Dec. 12, 1967 R. C. CAPEK 3,357,672

CONCRETE WALL FORM PANEL WITH PARTICULAR TIE ROD ASSEMBLY

Filed Aug. 7, 1964 5 Sheets-Sheet 1

FIG. 1

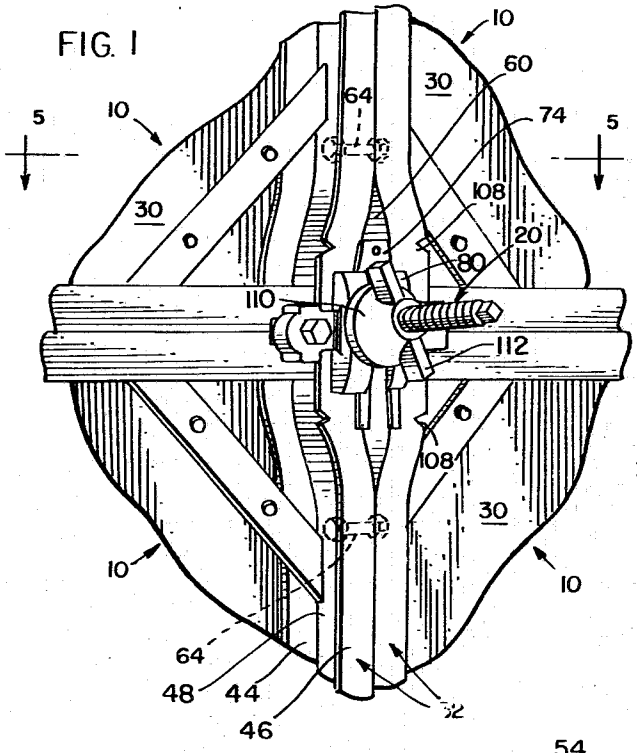


FIG. 2

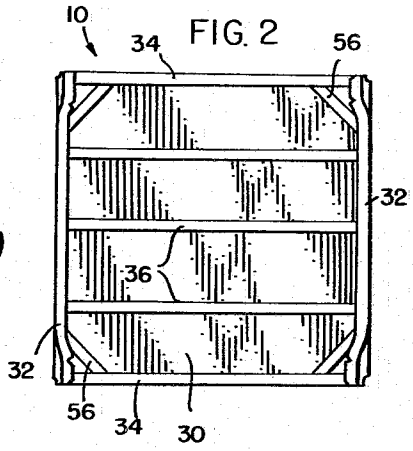


FIG. 3

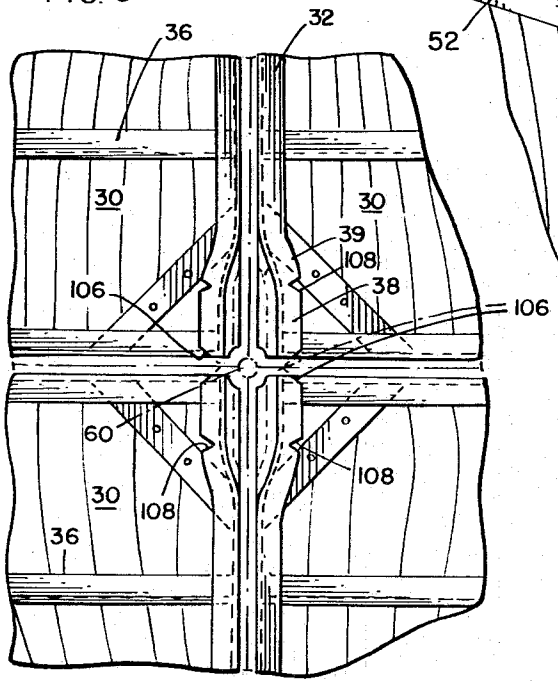
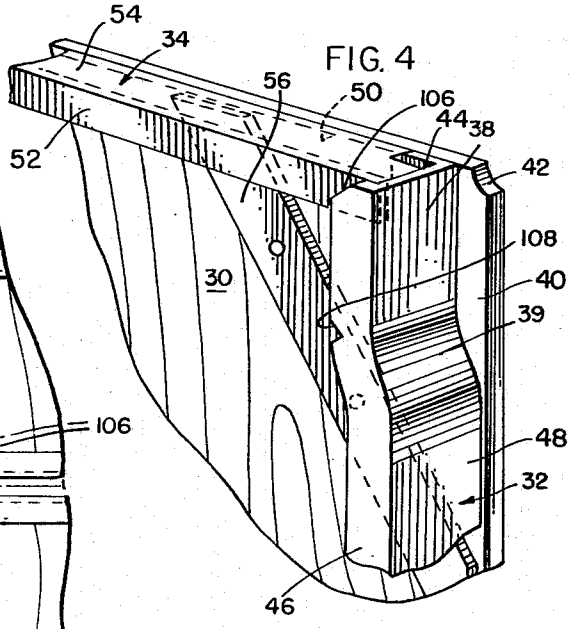


FIG. 4



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CONCRETE WALL FORM PANEL WITH PARTICULAR TIE ROD ASSEMBLY

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FIG. 8

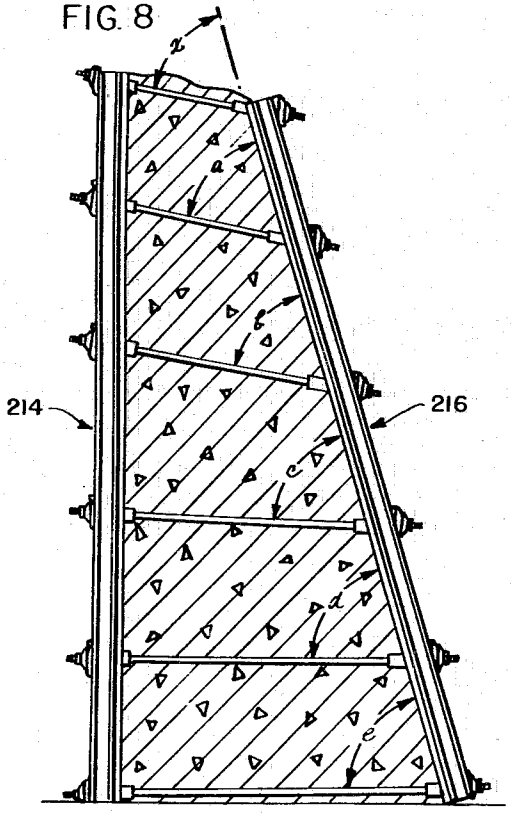


FIG. 11

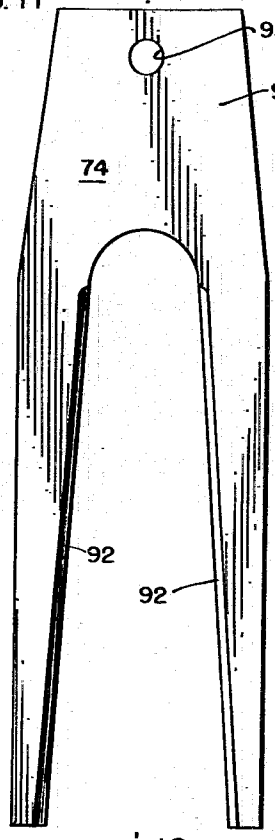


FIG. 12

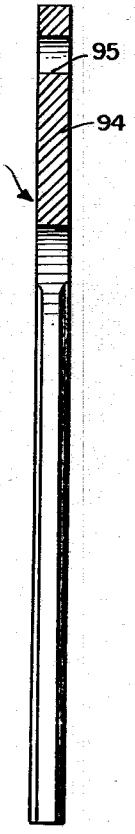


FIG. 5

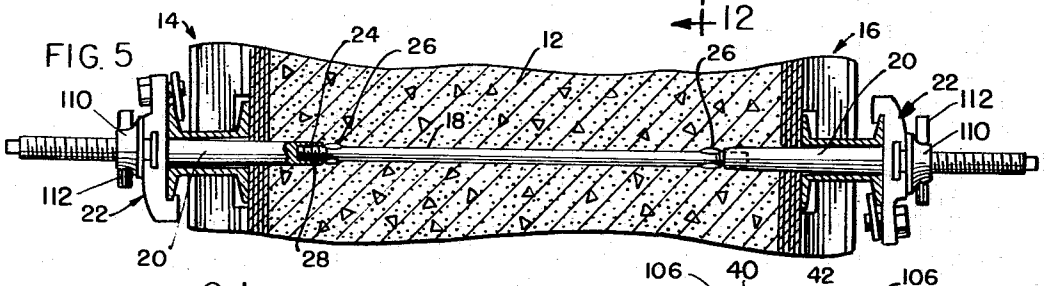


FIG. 7

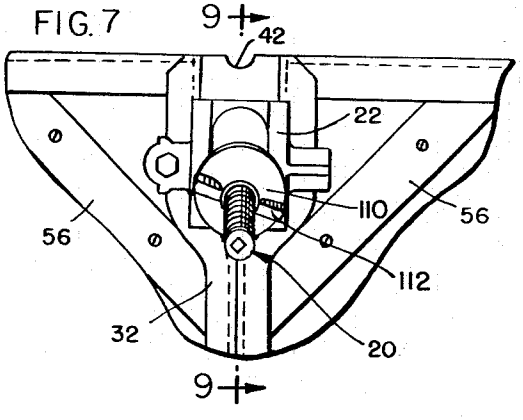
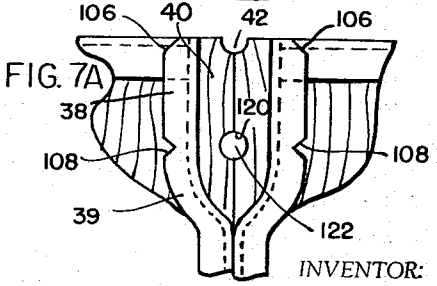


FIG. 7A



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CONCRETE WALL FORM PANEL WITH PARTICULAR TIE ROD ASSEMBLY

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FIG. 6

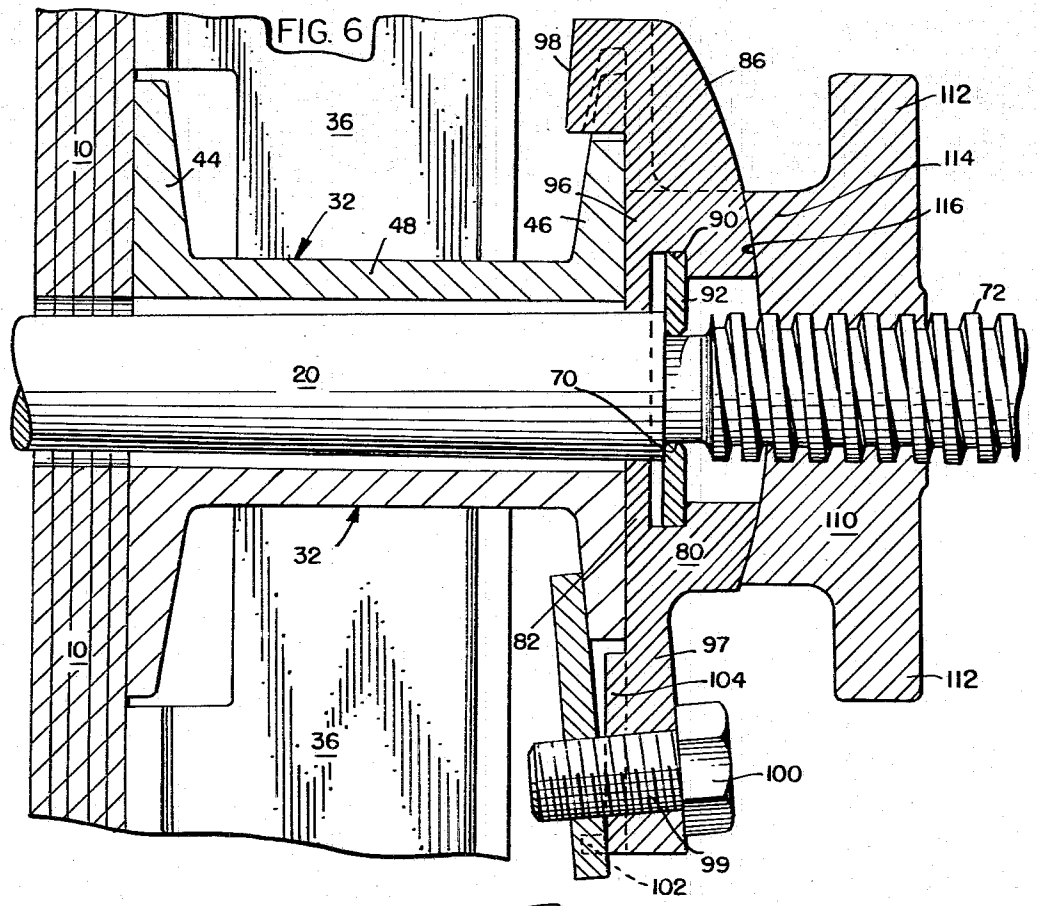
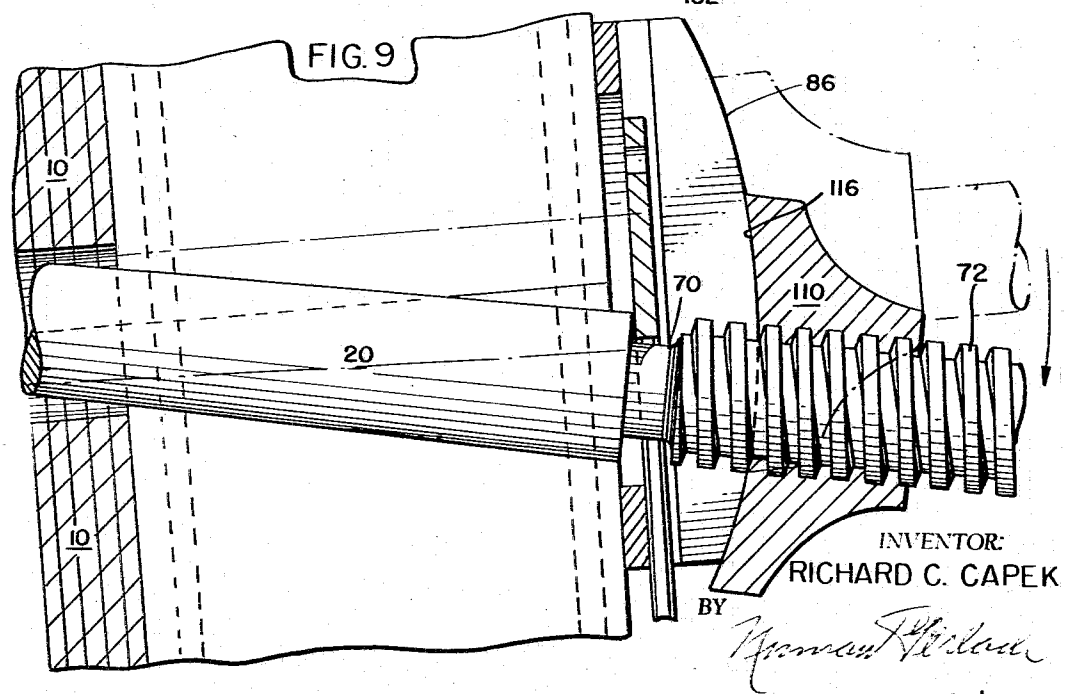


FIG. 9



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CONCRETE WALL FORM PANEL WITH PARTICULAR TIE ROD ASSEMBLY

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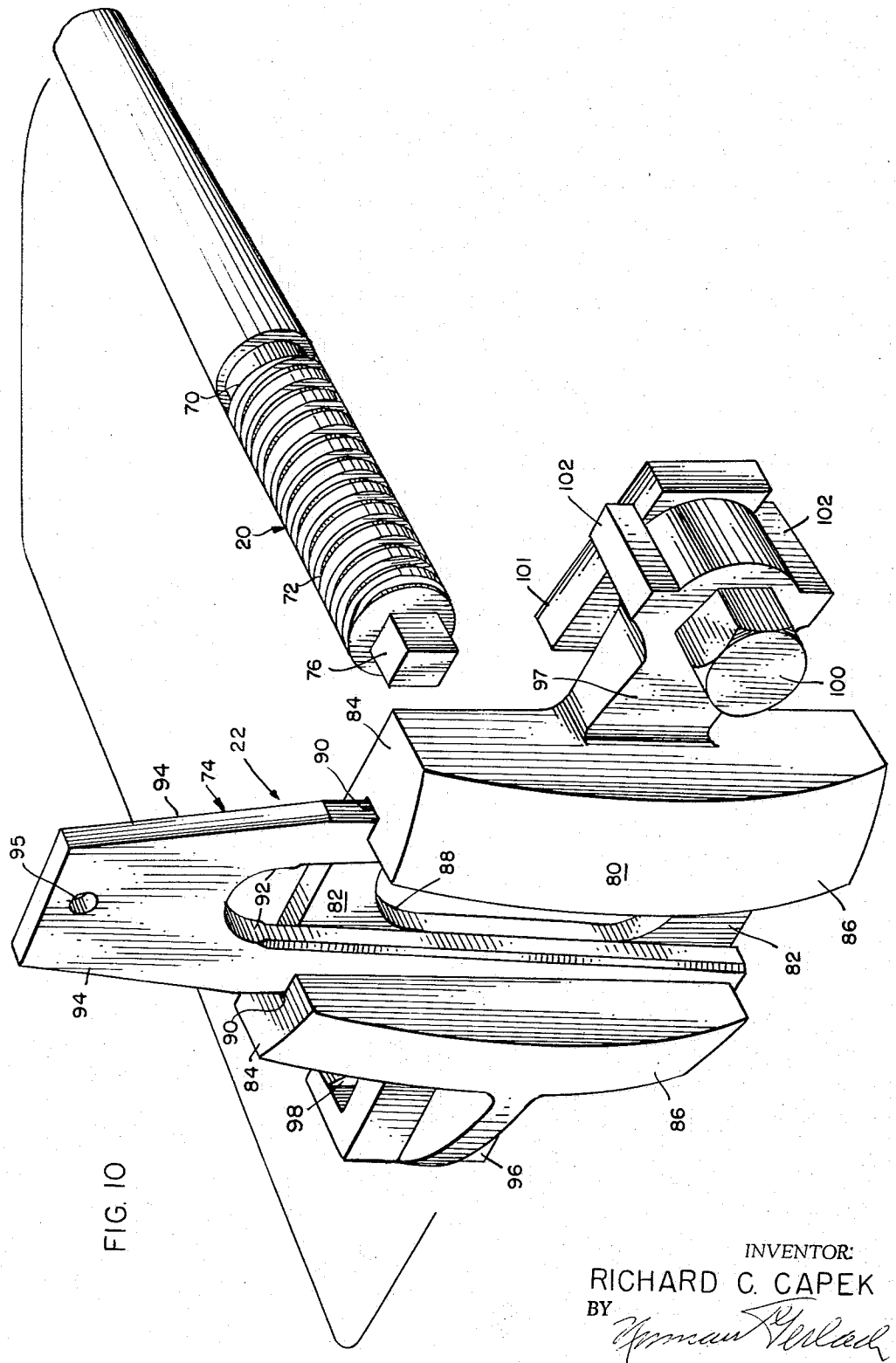


FIG. 10

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CONCRETE WALL FORM PANEL WITH PARTICULAR TIE ROD ASSEMBLY

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FIG. 13

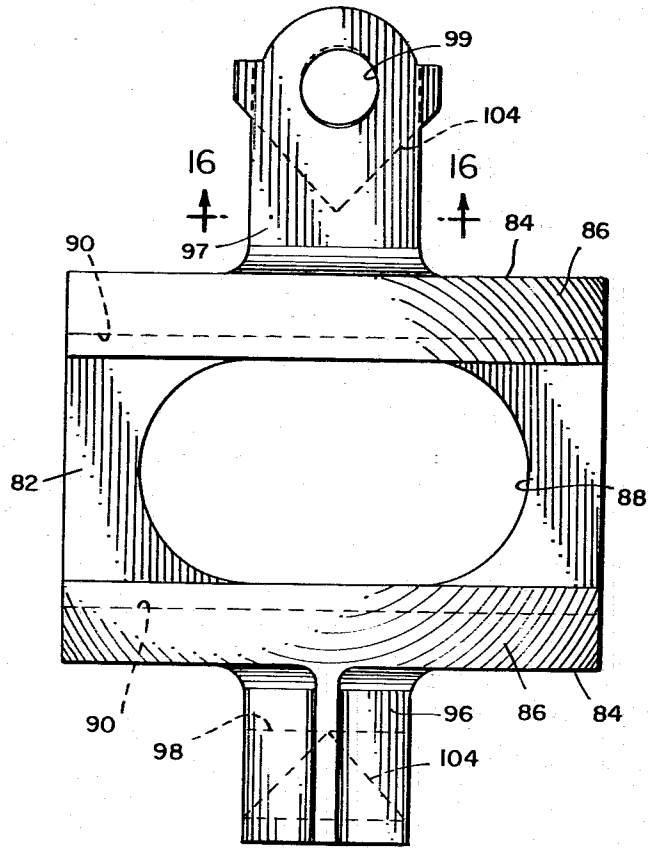


FIG. 14

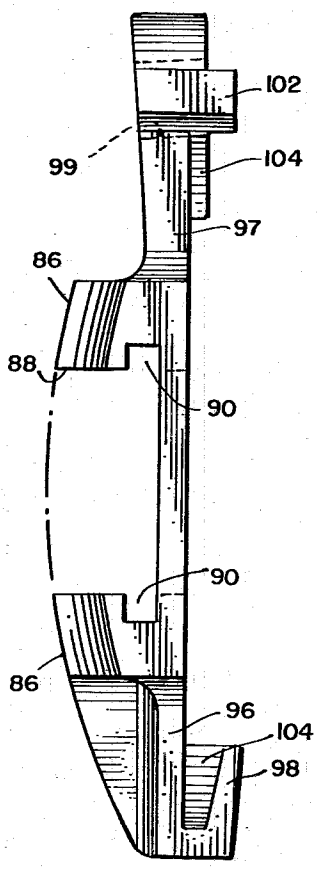


FIG. 15

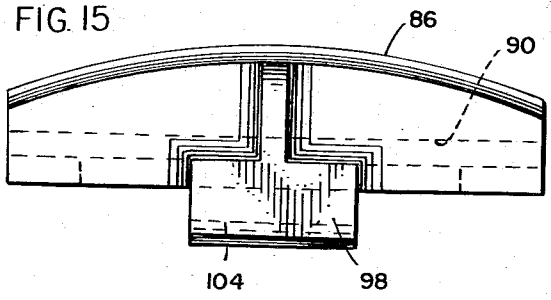
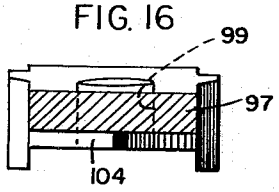


FIG. 16



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United States Patent Office 3,357,672 Patented Dec. 12, 1967

3,357,672

CONCRETE WALL FORM PANEL WITH PARTICULAR TIE ROD ASSEMBLY

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Filed Aug. 7, 1964, Ser. No. 388,166
12 Claims. (Cl. 249—45)

The present invention relates to a concrete wall form of the type that embodies a pair of upstanding, opposed, spaced apart wall form sides between which wet concrete is adapted to be poured for wall forming purposes, each side being comprised of a plurality of superposed series of coplanar, rectangular panels in edge-to-edge relationship and the two sides being maintained spaced apart by way of horizontally disposed tie rod assemblies which extend transversely across the form and bridge the space between the two opposed wall form sides.

The invention is primarily directed to a novel tie rod assembly which is normally adapted to be secured at each end region to the adjacent wall form side of a concrete wall form at the quadrilateral corner intersections of four adjacent panels, the assembly being such that when it is operatively installed or positioned with respect to the form, the two opposed wall form sides will be maintained spaced apart a fixed predetermined distance. It is to be understood that although reference is here made to a single tie rod assembly, many identical tie rod assemblies are used in a concrete wall form.

There is on the market at the present time a tie rod assembly consisting of an intermediate or inner unit which is in the form of a one-piece metallic rod and has externally threaded ends, and a pair of outer units which are in the form of one-piece metallic rods, extend outwards from and in coaxial relation with the inner unit, are sometimes referred to in the art as "she-bolts," have internally threaded sockets at their inner ends for threaded reception of the threaded ends of the inner unit, extend normally between adjacent edges of certain of the panels, have externally threaded outer ends, and carry nut-like clamping members or means on their threaded outer ends for panel-clamping purposes. The inner unit of the tie rod assembly is expendable and is adapted to remain embedded in the concrete wall after the form has been stripped therefrom, while the she-bolts and clamping members are recoverable for future use by disconnecting them from the form sides and unscrewing the she-bolts from the externally threaded ends of the embedded inner unit. It is to this particular type of tie rod assembly that the present invention relates.

Because, as heretofore indicated, the tie rod assembly of the present invention is adapted for use at the quadrilateral corner intersections of two opposed sets of four adjacent panels, the invention also is concerned with a novel form of rectangular wall form panel which, in each corner region thereof, makes provision for the counterpart quadrilateral intersection with other like panels in such a manner that when a particular corner intersection is effected, accommodations are provided whereby proper installation of the tie rod assembly may be made. The invention, therefore, is directed to a novel tie rod assembly, a novel cooperating panel, and a novel combination, in a concrete wall form, of such a tie rod assembly with a series of panels operatively arranged to receive the tie rod assembly.

As will become clear presently when the nature of the invention is better understood, the tie rod assembly of the present invention is not necessarily limited to use at the

quadrilateral intersections of two opposed sets of four panel corners on opposite sides of the wall form. It is also adapted for use at two opposed sets of bilateral corner intersections such as may occur along the bottom edges of the form sides or along the top edges of such form sides, this multiple alternative use of the tie rod assembly and panels constituting one of the important features of the present invention.

Another and extremely important feature of the present invention resides in the fact that the tie rod assembly and the particular panels of the present invention are usable, in the manner of combination for which they are intended, either in connection with a concrete wall form involving parallel wall form sides or a form involving at least one battered or sloping side. According to the invention, the panels and the tie rod assembly are capable of use in connection with battered concrete wall forms involving different slopes and with no modification whatsoever being required of either the panels or the tie rod assembly. This feature of the invention is made possible by the use of a novel clamping bracket and nut assembly having mating frusto-spherical surfaces which allow the axis of the tie rod assembly to deviate from the normal to the extent necessary to accommodate a given inclination of a wall form side that is associated with a battered wall form.

A still further feature of the invention resides in a permanent relationship which is established between certain elements of the tie rod assembly and the panels with which the assembly is associated. For example, after use in an initial concrete wall form wherein the brackets that are associated with the tie rod assembly have been affixed and bolted to the associated panels, these brackets may remain permanently attached to the panels, even during stripping of the form from the completed concrete wall, it being necessary merely to remove the she-bolts from the embedded inner unit of the tie rod assembly, whereupon large sections of the wall form sides may be removed bodily as units and left intact with the quadrilateral relationship existing between adjacent corners of the panels remaining undisturbed. These gang sections may then be reused in future gang installations, whether in connection with vertical wall form sides or with inclined wall form sides as used in connection with the formation of a battered concrete wall, the brackets remaining in position on the panels for insertion therethrough of the she-bolts which are then screwed onto the ends of the intermediate or inner unit of the associated tie rod assembly. In fact, the present invention has been developed specifically for use in connection with gang forming operations of the general character disclosed in United States Patent No. 3,067,479, granted on Dec. 11, 1962 and entitled "Panel-Securing Tie Rod Anchor Bolt with Offset Anchor Point," although it is not necessarily limited to such use.

The attainment of the above-outlined features constitutes the principal object of the present invention and it is an ancillary object to provide a novel combination of panels and a tie rod assembly, such combination, by reason of the novel quadrilateral arrangement of the intersecting panel corners in associated relation with the tie rod assembly, being conducive toward minimum concrete leakage so that the finished concrete wall will require a minimum of patching with grout after the form is stripped from the finished concrete wall.

The provision of a tie rod assembly which is relatively simple in its construction and, consequently, may be manufactured at a low cost; one which is rugged and durable and, therefore, will withstand rough usage; one which is capable of ease of installation and removal; one which requires no special tools for its manipulation; and

one which, otherwise, is well-adapted to perform the services required of it, are further desirable features which have been borne in mind in the production and development of the present invention.

Other objects and advantages of the invention, not at this time enumerated, will readily suggest themselves as the following description ensues.

In the accompanying five sheets of drawings forming a part of this specification, one illustrative embodiment of the invention has been shown.

In these drawings:

FIG. 1 is an outside fragmentary perspective view of the region of quadrilateral intersection between four adjacent panels on one side of a concrete wall form, the improved tie rod assembly being shown operatively installed therein;

FIG. 2 is an outside plan view of one of the individual panels of the form;

FIG. 3 is an outside fragmentary exploded side elevation view of the region of quadrilateral intersection between the four adjacent panels which are shown in a fragmentary manner in FIG. 1, the panels being shown prior to application of the tie rod assembly thereto;

FIG. 4 is an enlarged outside fragmentary perspective view of one corner region of one of the panels;

FIG. 5 is a sectional view taken substantially on the horizontal plane represented by the line **5—5** of FIG. 1 and in the direction indicated by the arrows, the section passing completely through the concrete wall form;

FIG. 6 (see sheet No. 3 of the drawings) is an enlarged fragmentary sectional view of a limited portion of the structure that is shown in FIG. 5;

FIG. 7 (see sheet No. 2 of the drawings) is a fragmentary outside perspective view similar to FIG. 1 but showing the tie rod assembly installed in a region of bilateral intersection between a pair of adjacent panels at one side of the top of a concrete wall form;

FIG. 7A is a fragmentary outside view of the structure that is shown in FIG. 7, the tie rod assembly being removed for illustrative purposes;

FIG. 8 is a sectional view somewhat schematic in its representation and taken transversely through a battered concrete wall form employing the panels and a plurality of tie rod assemblies embodying the present invention;

FIG. 9 is an enlarged fragmentary sectional view taken substantially on a vertical plane extending through a quadrilateral corner intersection of the battered concrete wall form of FIG. 8;

FIG. 10 is an enlarged fragmentary exploded perspective view of certain parts of the particular tie rod assembly of the present invention;

FIG. 11 (see sheet No. 2 of the drawings) is a plan view of a locking yoke that is employed in connection with the tie rod assembly of the present invention;

FIG. 12 is a vertical sectional view taken on the line **12—12** of FIG. 11;

FIG. 13 is a front elevational view of a clamping bracket that is employed in connection with the tie rod assembly of the present invention;

FIG. 14 is a top plan view of the clamping bracket of FIG. 13;

FIG. 15 is a side view of said clamping bracket; and

FIG. 16 is a horizontal sectional view taken on the line **16—16** of FIG. 13.

Referring now to the drawings in detail and in particular to FIGS. 1, 2, 3, 5, 7 and 7A, a fragmentary portion of a concrete wall form made up of individual rectangular panels **10** is shown in FIG. 1, this view representing the quadrilateral intersection of four adjacent panels on one side of the form. Both sides of the form appear in FIG. 5 with the pored monolithic concrete wall **12** interposed therebetween, the two form sides being designated generally by the reference numerals **14** and **16**. The two form sides are connected together by a plurality of tie rod assemblies, one such assembly being shown in its entirety

in FIG. 5 and including an intermediate or inner unit **18**, a pair of outer units or she-bolts **20** and a pair of clamping bracket assemblies **22** (see also FIG. 10), the nature and function of which will be described presently.

The inner unit **18** of the tie rod assembly is in the form of a length of rigid steel rod stock and its ends are provided with external screw threads **24**. The base regions of the threaded areas of the inner unit are flattened as indicated at **26** in FIG. 5 so as to constitute stops to limit the extent of threaded reception thereover of the she-bolts **20** as will also be described presently.

The she-bolts are likewise formed from rigid steel rod stock and are provided at their inner ends with internally threaded sockets **28** which, when the tie rod assembly is in assembled condition, are threadedly received over the threaded ends of the inner unit **18**, the flattened regions or areas of the inner unit constituting stops and serving to limit the extent of threaded engagement between the she-bolts and thus determining the effective length of the tie rod assembly when the latter is put to use. The she-bolts **20** are operatively connected to the adjacent form sides **14** and **16** by means of the aforementioned clamping bracket assemblies **22** in a manner that will be made clear when the nature of the individual panels **10** is better understood.

The tie rod assembly of the present invention is designed for use specifically in connection with specially constructed steel-reinforced panels of which the panels **10** are exemplary. Each panel includes a rectangular plywood facing **30** (see FIGS. 2, 3 and 4), the marginal regions of which are reinforced by studding in the form of a rectangular steel frame including vertical frame bars **32** and horizontal frame bars **34**. The medial regions of the plywood facings are reinforced by vertically spaced, horizontally extending crossbars **36** which extend between the vertical frame bars at spaced regions therealong. The end regions of each vertical frame bar **32** are provided with inwardly offset portions **38**, the degree of offset being comparatively slight and the longitudinal extent of these offset portions being comparatively small. These inwardly offset portions merge with the medial regions of the vertical frame bars **32** on a gradual incline as indicated at **39**. The inwardly offset portions **38** leave limited corner regions **40** of the facings **30** exposed on the outer side of the panels and the extreme apex or corner of each corner region is cut-away or truncated as at **42** on a 90° arc. The vertical frame bars **32** of the facing-reinforcing frames of the panels **10** are of inwardly facing channel shape construction, each bar having inside and outside inwardly extending flanges **44** and **46** and a channel web **48** between the two flanges. The horizontal frame bars **34** are of similar channel shape construction and include inside and outside, inwardly extending flanges **50** and **52** and webs **54** between the last-mentioned flanges. Straps or struts **56** extend diagonally between the vertical and horizontal frame bars and serve to reinforce the corner regions of the panels, as well as to provide a means whereby the plywood facings may be bolted to the reinforcing frames.

As illustrated in FIG. 1, when a series of four panels **10** are operatively disposed as parts of one side of the illustrated concrete wall form and are positioned in edge-to-edge relationship as further exemplified by the exploded view of FIG. 3, with the four panels being disposed in checkerboard or rectangularly arranged fashion so that adjacent horizontal frame bars **34** and adjacent vertical frame bars **32** are in contiguity or longitudinally aligned relation, the various adjoining offset portions **38** and the merging inclined portions **39** of the vertical frame bars **32** establishing a vertically elongated and generally diamond-shaped void at the meeting zone of the four adjoining corners of the four illustrated panels. Such a void appears in FIGS. 1 and 3 and is designated by the reference numeral **60**. The contiguous horizontal frame bars **34**, as well as the contiguous verti-

cal frame bars 32, are secured together by conventional nut and bolt assemblies 64 which, in the case of a given gang panel installation, remain in position that the panel frames are permanently bolted together.

Referring now to FIGS. 1, 6 and 10 of the drawings, the clamping bracket assemblies 22 on the opposite sides of the form include the she-bolts 20. They are identical and, therefore, a description of one of them will suffice for both. The she-bolt 20 of each clamping bracket assembly is of rod-like design and embodies an annular thrust reaction groove 70 around its medial region. Outwardly of this groove, the she-bolt is provided with a male or external screw thread 72. Thus, approximately one-half of the she-bolt is threaded while the other half is smooth. The she-bolt is approximately cylindrical but it is tapered on a very slight slant angle throughout its length to facilitate removal thereof from the hardened concrete of the finished wall as illustrated in FIG. 8. The groove 70 serves to form a pair of opposed shoulders and is designed for reception therein of the side legs of a locking yoke 74 which serves a function that will become clear presently. The outermost end of the she-bolt 20 is provided with a reduced square protuberance 76 to facilitate turning of the she-bolt by a suitable tool, such, for example, as a wrench when the she-bolt is to be extracted from the hardened concrete between the opposed sides of the form.

The she-bolt 20 is adapted to be connected to adjacent vertical frame bars 32 by means of a clamping bracket 80 which constitutes an element of the clamping bracket assembly 22 and is in the form of a casting having a flat rectangular base 82 from which there extend outwardly two side flanges 84. The outer surfaces 86 of said side flanges are of convex frusto-spherical design and represent portions of a common spherical contour. Between the two side flanges 84, the base 82 is provided with an elongated vertical slot 88. At the juncture region between the side flanges and the base, the side flanges are provided with undercut grooves 90, the two grooves opposing each other and being designed for sliding reception thereon of the outer portions of side legs 92 of the aforementioned locking yoke 74. Said locking yoke is provided at its upper end portion with a bight portion 94 and it has a small hole 95 for reception therein of a tool such as a hook by means of which the yoke may be pulled from its installed position within the opposed grooves 90. As shown in FIG. 8, when the locking yoke 74 is in position within the grooves 90, the inner portions of the side legs 92 thereof straddle and fit within the side portions of the groove 70 in the medial portion of the she-bolt 20. As will be described in greater detail presently, the locking yoke 74, when initially operatively positioned, maintains the clamping bracket 80 in an approximate position with respect to the she-bolt preparatory to final clamping operations.

As best seen in FIGS. 10 and 13 to 16, inclusive, the clamping bracket 80 is further provided with a pair of oppositely extending lateral attachment ears 96 and 97 by means of which the bracket may be permanently affixed to adjacent vertical frame bars 32. The ear 96 is formed with a reentrant hook portion 98 (see also FIG. 6) which is adapted to be hooked behind the outside flange 46 of a vertical frame bar 32 on one panel 10, while the ear 97 is provided with a bolt hole 99 for reception of a clamping bolt 100 which receives thereon an elongated rectangular nut 101. A pair of reaction lugs 102 (see FIG. 14) prevents turning of the nut when the latter is installed in position behind the outside flange 46 of a vertical frame bar 32 on an adjacent panel 10. With the nut and bolt assembly operatively in position, and with the hook portion 98 of the ear 96 hooked behind the flange 46, the clamping bracket 80 is effectively secured in position on a pair of adjacent panels 10.

Still referring to FIGS. 13 to 16, inclusive, it will be observed that the two ears 96 and 97 are each formed

with wedge-shaped locating or centering lugs 104 on the inner sides thereof, the lug that is associated with the ear 96 lying immediately behind the hook portion 98 as shown in FIG. 14. These centering lugs are designed for cooperation with two notches which are effectively established when the four panels 10 of FIG. 3 are brought into contiguity as shown in dotted lines. Such notches exist by reason of the provision of a relieved corner 106 (see FIGS. 4 and 7A) at each end of the outside flange 46 of the vertical frame bars 32. As will be described subsequently in connection with the arrangement of FIGS. 7 and 7A, the wedge-shaped centering lugs are also designed for cooperation with additional notches 108 in the outside flanges 46 when the tie rod assembly is used in a concrete wall form at the bilateral intersection of adjacent panel corner regions near the top or bottom edges of either of the two sides of the form.

With the flat base 82 of the clamping bracket 80 fitting against the outer faces of the outside flanges 46 of adjacent vertical frame bars 32, the she-bolt 20 projects through the vertical slot 88 and extends an appreciable distance forwardly of the clamping bracket 80 as shown in FIGS. 1 and 8. The opposed grooves 90 are in transverse alignment or register with the annular groove 70 in the medial portion of the she-bolt 20, and since the distance between the two side flanges 84 of the clamping bracket 80 is only slightly greater than the diameter of the she-bolt, the locking yoke 74, when in position within the grooves 70 and 90, serves to prevent relative axial shifting movement between the she-bolt 20 and the clamping bracket 80. The clamping bracket being thus locked to the she-bolt, and also being securely clamped to the outside flanges 46 of the adjacent vertical frame bars 32, the tie rod assembly and the two clamping bracket assemblies 22 serve to hold the form sides 14 and 16 in position against collapse or spreading.

The locking yoke 74 is of sufficient thickness to hold the associated form side against collapse or spreading as indicated above, but it is incapable of withstanding the tremendous forces involved by reason of the outward thrust of the wet concrete when the latter is poured between the two form sides 14 and 16 to produce a monolithic wall structure. Therefore, in order to take the load from the locking yoke, a clamping nut 110 is provided and is threadedly received on the screw thread 24 on the outer end of the she-bolt 20. The clamping nut 110 is circular in cross section and embodies two radially extending, longitudinally aligned, manipulating handles 112 which may be turned by hand for initial tightening of the parts and then struck with an impact tool such as a hammer for final tightening purposes. The nut is formed with an annular hub portion 114 having a convex frusto-spherical inner surface 116 which mates with the convex frusto-spherical surfaces 86 of the side flanges 84 of the clamping bracket 80 when the nut 110 is threadedly received on the screw thread 72 on the outer end of the she-bolt 20.

Referring now specifically to FIGS. 7 and 7A, it will be seen that the tie rod assembly and two clamping bracket assemblies 22 are capable of being employed at the bilateral intersections between adjacent panels which occur along the top or bottom edges of the sides of the form. Although the illustration of FIGS. 7 and 7A portrays the use of the tie rod assembly and one of the clamping bracket assemblies at a bilateral intersection established between adjacent panels at the top of one side of the form, these views, if inverted, would represent a similar bilateral intersection established between adjacent panels at the bottom of the one side of the form. The bilateral disposition of the adjacent corner regions of the two panels 10 of FIGS. 7 and 7A establishes a V-shaped void between the diverging portions 39 of the vertical frame bars 32, the panel facings 30 being

exposed within this void. Semi-circular notches **120** are provided in the plywood facings **30** at the level of the notches **108** in the outside flanges **46** of the vertical frame bars **32** so that when the two panels are brought into juxtaposition, a hole **122** is established for reception therethrough of the adjacent she-bolt **20**, this hole **122** being employed instead of the hole **60** which accommodates the she-bolt when a quadrilateral intersection of panel corners is involved. Installation of the tie rod assembly through the aligned holes **122** on opposite sides of the form is precisely the same as described in connection with the quadrilateral panel corner section of FIG. 3 except for the fact that the wedge-shaped locating lugs **104** on the clamping brackets **80** are caused to enter the notches **108** instead of the notches that are formed or provided by the relieved corners **106**.

In the erection of a concrete wall such as that fragmentarily shown in FIG. 5, and utilizing the panels **10** and tie rod assembly of the present invention, the panels are erected in their edge-to-edge relationship of checkerboard design and in such a manner that the frame voids **60** are created at the various regions where four panel corners of one form side come together in quadrilateral relationship. If a gang forming procedure such as has been illustrated in the aforementioned Patent No. 3,067,479 is to be resorted to, the requisite number of panels to produce a gang are thus arranged in contiguity and bolted together by way of the nut and bolt assemblies **64**, after which the assembled gang of panels is hoisted into position and the various gangs of panels on opposite sides of the form are caused to oppose one another in pairs, or at least, the groups of quadrilaterally arranged panels are caused to oppose one another for proper tie rod reception purposes. It will be understood, of course, that walers, strongbacks, suitable gang hoisting brackets and other articles of concrete hardware, as desired, may be applied to the gangs at the time of assembly thereof on the ground.

Assuming now that the various gangs on both sides of the form have been erected and bolted together, the tie rod assemblies consisting of the inner units **18** with the she-bolts **20** threadedly received on the ends thereof, are then caused to pass through the holes **60** so that the tie rod assemblies extend horizontally across the wall form as shown in FIG. 5. If the installation is an original or initial one, that is, one utilizing new panels **10**, the cut-away or truncated corners of the rectangular plywood facings **30** will not be present at the quadrilateral intersections of the various panels and these cut-away corners will be established by the drilling of holes accurately at the exact points of intersection after the form sides have been erected, or alternatively, during progressive erection of these sides. As soon as the holes **60** are established, the tie rod assemblies are installed therein as previously described and then the grooves **70** in the she-bolts **20** are aligned with the grooves **90** in the brackets **80** of the clamping bracket assemblies **22** so that the locking yokes **74** may be inserted in these grooves as previously set forth and as shown in FIGS. 1 and 8. Insertion of the yokes **74** is accomplished by sliding the side legs thereof endwise downwardly in straddling relationship with respect to the grooves **70** so that the inner edges or side portions of these side legs enter the grooves **70** while the outer edges or side portions thereof enter the grooves **90** in the brackets **80**. This operation locks the brackets of the clamping bracket assemblies and, consequently, the associated panels **10** to the she-bolts **20**.

With the locking yokes **74** in position, and prior to installation of the clamping nuts **110** on the she-bolts **20**, the load is solely upon the locking yokes, and although the panels **10** are in their correct position for concrete-pouring operations between the two form sides **14** and **16**, these locking yokes are normally incapable of withstanding the heavy load of the poured concrete. Accordingly, the clamping nuts **110** are provided and these nuts are threaded onto the projecting threaded outer ends of the she-bolts **20** and tightened against the clamping brackets **80**. During this tightening operation, the mating frusto-conical frusto-spherical surfaces **86** and **116** on the side flanges **84** of the clamping brackets **80** and the hub portions **114** of the clamping nuts **110**, respectively, make sliding metal-to-metal contact so that only a moderate amount of torque need be applied to the manipulating handles **112** to effect the desired turning movement of the nuts. Such application of the clamping nuts **110** to the she-bolts **20** relieves the locking yokes **74** of the load and this load is thus taken over, in the main, by the clamping nuts **110**.

It is to be noted at this point that when the clamping nuts **110** are tightened in the manner just described, the side legs of the locking yokes **74** are placed under compression with their inner side edge portions bearing hard against the inside faces of the grooves **70** in the she-bolts **20** and with their outer side edge portions bearing hard against the outside faces of the grooves **90** as shown in FIG. 6. In the medial regions of the form, the inner ends of the she-bolts **20** bear against the stops which are afforded by the flattened regions **26** of the inner units **18** of the tie rod assemblies (see FIG. 5), and thus, the relationship of the locking yokes **74** with respect to the grooves **70** and of the stops **26** with respect to the she-bolts **20** establish a fixed distance measurement between the two opposed form sides **14** and **16** at the points of entry of the tie rod assemblies.

It is contemplated that in manufacturing the tie rod assemblies of the present invention, the she-bolts **20** will be constructed to have a fixed predetermined length, while the inner units **18** will be made in varying lengths. Thus, by a proper selection of inner units for use with the she-bolts, concrete wall forms of different widths may be accommodated. As will be described subsequently, the tie rod assemblies that are associated with a battered concrete wall form, such as has been illustrated in FIG. 8, are required to be of different lengths. These lengths may be made available merely by varying the lengths of the inner units **18** of the tie rod assemblies. Manufacture of the inner units in increments of one-half inch with respect to their length will ordinarily suffice for all contemplated uses of the present improved tie rod assemblies.

Dismantling operations may be carried out by a substantial reversal of the procedure outlined above, but it is seldom that complete dismantling operations involving a separation of the individual panels of a gang form will be resorted to. Backing-off of the nuts **110** will relieve the pressure on the locking yokes **74** and these latter elements may then be pulled from the grooves **70** and **90**, utilizing a suitable hook or other tool in the holes **95** at the upper or bight-equipped ends of the locking yokes **74** (see FIGS. 11 and 12). Removal of the nuts **110** will suffice to permit the she-bolts **20** of the tie rod assemblies to be slid endwise from the holes **60** whereupon the various gangs are freed for stripping from the finished concrete wall, the various gangs being unbolted from one another to permit their separation and individual removal. The brackets **80** may be left in position on the various panels **10** of the individual gangs.

It is to be observed that when dismantling operations are resorted to, the only elements or parts which are expendable are the inner units **18** of the tie rod assemblies. All other parts including the she-bolts **20**, the brackets **80**, the nuts **110**, etc., are recovered for re-use in a subsequent concrete wall form. By preforming the 90° arcuate relief areas **42** at the corners of the plywood panel facings **30** on a radius which closely conforms to the common radius of the she-bolts **20**, relatively efficient seals are provided at the regions where the she-bolts pass through the sides **14** and **16** of the form. Thus, there is little likelihood of concrete seepage outwardly of the panel facings **30** for contamination of the clamping

brackets **80**, the external screw threads **24** on the outer ends of the she-bolts **20**, the locking yokes **74**, or the clamping nuts **110**, while at the same time, "honeycombing" areas at the points of she-bolt emergence from the concrete wall are avoided and patching is reduced to a minimum.

In addition to facilitating tightening of the clamping nuts **110** as previously described, the mating frusto-spherical surfaces **86** and **116** serve the additional function of accommodating a concrete wall form wherein certain of the panels are inclined at a slight angle or better. Although the she-bolts **20** may remain substantially horizontal in such an instance, the position of the clamping brackets **80** will vary according to the deviation of the vertical frame bars **32** from the vertical. The elongated slots **88** in the bases **82** of the clamping brackets **80** afford clearances for the she-bolts **20** throughout a limited range of angular positions of the clamping brackets.

A battered wall form installation is illustrated in FIGS. 8 and 9 wherein one side **214** of the form extends vertically and the other side **216** is disposed at a slight angle to the vertical. It will be understood that panel disposition within the two form sides, except for the slight inclination of the form side **216**, remains substantially the same as the panel disposition previously described in connection with the concrete wall form of FIG. 5, there being quadrilateral corner intersections similar to the corner intersection shown in FIG. 3 and bilateral corner intersections similar to the corner intersection shown in FIG. 7.

Due to the mating frusto-spherical surfaces **86** and **116** on the side flanges **84** of the clamping brackets **80** and the hub portions **114** of the clamping nuts **110**, the various tie rod assemblies of the battered wall form installation may assume their respective inclinations without causing binding of the brackets and their associated nuts **110**. Regardless of the extent of deviation of the tie rod assemblies from the horizontal, the associated nuts **110** will seek an area on the adjacent brackets **80** for coextensive seating purposes when the nuts are tightened. This coextensive seating of the mating surfaces **86** and **116** on the brackets **80** and the nuts **110**, respectively, is made possible by reason of the fact that the locating notches **108** and the composite notches that are established by the relieved corners **106** (see FIG. 7A) are in horizontal register with the holes **122** and **60**, respectively, so that for a normal non-battered concrete wall form, the nuts **110** will seat squarely on the brackets **80** in substantially centered relationship.

The invention is not to be limited to the exact arrangement of parts shown in the accompanying drawings or described in this specification as various changes in the details of construction may be resorted to without departing from the spirit or scope of the invention. Therefore, only insofar as the invention has particularly been pointed out in the accompanying claims is the same to be limited.

Having thus described the invention what I claim as new and desire to secure by Letters Patent is:

1. In a concrete wall form side, in combination, a series of four rectangular, upstanding form panels each of which comprises a rectangular panel facing and a continuous generally rectangular marginal reinforcing frame extending therearound and including opposed vertical and opposed horizontal frame bars, said panels being disposed in edge-to-edge relationship and arranged in a rectangular series and so that their four adjacent corners are in quadrilateral contiguity, the ends of each vertical frame bar being provided with a short laterally inwardly offset portion in order that the adjacent four corners of the frames define therebetween a clearance void which exposes the adjacent corner portions of the panel facings, said adjacent corner portions of the panel facings being truncated and, in combination with one another, defining a hole through the concrete wall form side, a she-bolt extending through said hole and clearance void and projecting outwardly beyond said concrete wall form side, the outer end of said she-bolt being threaded, a clamping bracket loosely received on the threaded projecting end of the she-bolt, means releasably clamping said clamping bracket to the inwardly offset vertical frame bar portions at said adjacent four corners of the frames, and a clamping nut threadedly received on the she-bolt and bearing against said clamping bracket.

2. In a concrete wall form side, in combination, a series of four rectangular, upstanding form panels each of which comprises a rectangular panel facing and a continuous generally rectangular marginal reinforcing frame extending therearound and including opposed vertical and opposed horizontal frame bars, said panels being disposed in edge-to-edge relationship and arranged in a rectangular series and so that their adjacent four corners are in contiguity, said frame bars of the frames being of channel-shape cross section, being arranged so that their flanges are presented inwardly, and having their inside flanges bearing against the panel facings and their outside flanges spaced outwardly from the panel facings, the ends of each vertical frame bar being provided with a short laterally inwardly offset portion in order that the adjacent four corners of the frames define therebetween a clearance void which exposes the adjacent corner portions of the panel facings, said adjacent corner portions of the panel facings being truncated and, in combination with one another, defining a hole through the concrete wall form side, a she-bolt extending through said hole and clearance void and projecting outwardly of the concrete wall form side, the outer end of said she-bolt being threaded, a clamping bracket received on the threaded projecting end of the she-bolt, said bracket including a flat base portion bearing against the inwardly offset portions of the vertical frame bars at said adjacent four corners of the frames, and laterally extending ears overhanging the outside flanges of said vertical frame bars, interengaging means on said outside flanges and ears for preventing vertical shifting of the bracket on the frame bars, and a clamping nut threadedly received on said threaded projecting end of the she-bolt and bearing against said clamping bracket.

3. In a concrete wall form side, the combination set forth in claim **2** and wherein the clamping bracket and the nut are provided with mating frusto-spherical surfaces designed for running engagement with each other to the end that said bracket may assume various batter-type inclinations.

4. In a concrete wall form side, in combination, a series of four rectangular upstanding form panels each of which comprises a rectangular panel facing and a continuous generally rectangular marginal reinforcing frame extending therearound and including opposed vertical and opposed horizontal frame bars, said panels being disposed in edge-to-edge relationship and arranged in a rectangular series and so that their adjacent four corners are in contiguity, said frame bars being of channel-shape cross section, being arranged so that their flanges are presented inwardly, and having their inside flanges bearing against the panel facings and their outside flanges spaced outwardly from the panel facings, the ends of each vertical frame bar being provided with a short laterally inwardly offset portion in order that the adjacent four corners of the frames define therebetween a clearance void which exposes the adjacent corner portions of the panel facings, said adjacent corner portions of the panel facings being truncated and, in combination with one another, defining a hole through the concrete wall form side, a she-bolt extending through said hole and clearance void and projecting outwardly of the concrete wall form side, the outer end of said she-bolt being threaded, a clamping bracket loosely received on the threaded projecting end of the she-bolt and bearing against the inwardly offset portions of the vertical frame bars at said adjacent four corners of the frames, said she-bolt being formed with an annular groove therearound, said bracket being formed with an internal keyway therein in register

with said annular groove in the she-bolt, a U-shaped locking yoke slidable endwise in said keyway to a locking position wherein it enters said annular groove in tangential relation with respect to the she-bolt, said bracket being formed with laterally extending ears thereon overhanging the outside flanges of said vertical frame bars, means for releasably clamping said ears to said outside flanges, and a clamping nut threadedly received on said threaded projecting end of the she-bolt and bearing against said clamping bracket.

5. In a concrete wall form side, in combination, a pair of rectangular form panels each of which comprises a rectangular facing with reinforcing studding on the outer face and around the margin thereof, said panels being disposed in edge-to-edge relationship with adjacent corner regions in contiguity, the portions of the studding at each adjacent corner region being offset so as to define as clearance void therebetween exposing the adjacent intervening corner portions of the panel facings, a portion of each of the thus exposed panel facings being cut away and, in combination with each other, defining a hole in the wall form side, a she-bolt extending through said hole and clearance void and projecting outwardly beyond the concrete wall form side, the outer end of the she-bolt being threaded, a clamping bracket loosely received on said projecting portion of the she-bolt and bearing against the inwardly offset portions of the studding, interengaging means on the clamping bracket and studding for preventing shifting of the bracket on the studding, and a clamping nut threadedly received on the she-bolt and bearing against the clamping bracket.

6. In a concrete wall form side, in combination, a series of four rectangular, upstanding form panels each of which comprises a rectangular panel facing and a continuous generally rectangular marginal reinforcing frame extending therearound and including opposed vertical and opposed horizontal frame bars, said panels being disposed in edge-to-edge relationship and arranged in a rectangular series and so that their four adjacent corners are in contiguity, the ends of each vertical frame bar being provided with a short laterally inwardly offset portion in order that the adjacent four corners of the frames define therebetween a clearance void which exposes the adjacent corner portions of the panel facings, said adjacent corner portions of the panel facings being truncated and, in combination with one another, defining a circular hole through the concrete wall form side, a she-bolt extending through said hole and clearance void, fitting snugly within said hole, and projecting outwardly beyond said concrete wall form side, the outer projecting end of said she-bolt being provided with a screw thread and embodying directly adjacent to the inner end of the screw thread a pair of opposed shoulders, a clamping bracket loosely received on the threaded projecting end of the she-bolt, the outer face of said clamping bracket presenting a frusto-spherical convex surface, releasable inter-engaging means on the she-bolt and bracket adapted to lock said she-bolt and bracket against relative axial shifting movement and consisting of a locking yoke slidable endwise in the bracket and engageable with said opposed shoulders on the outer projecting end of the she-bolt, and a clamping nut threadedly received on said she-bolt, the inner face of said clamping nut being formed with a concave frusto-spherical surface deesigned for running engagement with said convex frusto-spherical surface on the clamping bracket.

7. In a concrete wall form side, the combination set forth in claim 6 and including, additionally, means releasably clamping said clamping bracket to the inwardly offset vertical frame bar portions at said adjacent four corners.

8. In a concrete wall form side, in combination, a series of four rectangular upstanding form panels each of which comprises a rectangular panel facing and a continuous generally rectangular marginal reinforcing frame extending therearound and including opposed vertical and opposed horizontal frame bars, said panels being dispos d in edge-to-edge relationship and arranged in a rectangular series and so that their four adjacent corners are in quadrilateral contiguity, said four adjacent corners having means associated therewith forming a clearance void, a she-bolt extending through said clearance void and projecting outwardly beyond said concrete wall form side, the outer end of said she-bolt being threaded, a clamping bracket loosely received on the threaded projecting end of the she-bolt, releasable interengaging means on the she-bolt and bracket for locking said she-bolt and bracket against relative axial shifting movement, and a clamping nut threadedly received on the she-bolt and bearing against said clamping bracket.

9. In a concrete wall form side, the combination set forth in claim 8 and wherein said releasable interengaging means on the she-bolt and bracket is in the form of a locking yoke slidable endwise in the bracket and engageable with opposed shoulders on the she-bolt.

10. In a concrete wall form side, the combination set forth in claim 9 and including, additionally, means releasably clamping said clamping bracket to the end portions of certain of the frame bars at said adjacent four corners.

11. In a concrete wall form side, in combination, a series of four rectangular upstanding form panels each of which comprises a rectangular panel facing and a continuous generally rectangular marginal reinforcing frame extending therearound and including opposed vertical and opposed horizontal frame bars, said panels being disposed in edge-to-edge relationship and arranged in a rectangular series and so that their adjacent four corners are in contiguity, said frame bars of the frames of the panels being of channel-shaped cross section, being arranged so that their flanges are presented inwardly, and having their inside flanges bearing against the panel facings and their outside flanges spaced outwardly from the panel facings, said four adjacent corners having means associated therewith forming a clearance void, a she-bolt extending through said clearance void and projecting outwardly of the concrete wall form side, the outer end of said she-bolt being threaded, a clamping bracket received on the threaded projecting end of the she-bolt, said bracket including a flat base portion bearing against the end portions of the vertical frame bars at said adjacent four corners of the frames, and laterally extending ears overhanging the outside flanges of said vertical frame bars, interengaging means on said outside flanges and ears for preventing vertical shifting of the bracket on the vertical frame bars, and a clamping nut threadedly received on said threaded projecting end of the she-bolt and bearing against said clamping bracket.

12. In a concrete wall form side, in combination, a series of four rectangular upstanding form panels each of which comprises a rectangular panel facing and a continuous generally rectangular marginal reinforcing frame extending therearound and including opposed vertical and opposed horizontal frame bars, said panels being disposed in edge-to-edge relationship and arranged in a rectangular series and so that their adjacent four corners are in contiguity, said frame bars of the frames of the panels being of channel-shaped cross section, being arranged so that their flanges are presented inwardly, and having their inside flanges bearing against the panel facings and their outside flanges spaced outwardly from the panel facings, said four adjacent corners having means associated therewith forming a clearance void, a she-bolt extending through said clearance void and projecting outwardly of the concrete wall form side, the outer end of said she-bolt being threaded, a clamping bracket loosely received on the threaded projecting end of the she-bolt and bearing against the end portions of the vertical frame bars at said adjacent four corners of the frames, said she-bolt being formed with an annular groove thereabout, said bracket being formed with an internal keyway

therein in register with said annular groove in the she-bolt, a U-shaped locking yoke slidable endwise in said keyway to a locking position wherein it enters said annular groove in tangential relation with respect to the she-bolt, said bracket being formed with laterally extending ears thereon overhanging the outside flanges of said vertical frame bars, means for releasably clamping said ears to the last mentioned flanges, and a clamping nut threadedly received on said threaded projecting end of the she-bolt and bearing against said clamping bracket.

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