

FIG. 4

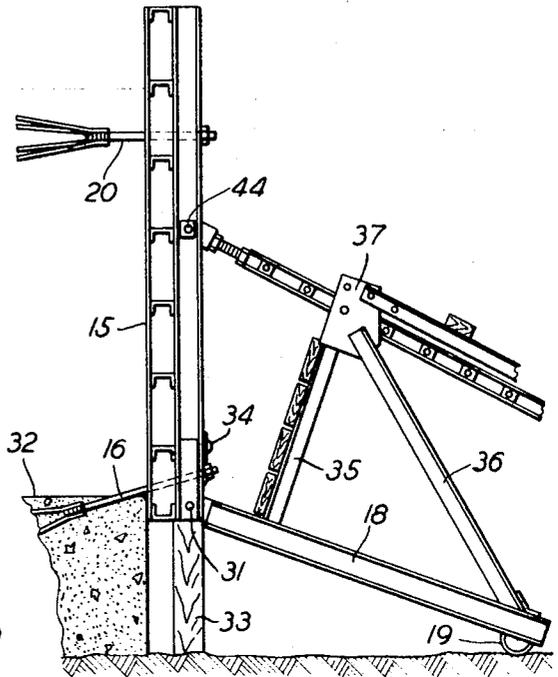


FIG. 5

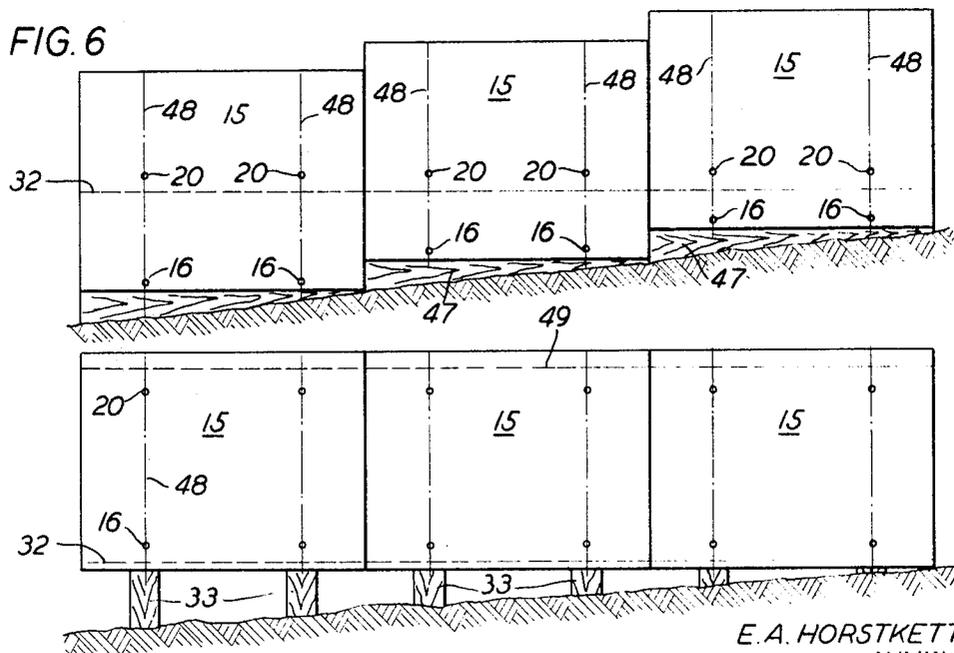


FIG. 7

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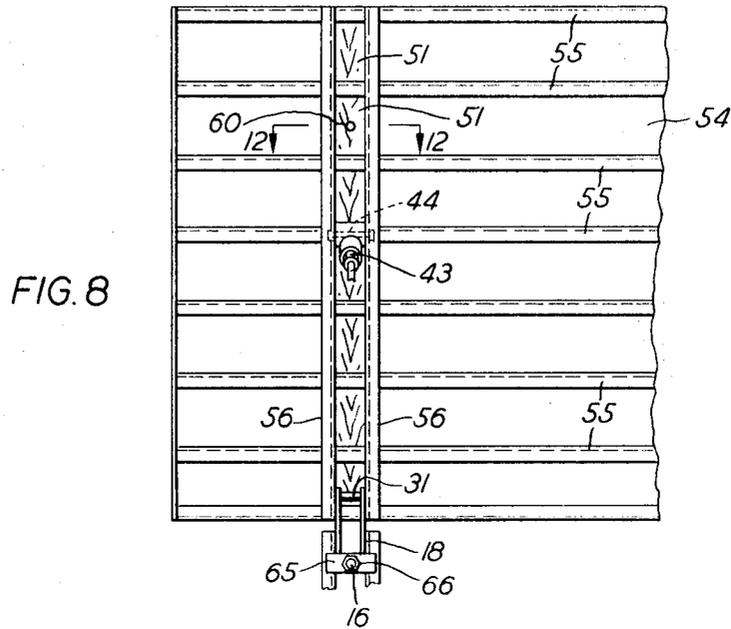


FIG. 8

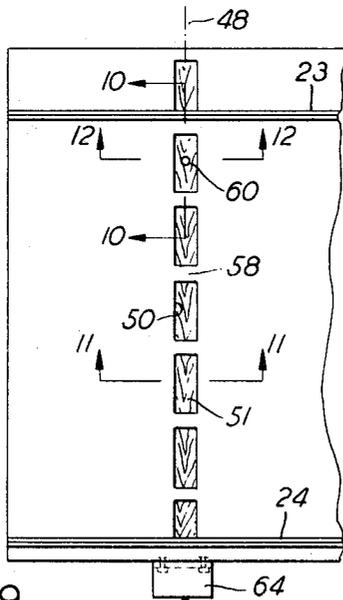


FIG. 9

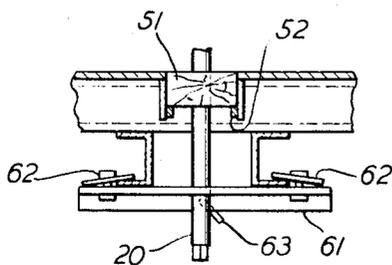


FIG. 12

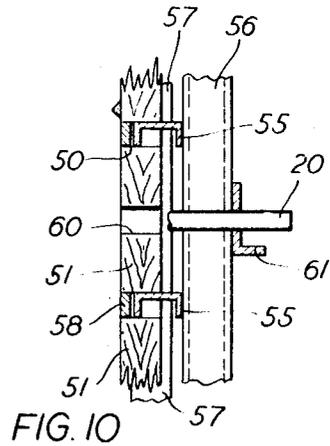


FIG. 10

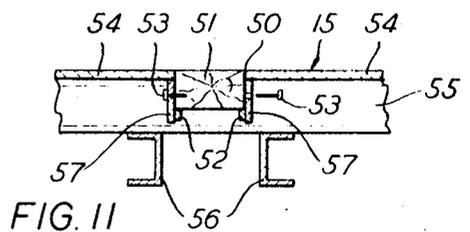


FIG. 11

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## CONCRETE FORMS WITH REPLACEABLE INSERTS

In the construction of dams or other large concrete structures, the concrete is often poured in a sequence of layers using cantilevered forms. The forms are supported by the previously poured layer, an anchor being set into each layer as it is poured to support the form in a cantilever position when pouring the next layer. These cantilever forms may well be of universal configuration whereby the form is adjusted to permit its use for vertical or slanted positions, or for starting positions wherein the first layer is poured on bedrock.

The anchor bolts or like devices which must be set into each layer extend through the form, and for this purpose holes must be punched in the face of the form. Use of the form in the various configurations of vertical, slanting, starting, etc., as well as use of the same form for layers of varying depths, requires the holes for the anchor bolts to be in different positions virtually every pour. This fact would result in the flat panel or face of the form being perforated after a short period of use, producing leakage of the wet concrete and rough concrete finishes, and require early replacement of the panels.

In addition to the anchor bolts which must penetrate the form faces, other devices must be attached to the face in pouring the typical structure. For example, chamfer strips are attached to the form to produce beveling at each construction joint so that ragged edges are avoided. These strips must be placed at different positions depending of course upon the angle of the form and the depth of the layer to be poured, and also dependent upon the position of the anchor previously set. Also sealing devices must be inserted at expansion joints to avoid leakage of water while allowing the concrete structure to shift with temperature changes and foundation settling. These devices usually consist of copper strips which provide a bellows function, but in any event must be attached to the face of the concrete form for proper insertion into the structure. Fastening these chamfer strips and sealing devices onto the form face should be expedient, and should not perforate the form whereby replacement of the panels is necessary. Of course, the concrete forms should permit attachment of the strips and other devices at any point on the form face, rather than the placement being restricted to particular positions.

All of the concrete forms, particularly cantilever forms of the nature discussed, which are in widespread use at the present time are of two general types. One is the all-steel form which of course may be reused for long periods, but which does not permit attachment of strips or other devices, or positioning of anchor bolts, with facility. Placement of these devices at varying positions of course results in undesirable perforation of the form face. The other type of form in common use is an all-wood form which permits ready attachment of devices and positioning of anchor bolts, but this form must be virtually reconstructed for each layer and thus requires a great deal of excess labor.

In view of the foregoing, it is a primary feature of the present invention to provide concrete forms, particularly cantilever-type forms, which permit expedient placement of anchor bolts or the like for pouring successive layers of concrete. Another feature is the provision of forms for pouring concrete or the like which permit placement of various shaping structures such as chamfer strips or the like on the form face. A further feature is the provision of versatile forms which need not be substantially reconstructed for each different type of deployment.

In accordance with a preferred embodiment of the invention, concrete forms of the cantilever type are provided which are of essentially all-steel construction, but which include replaceable inserts positioned along the major vertical structural members. Holes may be drilled in these inserts for placement of the anchor bolts, and any desired type of forming device may be attached to the face of the form in any position desired. After one of these inserts has been penetrated, it may be easily replaced when the form is used for the next pour

where the form need be penetrated at a different position. The inserts are segmented to avoid interruption of major horizontal structural members. The cantilever form illustrated is adapted for vertical or slanting faces, as well as for starting positions. In this manner, a versatile form is provided which permits use with anchoring devices and any of the other common attachments, but which need not be reconstructed for pouring each layer, and the face of the form need not be repeatedly replaced when reused.

Novel features which are believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as further features and advantages thereof, may best be understood by reference to the following detailed description of particular embodiments, when read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a schematic representation of a technique for pouring concrete in a sequence of layers whereby the cantilever forms with inserts according to the invention may be utilized;

FIG. 2 is an elevation view in section of a cantilever form for pouring concrete as may utilize the principles of the invention, the form being positioned for a slanting face;

FIG. 3 is an elevation view in section of a concrete form according to the invention positioned for a vertical lift;

FIG. 4 is an elevation view in section of the form of FIGS. 2 and 3 positioned for a starter pour;

FIG. 5 is an elevation view in section of the cantilever-type concrete form of FIGS. 2—4, positioned for the second pour, above the starter;

FIG. 6 is a front view of three of the cantilever forms of FIGS. 2—5, in the position for the starter pour as in FIG. 4;

FIG. 7 is a front view of three of the cantilever-type concrete forms of FIGS. 2—5, positioned for the second pour as in FIG. 5;

FIG. 8 is a rear view in elevation of the concrete form of FIG. 3;

FIG. 9 is a front view in elevation of the cantilever-type concrete form of FIG. 8;

FIGS. 10—12 are detail views in section of the replaceable inserts used in the form of FIGS. 8 and 9, taken along the lines indicated.

The drawings are considered a part of this specification, and are incorporated herein. It will be noted that like parts appearing in several views of the drawings will bear like reference numerals.

Referring to FIG. 1, the concrete forms of this invention have perhaps their primary utility in the construction of large concrete structures having sloping and curved faces which are poured in layers. A small segment of a dam 10 is illustrated which comprises a plurality of layers 11, 12, and 13, each of which is made up of a plurality of horizontal sections, with a sloping face 14 which defines the surface of the dam. The sloping face 14 might be at almost a vertical angle near the top of the dam, but might be a much more shallow angle near the base, and so the form which defines this boundary of the concrete must be variable. Also, the forms used for pouring the concrete must accommodate the curved faces as would appear in plan view, i.e. in a horizontal plane, as well as the vertical plane as seen in FIG. 1. The layers 11—13 are poured in sequence, each layer being perhaps 6 or 7 feet in height, and the same set of forms is used so that when one layer is poured and set, the forms are moved up to provide the boundaries of the next layer.

Referring now to FIG. 2, a concrete form of the cantilever type as used in construction of a dam of FIG. 1 is illustrated. This cantilever form includes a form face or panel 15 composed principally of sheet steel with wood inserts as will be explained, for holding the wet concrete and defining the outer face of the concrete. The cantilever form is held in place by a large anchor bolt 16 which engages an anchor 17 placed in the layer 11 of the previous pour. The form is held in place against the force of the wet concrete by a pair of beams including a beam 18 having a foot 19 which bears against the surface of

the hardened concrete. When wet concrete is poured into the next layer, forming the layer 12, pressure against the face 15 will tend to rotate the form about the anchor bolt 16, and this tendency is restrained by the beam 18 and its supporting structure which prevents such rotation. To provide an anchor bolt for the next pour, i.e. after the layer 12 is hardened and the form of FIG. 2 moved up to pour the layer 13, an anchor bolt 20 is positioned at the upper end of the form to hold in place an anchor 21.

The concrete anchors 17 and 21 may be any one of a number of types commercially available, but are shown as coil-rod-type anchors consisting of a steel coil having four elongated rods welded thereto. The coil defines the courses or female threads for engagement with the threaded end of the bolts 16 and 20. The same bolt 20 as is used when in the upper position as seen in FIG. 2 to set the anchor, is used as the bolt 16 when the anchor is holding the cantilever form for the next successive pour. Thus, the bolt 20 would engage the anchor 21 until the concrete of the layer 12 hardened, then the bolt 20 would be withdrawn and used as the bolt 16 while the layer 13 was being poured. These anchor assemblies including the bolts and anchors are commercially available and will not be treated in detail in this application.

The bolt 20 in the position shown, as well as perhaps another similar bolt in the same section of cantilever form horizontally spaced along the form, must be positioned properly with respect to what will be the next construction joint 22, i.e. the top of the layer 12 to be poured. Depending upon the slope of the face 14, and upon the exact position of the previous anchor, and upon various other factors, the desired position of the bolt 20 may vary considerably in a vertical direction along the form face 15. A hole must be bored in the face of the form to accommodate the bolt 20, but if in the next layer the bolt must be in a different vertical position then another hole must be bored. After many successive layers, if a new hole is bored for each layer, the form will be rendered useless due to the leakage of wet concrete through the holes, or if the holes are patched a rough concrete surface will result.

To provide a smooth exterior edge of the joint between each layer, chamfer strips 23 and 24 are used, these being horizontal strips in the view of FIG. 2, or vertical at the edges of the joints, and these strips must be secured to the interior face of the concrete form before the pour is made. Again, depending upon the angle of the sloping face 14, the depth of the layer, and like factors, the exact position of the chamfer strip 23 will vary with each pour. If all-steel forms were used, the fasteners employed to hold the chamfer in place would leave holes in the form which would require that the face of the form be replaced periodically after a number of uses due to these perforations.

Referring to FIG. 3, a cantilever form is shown in another condition of use, this being for successive layers 25 and 26 which have a vertical outer wall. The vertical thickness of the layer 26 to be poured is still perhaps the same as that of the layer 12 in FIG. 2, but the distance between anchor bolts 16 and 20 will be much less, as will the distance between the chamfer strips 23 and 24. Thus, all of the holes for the bolts 20 and fasteners for the chamfer strips 23 will be in different places.

Another situation in which the cantilever form discussed above may be used is illustrated in FIGS. 4 and 5. The technique for starting the first layer of concrete directly on the bedrock is set forth in these Figures. The bedrock will be quite uneven, probably of varying elevation, whereas the proper utilization of the technique of pouring layer by layer, a perfectly even flat surface must be generated. To this end, a series of the forms including the form faces or panels 15 is placed around the base to be poured, and the lower anchor bolt 16 is positioned as shown, with this bolt 16 being held in place by a rock anchor 30 which is driven or otherwise placed into the rock bed. When the wet concrete has been poured, the form of FIG. 4 will tend to be forced to the right, but will be held by the rock anchor. The lower end of the panel 15 rests directly

on the rock, or on temporary wooden shoring if the rock is uneven, and the beam 18 is pivoted about a pivot point 31 so that the foot 19 rests against the rock. In this view, the top of the pour, referred to as the construction joint, will be as indicated by a dotted line 32. Above the construction joint 32 is positioned the anchor bolt 20 with an anchor on the end to be embedded within the poured concrete. Again, it is seen that the positions of the bolts 16 and 20, as well as the angles of these bolts, is different from that discussed above.

After the pour is made for which the form is set up as in FIG. 4, this being referred to as the starter, the next pour will be made with forms in place as seen in FIG. 5. Here the panel 15 is moved upward and held in place by the bolt 16 which will be threaded into the anchor which was set in place by the bolt 20 of FIG. 4. The beam 18 will be at a different angle, pivoted about the point 31, and the foot 19 will rest on the rough rock surface. In this position, the anchor bolt 16 would be subjected to considerable bending, whereas it is designed to withstand primarily tension. To avoid shear stress upon the bolt 16, shoring members 33 are positioned below the forms and held in place by clamps 34. These shoring members are of varying length depending upon the original rock elevation as will be explained.

The bracing members used to support the form in the various positions of FIGS. 2—5 are seen to be adjustable over a considerable range of angles while at the same time providing firm support. Attached to the beam 18 is a perpendicular member 35 and an angle member 36 which are secured together at their ends by a bracket 37. The upper side of the member 35 may provide the support for a walkway made of boards 38 needed when the forms have been moved up to an elevated position on the side of the dam after the first two pours. A handrail post 39 may be attached to the bracket 37, with horizontal wooden strips being connected to the handrail posts. The bracket 37 includes provision for a pivot pin 40 which engages one of a series of holes 41 in a strut 42. The upper end of the strut 42 includes an adjusting jack 43, and is connected to the vertical structural member of the form by a pivot 44. By removing the pin 40 and reinserting it in the proper one of the holes 41, the form may be placed in the starter position as in FIG. 4, in the position first above the starter as in FIG. 5, or in the typical vertical left position of FIG. 3. It is understood, of course, that the position of FIG. 2 is similar to that of FIG. 3, but is tilted. In this regard it may be noted that a different walkway and handrailing construction would be necessary in the tilted position, this construction not shown. In any of these positions, the members 35 and 36 remain fixed with respect to the beam 18, the variation in angular position of the beam 18 being effected by positioning the strut 42 with respect to the bracket 37 in one of the holes 41. After placing the pin 40 in one of the holes 41 closest to the desired position, the form panel 15 is placed in exactly the proper vertical position by adjusting the jack 43 which is a screw-type device of conventional form.

It should be noted that in the vertical lift position of FIG. 3 the form panel 15 is of sufficient height to provide freeboard 45, seen in FIG. 3, to permit use of the same form in a lift having a slanting face as in FIG. 2 wherein the exposed face would be greater. Thus the total height of the form face 15 is considerably greater than the height 46 of the lift or pour, so the same form may be used in the tilted configuration where the slant distance would be longer while the height of the lift 46 would be the same. Comparing FIGS. 2 and 3, the height 46 of the pour is the same, but the amount of freeboard 45 is quite different.

Turning now to FIGS. 6 and 7, the positions of three of the form panels 15 are shown for the starter pour and for the second pour. In FIG. 6 which depicts the starter pour, the form panels 15 are generally in the condition of FIG. 4, but will be at varying heights. The bottom of the panels 15 may be resting directly on the rock, or may be positioned slightly above the rock as in FIG. 4 due to the slope and uneven nature of the rock bed. In the later situation, temporary wooden shor-

ing 47 composed of plywood with suitable bracing would be used as seen in FIG. 6. It is noted that three of the panels 15 are illustrated, each being perhaps 10 feet in width and each having two major vertical structural members, referred to as strongbacks, arranged on centerlines 48. These lines 48 are the centerlines of the holes 16 and 20 or of the strongbacks, rather than centerlines of the panels 15. It is on these centerlines 48 that the anchor bolts 16 are placed, while the anchor bolts 20 will be also placed on the centerlines above the construction joint or line 32, seen also in FIG. 4. It is noted that the line 32, to which wet concrete will be poured, will be at a varying height with respect to the bottom of the three panels 15 seen in FIG. 6. The line 32, however, will be flat and horizontal since this base line is needed to begin pouring the straight even lifts. The situation in FIG. 6 requires the positioning of the holes 16 and 20 in many different vertical positions along strongback centerlines 48, and the utility of the replaceable inserts according to the invention is particularly apparent.

FIG. 7 shows the position of the same three panels 15 as in FIG. 6, but after having been raised vertically for the second pour. The tops of the panels 15 will be aligned, and each of the forms will be generally in the configuration of FIG. 5, but using shoring members 33 of perhaps different lengths underneath. The lower anchor bolts 16 of FIG. 7 will be inserted into the anchors which were set by the bolts 20 of FIG. 6, while the upper bolts 20 will be positioned near the top, just beneath what will be the new fill line or construction joint 49. Subsequent layers will be poured using the standard vertical lift position of FIG. 3.

Referring now to FIGS. 8 and 9, detail views of the front and back of one end of one of the panels 15 are illustrated, and FIGS. 10-12 show enlarged sectional views of details of the panels. In accordance with the major feature of the invention, the panel includes a plurality of vertical slots 50 arranged along the vertical centerline 48 of the strongback, and in these slots are positioned removable wooden inserts 51. These inserts 51 are supported from the back by stops in the form of bars 52 fixed to the vertical members. The inserts 51 may be about 1 foot long, being sections of standard 2x4, or the like. Each of the wooden inserts 51 is held in place by fasteners such as nails 53, seen in FIG. 11. The panel 15 generally includes a flat sheet metal face member 54, which is solid except for the slots 50. Horizontal structural members 55 of U-shaped iron provide the main rigid supports for the flat sheet 54. Each strongback is provided by a pair of large U-shaped beams 56. To support the inserts 51 from the sides, a pair of vertical risers 57 are provided, one of these being on each side of each insert. The risers are secured to the horizontal members 55 by suitable fasteners, not shown. Other vertical braces may be secured to the horizontal members 55 on the back if additional stiffening is needed. Instead of using a solid sheet for the front plate 54, with slots 50, the plate 54 may be in strips with fillers 58 between the inserts 51. The chamfer strips 23 and 24 would be secured to the front face of the panel 15 as seen in FIGS. 9 by nails or the like.

In the views of FIGS. 8, 9 and 10, one of the inserts 51 is shown containing a bore hole 60 into which would be placed one of the anchor bolts 20. This hole 60 would be drilled at any suitable position, and after the form is used once this insert 51 containing the hole 60 would be removed and replaced with a new wooden insert so that concrete would not leak out or a rough projection would not be left on the concrete face.

The bolt 20 would be held in place by a temporarily attached bracket 61 which is held in place at any point along the strongback members 56 by clamps 62. In this manner the vertical position of the bolt 20, as well as its angle, may be adjusted as needed. The bolt is held in place by a pin 63.

In FIG. 9 the structure for supporting the form above the bolt 16 is illustrated at the lower end of the strongback centerline. A support bracket 64 is bolted to the lower edge of the form, the bolts passing through the lowermost one of the horizontal members 55. The bracket may include suitable

bracing members if needed. It is noted that the bracket 64 does not support the form against outward movement—this is borne by the beam 18 through which the anchor bolt 16 extends. A bracket 65 on the beam 18 is engaged by a nut 66 after the bolt 16 is tightened into the threads of the coil anchor.

It may be noted that while the inserts 51 have been described as being composed of wood, other replaceable or expendable materials might be used, although wood is preferred as it is easily drilled and nailed and is cheap.

The inserts 51 are interrupted by the fillers 58, it being necessary that the horizontal members 55 extend all the way across for structural rigidity. Therefore, the hole 60 for the anchor bolt may not be placed at some vertical positions, i.e. at the locations of the horizontal members. However, this presents no problem because substantial leeway is permitted in positioning the form above the prior anchor bolt 16, and in positioning the next anchor bolt 20 below the next pour line. Nevertheless, the dimensions of the form are selected to permit the borehole 60 to fall at about the center of an insert 51 for nominal pour depths and for a standard size bracket 64. Of course the bracket 64 may be changed, but usually the vertical position of the form relative to the construction joint would be shifted to accommodate situations where the bolt position falls on a horizontal member.

While the invention has been described with reference to particular embodiments, it is understood that this description is not to be construed in a limiting sense. Various modifications of the disclosed embodiments, as well as other embodiments of the invention, may be apparent to persons skilled in the art upon reference to this description. It is therefore contemplated that the appended claims will cover any such modifications or embodiments as fall within the true scope of the invention.

What I claim is:

1. A form of the cantilever type for use in pouring concrete or the like comprising:

a generally flat panel providing the face of the form, a plurality of transverse structural members extending along the back of said panel for the entire length thereof without interruption, the panel being attached to said transverse structural members,

at least one vertical structural member extending along the rear side of the panel for vertical support of panel and the transverse structural members, the vertical structural member extending a substantial distance below the panel for anchoring,

means for securing the vertical structural member to first anchor means located near the lower part of the panel and extending through the plane of the panel, and

a plurality of replaceable inserts positioned in the panel and forming part of the face thereof, the inserts being positioned between the transverse structural members and generally aligned with the vertical structural member, the inserts being adapted to receive second anchor means penetrating therethrough for setting in the concrete or the like being poured, the inserts being comprised of wood or the like while the panel and structural members are comprised of metal.

2. A form for use in pouring concrete or the like, according to claim 1, wherein:

the portion of the vertical structural member extending below the panel is adjustable to permit positioning the panel closely adjacent a horizontal surface.

3. A form for use in pouring concrete or the like, according to claim 2, wherein:

the means for securing the vertical structural member to the first anchor means may be positioned above the lower edge of the panel penetrating through one of said replaceable inserts.

4. A form for use in pouring concrete or the like, according to claim 3, wherein:

the second anchor means for setting in the concrete or the like being poured is positioned vertically above the first anchor means which may be positioned above the lower edge of the panel, the first anchor means being positioned at an angle to penetrate the top surface of a previously poured layer of concrete.

5. A form for use in pouring concrete or the like, according to claim 1, wherein:

the vertical structural members are positioned behind the transverse structural members, and both of said anchor means extend through the vertical structural members and are fastened thereto.

6. A form of the vertical cantilever type for use in containing plastic material for hardening thereof, comprising: panel means providing the face of the form,

a plurality of transverse and vertical structural members composed of steel or the like extending along the back of said panel means, the panel being attached to said structural members,

means adjacent the lower part of the panel for securing at least one of the vertical structural members to first anchor means extending into an area below the plastic material to be hardened, and

a plurality of replaceable inserts positioned in the panel means generally aligned with a vertical structural member, the inserts being spaced between transverse structural members whereby the transverse structural members extend along the panel without interruption, the inserts being adapted to receive second anchor means penetrating therethrough for setting in the plastic material to be hardened, the inserts being comprised of wood or like expandable material which is easily bored for positioning of the anchor means.

7. A form for use in containing plastic material or the like, according to claim 6, wherein:

the inserts are positioned along a vertical structural member, the second anchor means extending through the vertical structural member.

8. A form for use in containing plastic material or the like, according to claim 7, wherein:

the form is of the cantilever type and the first anchor means extends through a vertical structural member below the panel means.

9. A form for use in containing plastic material or the like, according to claim 8, wherein:

the vertical structural member extends a substantial distance below the panel means to previously previously hardened material into which the first anchor means had been set.

10. A form for use in containing concrete or the like, according to claim 6, wherein:

the lower end of the vertical structural member is foldable

with respect to the upper end whereby the form may be adjusted to engage a horizontal surface just beneath the panel means.

11. A form for use in containing concrete or the like, according to claim 10, wherein:

there are at least two of said vertical structural members, and the edges of the form are adapted to be releasably secured to edges of like forms.

12. A form for use in containing concrete or the like, according to claim 11, wherein:

adjustable vertical supports are secured to the lower end of the panel means to support the panel means above the horizontal surface.

13. A form for use in containing concrete or the like for hardening thereof comprising:

panel means providing the face of the form,

a plurality of structural members composed of steel or the like extending along the panel means in a pattern,

a plurality of expendable, easily drilled, removable inserts positioned in the panel means along and generally aligned with a structural member, the form being anchored by first anchor means extending through said structural member, the inserts being adapted to receive second anchor means penetrating therethrough for setting in the concrete to be hardened,

the form being of the vertical cantilever type and the inserts being positioned along a vertical structural member, and said second anchor means extending through said vertical structural member spaced from the panel means.

14. A form for use in containing concrete or the like, according to claim 13, wherein:

said vertical structural member extends a substantial distance from the panel means to engage previously hardened concrete into which said first anchor means had been set.

15. A form for use in containing concrete or the like, according to claim 14, wherein:

the inserts are spaced between transverse structural members, whereby the transverse structural members extend along the panel means without interruption.

16. A form for use in containing concrete or the like, according to claim 15, wherein:

the inserts are comprised of wood or like expendable material easily bored for positioning of the anchor means, and the panel means and structural members are comprised of steel or the like.

17. A form for use in containing concrete or the like, according to claim 16, wherein:

the lower end of said vertical structural member is foldable with respect to the upper end whereby the form may be adjusted to engage a horizontal surface just beneath the panel means.

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