site at which the building or structure is to be located. This method of construction, wherein the concrete is poured between the form boards and the latter are removed upon setting of the concrete and discarded or gathered for re-erection at another location, is highly expensive and time consuming. The costs of this type of falsework must include replacement of falsework damaged in the disassembly and re-erection as well as the cost of those portions of the falsework which cannot be reused because of cutting or shaping to produce structures of various sizes. In order to reduce the expenses and inefficiencies of these conventional methods, it has been proposed to employ prefabricated inner and outer falsework, constituted by wall-size plates or the like which are joined together at the building site to form the concrete mold. Concrete forms of the latter type are generally inconvenient when a monolithic concrete structure, having angularly adjoining walls and roof, is to be produced because of the difficulties involved in disassembling the larger plates. Additionally, it is frequently necessary to cast the upright portions or walls of the structure directly on a concrete slab constituting a base or foundation for the superstructure. To ensure effective joining of this superstructure to the base it has hitherto been necessary to provide the latter with a peripheral channel or socket into which concrete of the wall portions of the structure is poured to provide a male formation received within the female formation or socket. This type of construction involved considerable difficulties with regard to the formation of the socket since it was not possible simply to pour and strike off the slab surface.

It is, therefore, the principal object of the present invention to provide a method for the production of cast concrete structures wherein the aforementioned disadvantages can be avoided.

A further object of this invention is to provide a method of monolithically casting large space-enclosing structures of concrete having angularly adjoining walls and/or roof portions.

Still another object of this invention is to provide a method for the casting of concrete walled structures upon slab foundations wherein the necessity for socket-forming peripheral channels in the slab, as required heretofore, is eliminated.

According to one aspect of the present invention, the foregoing objects are attained by a method of casting concrete structures wherein a displaceable falsework-forming body is disposed upon a preformed foundation slab and wall-size form members or panels, mounted upon this body, are spread outwardly and juxtaposed with outer form members to provide a mold compartment adapted to receive the concrete. Concrete is then cast in these chambers and permitted to set, whereupon the outer form members are removed, the inner members retracted and the falsework body in its entirety shifted out of the con-

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crete structure thus produced. The foundation slab can be cast at the construction site by conventional methods without the formation of a socket or channel therein so that the inner-form body can, as a unit, be disposed upon this slab and its panel members spread to the desired inner dimensions of the structure. In general, it is desirable to provide the inner-form members with means for removably connecting the outer-form members to them so that, prior to casting of the structure, both sets of form members are mounted upon the movable body disposed on the slab.

An important feature of the present invention involves the provision of means on the inner-form body adapted to produce a downwardly and inwardly enlarged and preferably tapering footing adjacent the foundation slab, this footing obviating the need for a socket and providing a large supporting surface at the junction between the upright walls of the structure and the horizontal slab so as to prevent relative movement of the slab and the superstructure and any passage of fluid between the interior and exterior of the structure along this junction. The increased contact surface thus provided also ensures some degree of bonding to the foundation slab when the latter is composed of concrete. To this end the inner-form body may be provided with a downwardly and inwardly inclined mold plate along its lower peripheral portion, this plate being shiftable inwardly and outwardly, at an angle to the vertical, by suitable actuating means and co-operating with the adjoining inner-wall form members to produce a downwardly and inwardly widening extension of the casting compartment of the walls.

The inner-form body comprises a generally rectangular framework mounted upon antifriction means for facilitating its displacement to the construction site and away therefrom, this framework supporting the inner-wall form members and, preferably, the inner-roof form member. According to a more specific feature of this invention, at least one inner-wall form member of each pair of opposite inner members is joined to the framework by displacing means for shifting the respective member outwardly with respect to the framework so that the distance between opposite inner wall members can be brought to the required inner dimension of the completed structure. The framework itself can be provided with a plurality of spaced pedestals (e.g. disposed at corners of the framework) also carried by displacing means upon which the framework can be raised to determine the height of the roof-form panel. Thus the roof-forming panel is shifted vertically together with the framework while the wall-forming panels can be displaced laterally with respect to the framework. More particularly, I have found that excellent results are obtained when the framework is provided with a plurality of inwardly directed supports carrying swivelable casters forming the antifriction means and facilitating the manipulation of the framework. The latter, which is generally prismatic, can have a rear wall-forming panel affixed thereto and a pair of shiftable lateral panels along the sides of the framework adjoining the rear panel and the roof panel mentioned above. One end of the framework can thus be free from any form panel in order to permit the withdrawal of the inner-form body through the opening remaining at this end of the structure. The mold plate adapted to form the footing of the walls is either provided integrally with the wall panels or can be movable relatively thereto and preferably at an angle to both the horizontal and vertical planes. The displacing means for the wall panels and the framework on the pedestals can be fluid-responsive (i.e. hydraulic) or manually manipulable and constituted by simple mechanical means. According to one embodiment of the present invention, the displacing means for shifting the lateral panels relatively to the framework includes a plurality of threaded spindles re-

ceived within threaded bosses on framework uprights and formed with a handle permitting rotation of the spindles to shift the lateral panels outwardly for setting up the mold or withdrawing them inwardly upon setting of the concrete. Similarly, the displacing means for the framework upon the pedestals can include threaded spindles received in bushings affixed to the lower framework elements. The orthogonally adjoining elements of the lower frame portion can, according to the present invention, be reinforced by triangular webs at their corners, the webs being formed with the bosses in which the spindles are threaded. Alternatively, a toggle linkage can be interposed between the frame uprights and the lateral panels to shift the latter by lever action. In general, I have found that it is important to support the lateral panels at least at two vertically spaced locations in addition to a plurality of longitudinally or horizontally spaced locations. Thus, when spindles constitute the displacing means, they can be provided in vertically spaced coplanar pairs, whereas, when a toggle linkage is employed, at least two vertically offset guide elements can be provided at each support location of the lateral panels. The vertically spaced guide elements can each cooperate with a pair of rollers, spaced in the direction of displacement of the lateral panels, engaging the guide element or rail affixed to the panel on opposite sides of this rail in the vertical plane thereof so that the weight of the lateral panels holds the rails in engagement with both of the rollers of each pair.

According to a more specific feature of the present invention, at least one of each pair of adjoining panels is provided with a resilient formation of sheet material elastically bearing upon the other panel for maintaining a seal at the junction between them in all relative positions of the panels in which they are contacted. Thus the roof panel can include downwardly directed flanges along its periphery resiliently bearing upon an inwardly directed flange at the upper portion of each of the lateral panels either one or both of the overlapping flanges being resilient. Similarly, an inwardly directed flange of the lateral panels can resiliently bear upon the mold plate forming the enlarged foot portion at the base of the walls. In all cases, however, the outer-form members can be joined to the inner-form members at external flanges of the latter by slotted connecting plates passing through aligned slots in the inner and outer members and adapted to receive a locking wedge. Similar wedges and clamping elements can be employed to interconnect the outer form members.

Still another feature of the present invention resides in the provision of formations along the periphery of the panels which diverge inwardly so as to impart a wedge-like character to the concrete walls at their junctions and facilitate the withdrawal of the inner panels from the concrete walls upon disassembling of the mold. These wedge-like formations can be constituted by the resilient flanges of the panels described above, the latter adjoining one another at an inclination or at right angles as will be more readily apparent hereinafter. The panels can thus be composed of respective support frames upon which is mounted a sheet-metal plate integrally formed with the flanges, the displacing means acting upon the support frames.

The method for producing concrete structures described above have several important advantages. Firstly it requires only a minimum number of connecting elements of the type as has been required heretofore for the joining of the mold sections; secondly, a significantly reduced amount of labor is needed for the setup and disassembly of the forms and these steps can be carried out with unskilled or semiskilled workers in contradistinction to earlier systems of erecting falsework wherein skilled labor was required; the inner-form body permits the serial production of a large number of similar structures with ease in spite of the fact that successive structures may have different dimensions; and the high-strength structures

produced in accordance with the present invention (as modular units) can be used directly for garages and vacation homes and can be vertically stacked or horizontally aligned to produce multiple-chamber dwelling units and factories.

The above and other objects, features and advantages of the present invention will become more readily apparent from the following description, reference being made to the accompanying drawing in which:

FIG. 1 is a perspective view of a falsework system according to the present invention;

FIG. 2 is a perspective view of the exterior of the falsework;

FIG. 3 is a perspective detail view drawn to an enlarged scale of the corner portion of the inner-form body illustrated in FIG. 1;

FIG. 4 is a vertical cross-sectional view of a portion of the system of FIG. 1 after pouring of the concrete;

FIG. 5 is a detail of the system of FIG. 4 drawn to an enlarged scale and in cross-section;

FIG. 6 is a view similar to FIG. 4 illustrating another embodiment of the present invention;

FIG. 7 is a cross-sectional view taken along the line VII—VII of FIG. 6;

FIG. 8 is a cross-sectional view taken along a horizontal plane through a portion of the system of FIG. 6;

FIG. 9 is a fragmentary cross-sectional view taken in a vertical plane through the roof-forming part of this system; and

FIG. 10 is a view similar to FIG. 4 showing still a further modification of the present invention.

In FIG. 1, I show the generally prismatic skeletal inner-form body, designated with the reference numeral 1, from the open end of a concrete structure formed therearound. The framework 1 is composed of a lower frame portion 2 of rectangular configuration and a similar upper frame portion 3 supported on the lower frame portion by a plurality of longitudinally spaced uprights 4 interconnected at their upper and lower extremities by struts 5 and 5' and spaced apart thereby. As is evident from FIG. 4, the upper frame 3 carries a stationary roof-forming panel 6 of sheet metal while a rear panel 7 is rigidly fixed to another frame structure 7' (FIGS. 1, 3 and 5). The entire framework 2-4 etc. can be elevated as will be apparent hereinafter.

At spaced locations along the inner-form body 1, there are provided inwardly directed support members 9 to which the forks 11 of a corresponding number of casters 8 are pivoted for rotation about respective vertical axes at bearings 10 (FIG. 3). The casters 8 are journaled between the arms of forks 11 on respective axes 12 so that all of the casters can, independently from one another, swing freely about vertical axes to permit a precise positioning of the inner-form body 1 upon a concrete slab 42 (FIGS. 1 and 4).

The body 1 is formed on opposite sides with a pair of outwardly facing wall panels 25 of sheet metal; at the lower portion of these wall-forming panels are hinged at 21 angular mold plates 22 (FIG. 4) which form respective downwardly and inwardly diverging compartments 23 communicating with the main mold compartments 41 provided between wall panels 25 and the sheet-metal surfaces 26 of the outer-form members 50. The downwardly widening chamber 23 produces an enlarged footing at which the wall-forming chamber 41 is joined to the base plate 42. The roof 43 is formed integrally with the side wall 41 and 44 of the completed structure and thus bonded to the foundation slab 42 as will be apparent from FIGS. 4 and 5.

At the four corners of the lower frame portion 2 of the movable body 1, there are provided triangular horizontal reinforcing webs 18 (FIG. 3) whose bushings 18' threadedly receive vertical spindles 19 upon whose pedestals 19' the movable framework 1 is carried. Spindles 19 constitute the actuating means for elevating the frame-

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work and are each provided with handles 19a, serving as levers for facilitating the rotation of the spindles 19 to elevate the framework 1 from the slab 42 (FIG. 4) and thus position the roof panel 6 at the proper height for the formation of the roof 43 of the structure.

It is clear, therefore, that a concrete monolithic structure having large space-enclosing capacities (e.g. of the size of a room or larger) can be produced by manipulating the movable framework 1 onto the base plate 42 and positioning it thereon in the desired relationship to the marginal portions of this slab. The wall panel 45 can then be spread laterally by the rotation of threaded spindles 16 and 17, disposed in vertically spaced pairs and threaded into bushings 16', 17' on uprights 4. These spindles are journaled at 16'', 17'' to a frame member 25' of the front panel 25 and are longitudinally spaced along the framework 1 while having leverage handles 16a and 17a, respectively. Hydraulic means can also be used to spread the lateral panels 25 and to elevate the framework 1 as will be described in greater detail hereinafter. After the framework has been raised to the desired height and the lateral panels 25 are spread to ensure the desired inner dimensions of the structure, the outer-form members 50 can be mounted upon the inner panels to provide the mold compartments therewith.

The outer-form members can (e.g. as illustrated in FIGS. 2, 4 and 5) be composed of shell-like elements 51 along the longitudinal sides of the structure and a further shell element 52 along the rear thereof. Clamps 53 and pins 53', 53'' hold the outer form members in place in the usual manner against the tendency of the concrete to push these outer members away from the inner-form body. After the pouring of concrete and its hardening in the chambers between the inner- and outer-form members, the outer members are removed and the spindles 16, 17 and 19 rotated to withdraw the panels 6 and 25 from the concrete structure and permit the entire body 1 to be pushed out of the structure through its open end on wheels 8. The device can then be repositioned adjacent the completed structure or thereabove, with the roof of the completed structure serving as the foundation slab, whereupon another modular section is produced. From FIGS. 4 and 5, it can be seen that the upper panel 6 is provided with a downwardly turned flange 6' resiliently bearing upon an inwardly directed resilient flange 25'' of the side panels 25 so as to ensure a project cell against the penetration of concrete between the adjoining panels in all relative positions thereof. A similar construction is provided between the rear panel 7 and the side panels 25. In this case, the rear panel is formed with a flange 7'' bearing resiliently upon the inwardly turned flange 25a of side panel 25. In general, these flanges are so constructed that the panels diverge in the direction of their withdrawal from the concrete wall and facilitate the disassembly of the structure. The plate 22, forming the footing 23 at the base of the walls 41 and 44 (FIG. 4), also resiliently bears upon the foundation plate 42 when the mold plate 22 is in its position illustrated in FIG. 3. When it is necessary to remove the forms, plates 22 can be swung about the respective hinges 21.

In FIGS. 6-9, I show another embodiment of the present invention wherein, however, identical reference numerals refer to parts corresponding to those of the system of FIGS. 1-5. In this case the framework 1 is again provided with a sheet-metal roof panel 6 and a rear panel 7 mounted upon respective frameworks, the framework 3 again being joined to the lower framework 2 by uprights 4. As will be apparent from FIGS. 6 and 7, the uprights 4 are provided in pairs and guide between them the vertically spaced supporting elements 40 of FIG. 2 at frame 27 upon which the movable latter panel 25 is mounted. Panel 25 is juxtaposed with the outer form member 26 whose frame 50 is secured to the frame 27 by a plate 70 which is clamped by a wedge 71, pass-

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ing through a slot therein against a girder 72 at the vertical pin or head 73 of this plate 70. Plate 70 extends transversely to the panels 25 and 26 in a horizontal plane and passes through the clearance between a pair of channels 74, 74' affixed to the framework 50 of the outer member. Plate 70 can extend directly through the wall 41 or bypass the latter at one of its extremities.

At the junction between the panel portions of the device, the panels are formed with resilient flanges as previously described. Thus, an inwardly turned resilient flange 29 may be provided along the cantilevered lower edge 28 of the lateral panels 25 (FIG. 6), this flange being inclined inwardly and downwardly and adapted to abut against the mold plate 33 for forming an enlarged footing 43' at the base of wall 41. This form plate 33 is movable with its mold surface parallel to that of panel 25 at an angle to the vertical and the horizontal defined by a guide 34 slidable within a sleeve 34' and shiftable by displacing means including a threaded spindle 34'' having a handle 34a and threadedly received in a bushing 34b of sleeve 34'. The spindle 34'' is rotatably journaled at 34c to the guide 34. The mold plate 33 is constituted as a generally L-shaped frame having angular arms 35 affixed thereto and telescopically joined to the corresponding lower form member 36 disposed below the rear panel 7. Both of these members are of channel-shaped cross-section and are relatively slidable, as indicated in FIG. 6 so that a fish plate 35' on arm 35 is slidable into a pocket 37, a bolt 38 interconnecting the arm 35 in member 36 for locking these members in place by a wedge 39 driven into a slot in bolt 38.

At the upper end of frame 27, the front panel 25 is provided with an inwardly turned resilient flange 30 diverging inwardly and having a resilient supporting edge 32 bearing against the upper frame member 27'. A cantilevered portion 26 of the roof panel 6 bears resiliently against the flange 30 via another flange 29 which also constitutes an inwardly and upwardly directed formation imparting to the panels at their junction an inwardly diverging configuration facilitating the removal of the panel in the inward direction while sealing the joints against passage of concrete.

The guide elements 40 are each supported by pairs of rollers 45 journaled between the paired uprights 4 on opposite sides thereof and in engagement with the elements 40 at vertically offset locations. These elements 40 constitute arms which are interconnected by a cross-piece 40a to which is pivoted one link 47' of a toggle mechanism 47 whose fulcrum is located at 47'' on an upright 4, the link 47' being articulated to the lever 47 at 47a. When lever 47 is swung in the clockwise direction, the lateral panel 25 is shifted to the left (FIG. 6 and vice versa). In FIG. 8 it will be seen that the rear panel 7 also has a cantilevered portion 28 lying in a vertical plane and formed with a flange 28' resiliently bearing upon the resiliently yieldable and inwardly directed flange 25c of channel 25, the latter resting at 25d against the outer surface 27b of frame 27. Thus even at the vertical joints, separation of the panels and their removal from the concrete walls are facilitated. It can also be seen from FIGS. 8 and 9 that the outer-form members 50, 54 etc. are joined to further flanges 27c and 3a of frames 27 and 3 respectively by T-shaped plates 55 whose longitudinal slots 56 accommodate wedges illustrated diagrammatically at 39 and similar to that shown in view at 71. This unit is assembled and disassembled in a manner similar to that previously described with respect to the embodiment of FIGS. 1-5.

In FIG. 10 I show another system wherein the framework 101 carries, at its corners, casters 108 as previously described and four hydraulic cylinders 118 whose pistons 119 are mounted upon pedestals 119' for elevating the frame 101. The lateral panels 25 are each provided with a plurality of guides 113, 114 supporting them for lateral

movement and laterally displaceable spindles 116, 117 which are toothed at 116a, 117a for co-operation with a releasable detent means such as locking pawls 116', 117' which fall by gravity into the successive notches of bars 116, 117 as the latter are shifted outwardly to prevent their inward displacement by the concrete. Bars 116 and 117 are guided in respective bushings 116'', 117'' and are formed with heads 116b, 117b engageable by the respective pistons 185, 187 of vertically aligned double-acting hydraulic cylinders 188, 189, a plurality of sheets of which are provided longitudinally along the structure to displace the longitudinally spaced sets of bars 116, 117, when hydraulic fluid is fed by a pump 190 from a reservoir 191 to these cylinders. The cylinders 188, 189 etc., pump 190 and reservoir 191 are mounted upon a carriage 192 which is displaceable on rollers 193 along a track 194 extending through the body 101 so that the hydraulic system can be removed after setting of the panels and their locking by pawl 116', 117' for use in positioning the panels of other falsework frame works. Hydraulic couplings 194, 195 can supply fluid to the hydraulic cylinder 118 via valves 196 to elevate the frame work. Various hydraulic systems and locking devices other than those described can obviously be used in accordance with the present invention. Thus, each of the elements 116, 117 can be provided with a respective cylinder nonremovably associated with it, if desired.

The invention described and illustrated is believed to admit of many modifications within the ability of persons skilled in the art, all such modifications being considered within the spirit and scope of the appended claims.

I claim:

1. A method of producing concrete structures having a plurality of angularly adjoining walls, comprising the steps of:

- (a) forming a generally flat concrete foundation slab having a plurality of edges;
- (b) disposing a movable inner-form body having spreadable upright wall-forming panels and a roof-forming panel upon said foundation slab;
- (c) shifting said wall-forming panels laterally to dispose them substantially in the region of said edges of said foundation slab and affixing outer-form members to said body in spaced relationship with said panels so as to define therewith mold chambers for the roof and walls of a structure to be cast with said mold chambers terminating at said edges of said slab;
- (d) pouring concrete into said chambers and permitting said concrete to set therein to form walls of said structure in situ substantially contiguous with

said slab and a roof substantially monolithically connected with said walls;

- (e) detaching said outer-form members from said body and withdrawing said panels inwardly on said body from engagement with the walls and roof of the structure formed upon setting of said concrete; and
  - (f) shifting said body unitarily with said panels thereon out of said structure.
2. The method defined in claim 1, further comprising the steps of:
- (g) laterally elevating said body to raise said roof-forming panel preparatorily to the mounting of said outer-form members on said body to provide a structure having an interior cavity whose dimensions are greater than the corresponding dimensions of said body in a retracted state of said wall-forming panels and a lowered condition of said roof-forming panel;
  - (h) laterally displacing a respective mold-plate member along a lower edge of each of said wall-forming panels so as to define with a juxtaposed outer form member along a respective edge of said slab a downwardly enlarged footing adjoining said slab at the base of the respective wall upon setting of the concrete, said wall-forming panels being shifted in step
  - (c) laterally beyond the outline of said slab and said mold-plate member extending inwardly and downwardly from the respective wall-forming panels; and
  - (i) overlapping the edges of adjoining ones of said panels with resilient interengagement prior to the pouring of said concrete into said chamber to prevent the passage of concrete between the adjoining panels.

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J. A. FINLAYSON, JR., *Assistant Examiner*.