March 2, 1965 G. F. BOWDEN 3,171,186

WALL FORM PANEL WITH INHERENTLY REINFORCED CROSSBARS

Filed April 5, 1963 3 Sheets-Sheet 1

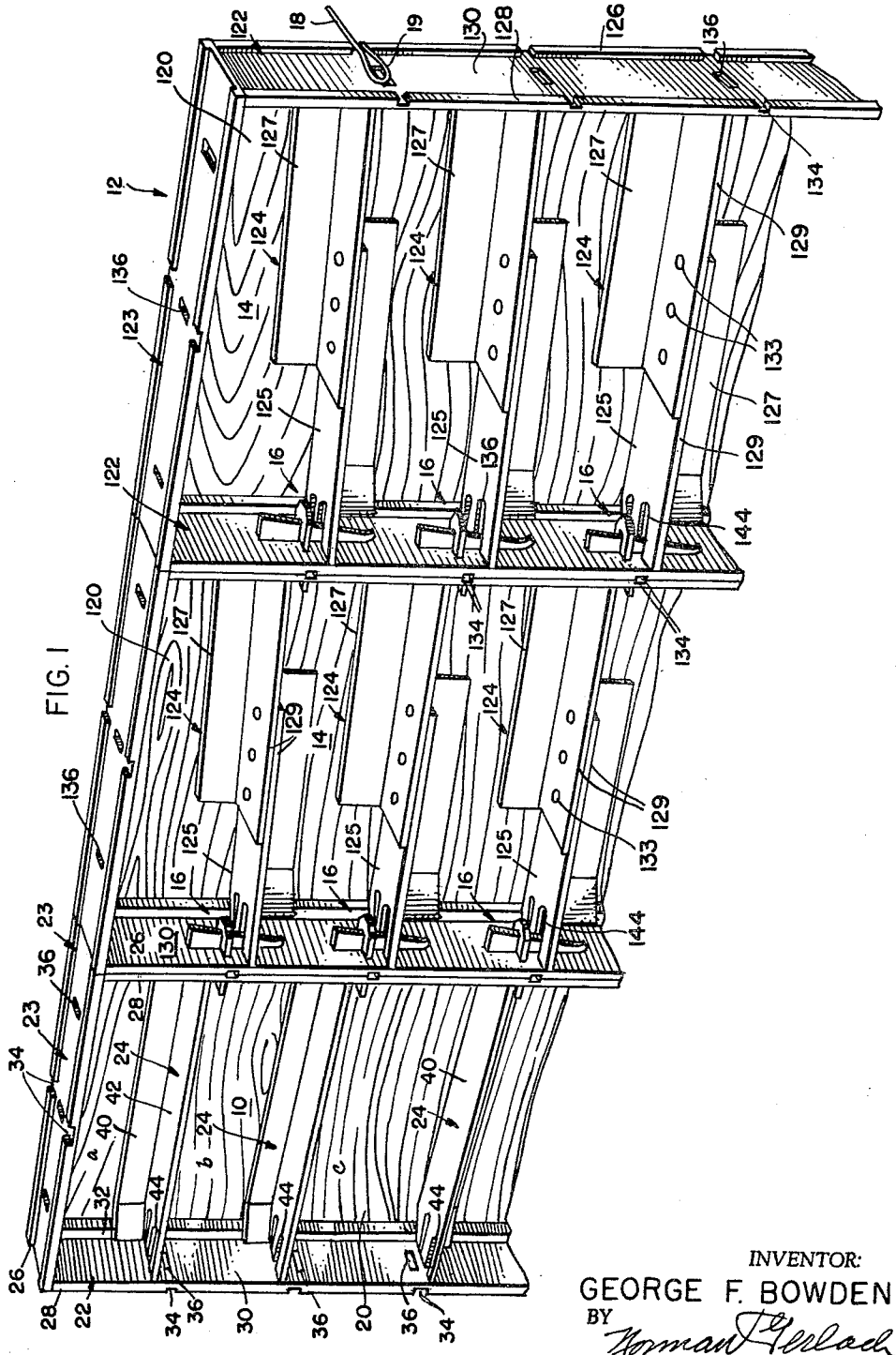


FIG. 1

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FIG. 2

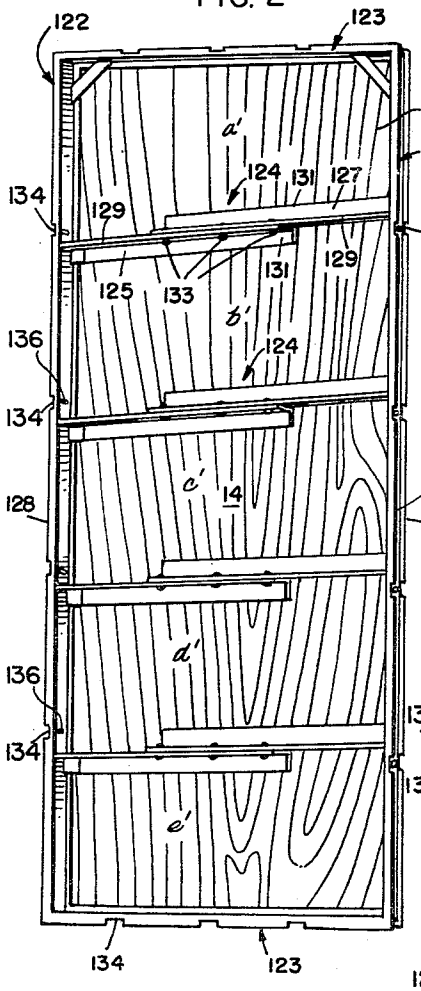


FIG. 3

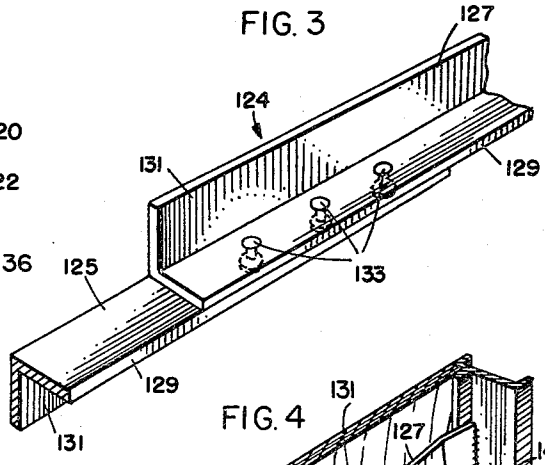


FIG. 4

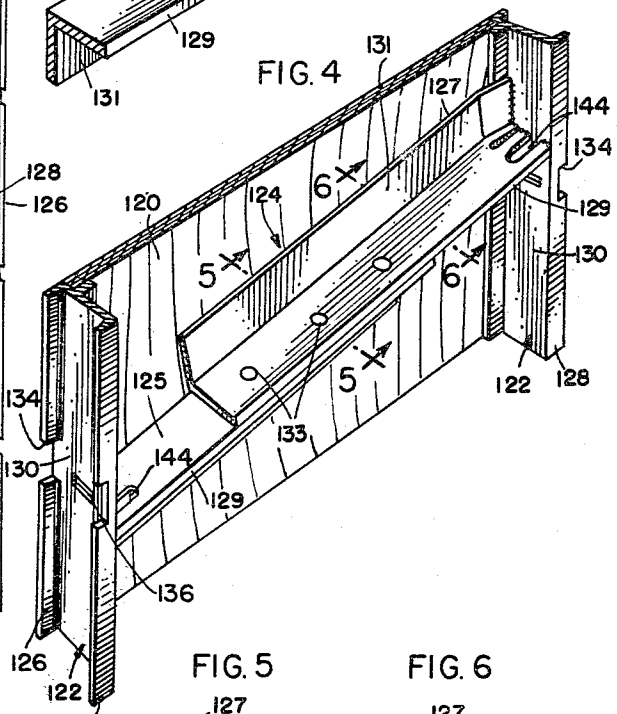


FIG. 5

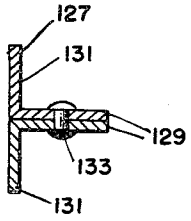
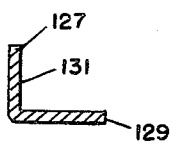


FIG. 6



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FIG. 7

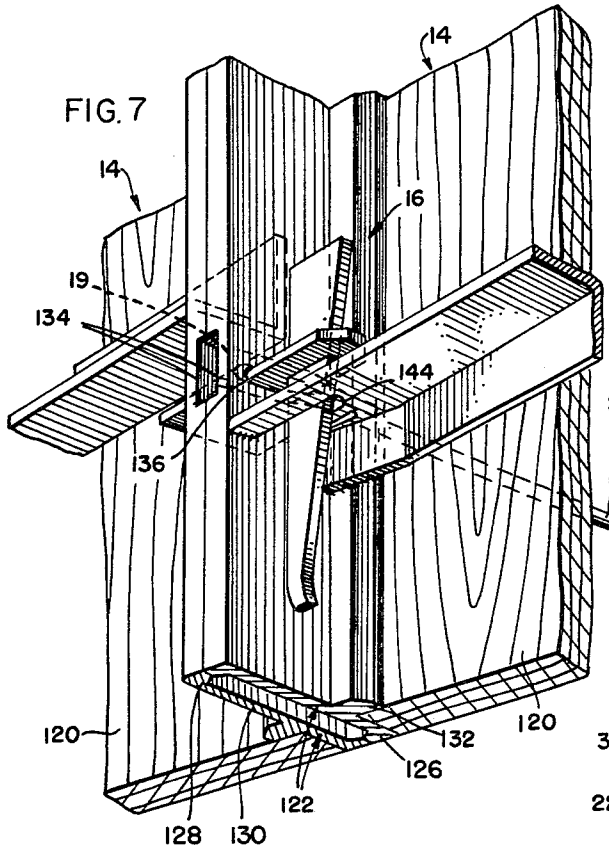


FIG. 9

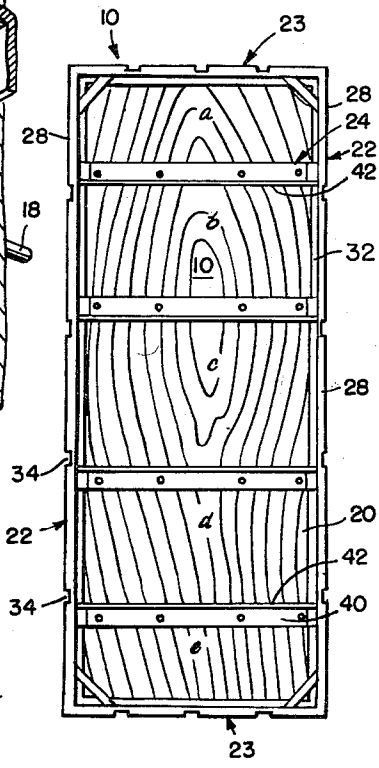
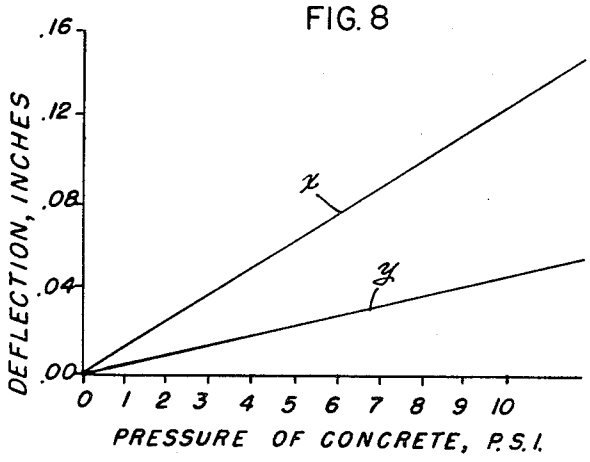


FIG. 8



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3,171,186

WALL FORM PANEL WITH INHERENTLY REINFORCED CROSSBARS

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Filed Apr. 5, 1963, Ser. No. 270,923
4 Claims. (Cl. 25—131)

The present invention relates to a panel-type concrete wall form wherein the opposed spaced apart sides of the form are each constructed of a group or series of rectangular panels in edge-to-edge relationship, with the wet wall-forming concrete being poured into the space existing between the sides of the form, and with the two form sides being connected by horizontal tie rods to prevent the two series of panels from separating under the lateral thrust of the wet concrete. The invention is particularly concerned with a novel panel for use in connection with such a concrete wall form, the panel having associated therewith novel reinforcing crossbars by means of which the plywood panel facing is more effectively braced against outward bulging than has heretofore been possible.

The present invention has particular reference to a prefabricated concrete wall form panel of the type which is commonly known as a "steel-ply" panel and is manufactured and sold by Symons Mfg. Company of Des Plaines, Illinois. Steel-ply panels, in various forms, are widely used in the building industry. They are assembled at the factory rather than in the field, and when shipped to the site or place of use, they are capable of immediate use without modification. Such panels are of special construction in that they are designed to be used with various articles of concrete hardware which also are of special construction and permit the panels to be quickly and easily erected in a wall form installation and subsequently removed from the installation for reuse after they have served their purpose.

A concrete wall form panel of the steel-ply type consists essentially of a shallow tray-like structure including a rectangular plywood facing, the marginal edges of which are completely encased in a metallic rectangular reinforcing frame comprising longitudinal and transverse frame members, together with a series of parallel, spaced apart, transverse crossbars which extend between the longitudinal frame members and lend reinforcement to the medial or central regions of the plywood facing by constituting a backing therefor. Such a panel is adapted to be set up in edge-to-edge relationship with similar panels to provide two opposed form structures wherein the plywood facings of the panels of each structure oppose the facings of the panels of the other structure in spaced relationship, and the wet concrete is adapted to be poured between the two structures. Panels of the type under consideration also find use in connection with the formation of horizontal concrete floor slabs and ceiling slabs, and in such instances, they are arranged in edge-to-edge relationship with the panel facings lying in a common horizontal plane so that the concrete may be poured on the continuous unbroken upwardly facing slab-supporting surface that is offered thereby.

In order to accommodate the concrete hardware which is used with panels of the type and character under consideration, the longitudinal and transverse frame members of the reinforcing frames of the panels are formed with transverse slots therein, such slots being set at approximately one-foot centers. Most of the hardware that is employed is designed to cooperate with these slots, and included in such hardware are conventional T-bolt and wedge assemblies which are employed for drawing the adjacent edges of the edge-to-edge panels together and

holding them secure, and also, if desired, providing anchoring points for the looped or apertured ends of tie rods which extend between the opposite sides or side structures of the final form installation. In order that the various panels may be interlocked with one another regardless of their positions in space, and also in order to accommodate such special hardware as waler clamps and the like at the same horizontal level, it is necessary that the slots be positioned at equally spaced centers.

Panels of this character are manufactured in sizes which vary both as to length and width. These sizes have become well standardized in the industry and are seldom, if ever, deviated from. Specifically, in the large-sized panels which constitute as much as 95% of all the panels which are manufactured, it is absolutely essential that the medial regions of the plywood facings be reinforced against outward bulging under the tremendous thrust of the wet poured concrete and, accordingly, the aforementioned reinforcing crossbars are provided, and they divide the rectangular marginal reinforcing frames into a number of included frame openings which are rectangular and have their long dimensions extending transversely of the panel.

While the most expeditious spacing of the crossbars would ordinarily be at one-foot centers, interference of the crossbars with the proper use of the hardware-attaching slots in the longitudinal frame members prevents such spacing of the crossbars. However, to maintain a spacing as nearly as possible to twelve inches, the crossbars of each panel are caused to traverse the reinforcing frame slightly above or slightly below the level of the slots. To preserve end-for-end reversibility of each panel, all of the crossbars on one side of (i.e., above) a medial horizontal plane are positioned just above the level of the adjacent slots, while the crossbars on the other side of (i.e., below) such plane are positioned just below the level of the adjacent slots. This obviously establishes a medial included opening which is of greater height than the remaining openings.

The crossbars of a steel-ply concrete wall form panel are in the form of angle pieces which are L-shaped in transverse cross section, and when installed, one flange of each crossbar lies flat against the plywood facing, thus reinforcing the facing along a strip which is approximately one and one-quarter inches wide, this being the standard or regular width of the flange. The direction of extent of the various crossbar flanges still further modifies the height of the included openings between cross-bars. When the flanges extend in the same direction, the height of the included opening is reduced by one and one-quarter inches. When the flanges extend away from each other in opposite directions, the height of the included opening is at a maximum. To preserve end-to-end reversibility of panels as mentioned above, it has been customary to cause the flanges of the crossbars above the previously-mentioned medial horizontal plane to project upwardly and the flanges of the crossbars below such plane to project downwardly. The net result of this is that the included openings at the ends of the panels are approximately only nine and one-quarter inches in height, the medial opening is approximately thirteen and one-half inches in height, while the intermediate openings are each approximately ten and one-half inches in height.

The problem of outward bulging of the plywood facings of steel-ply concrete wall form panels under the influence of the hydrostatic pressure of the wet concrete during hardening thereof has presented a problem since the advent of such steel-ply panels in the year 1950. The early steel-ply panels employed flat crossbars placed on edge against the plywood facings, thus maintaining in each panel included openings at the ends of the panel, a single central included opening of fourteen inch height, and a series of intermediate included openings of twelve inch height each. The subsequent use of L-shaped angle pieces

for the crossbars reduce the height of certain of the included openings between crossbars, thus reducing the extent of outward bulging of the plywood facings in certain areas to a marked degree. In the medial areas of the panels, however, where it is impractical to extend the angle flanges of adjacent crossbars in the same direction and where they must necessarily extend in opposite directions, no improvement in the anti-bulging character of the medial included openings has been attained.

The principal objection to localized outward bulging of the plywood facings of steel-ply panels lies in the character of the finished concrete wall or other surface undergoing formation. Localized bulging at the included openings of steel-ply panels results in a condition in the finished wall surface known variously as "pillow blocking," "counter-paning" or "quilting," the finished wall surface taking on a resemblance to a sewed counterpane or quilt with a-series of checkerboard-like bulges appearing throughout the surface, particularly in the lower regions of the structure where the weight of the concrete is greatest. Not only is such localized outward bulging of the plywood facings themselves an undesirable phenomenon from the standpoint of appearance of the finished wall surface, but it opens up cracks and crevices between the edges of the plywood facings and the marginal frame members within which the facings are confined, thus giving rise to seepage of moisture into the raw edges of the plywood facings.

Manufacturers of steel-ply panels have gone to great lengths in an effort to reduce such outward bulging of the plywood panel facings, any reduction, however slight, being worth a considerable increase in cost. However, such reduction in bulging must not be at the expense of a material increase in over-all weight of the panels since much handling of the panels is resorted to in the field during installation and panel knockdown operations. Increasing the number of intermediate crossbars so as to decrease the height of spaces therebetween, or the addition of longitudinally extending crossbars, would offer an appreciable degree of reinforcement to the plywood facings, but these expedients add greatly to the weight of the panels as a whole. Obviously, the use of crossbars of T-shape cross section would reduce the height of all of the included openings, but, here again, the weight limitation precludes such use.

Although an increase in the stiffness of the plywood facings of a steel-ply panel is readily attained by the use of a panel facing of increased thickness, for example, a five-eighths' inch plywood facing instead of the conventional one-half inch plywood facing, and such an increase in facing stiffness would solve the problem of plywood bulging for practically all contemplated installations, the increased weight factor could preclude this obvious expedient. Additionally, since deeper notched edges would be required to receive the marginal edges of the plywood facings, such edges would interfere with the installation of the concrete hardware which is associated with the panels and serves to lock them together, to say nothing of the rendering of the many thousands of steel-ply panels now in use obsolete since they would be incapable of conversion.

The present invention offers a new approach to the problem of plywood bulging in connection with the use of steel-ply panels, and toward this end, it contemplates the provision of a steel-ply type wall form panel having associated therewith novel plywood-reinforcing crossbars which offer added strength and rigidity to the plywood facing at a region where such strength and rigidity are most needed, i.e., at a region where maximum plywood deflection takes place. According to the present invention, the crossbars are so designed that only a limited amount of excess metal is required for their construction, this amount of metal contributing to the over-all weight of the panel in such a small proportionate amount that even when the maximum number of crossbars employed in connection with the largest manufactured size of panel is

considered, the total weight of the panel is within acceptable limits. Still further, according to the invention, the novel crossbars, considered collectively, are so disposed in the panel that equal crossbar spacing is attained, thus rendering the various included openings in the rectangular marginal frame of the panel substantially the same in size or area, while at the same time, the effective spacing between each pair of adjacent crossbars is reduced to such an extent that in-between maximum plywood deflection is reduced by approximately one-half. Still further, this reduction in the effective spacing between adjacent crossbars is accomplished without disturbing the normal function of the various articles of concrete hardware which may be employed in connection with the panel as a whole. Thus, panels constructed according to the present invention and employing such novel crossbars may be used interchangeably with conventional or standard steel-ply panels in either end-to-end position and may be fitted with the usual T-bolt and wedge assemblies between adjacent panels, as well as with various standard forms of waler-clamping devices, gang-forming bolts, fill-in strips, and the like.

It is pointed out that any reduction in the effective spacing between the pairs of adjacent crossbars of a steel-ply concrete wall form panel, even though such reduction is small and is measured in fractions of an inch, results in a phenomenal reduction in the maximum deflection that takes place in the plywood facing across the central regions of the associated included openings. This is because the deflection of a simple beam that is subjected to a uniform load across its span is a function of the fourth power of the length of the span. Heretofore, and as previously set forth, the shortest practical span between adjacent crossbars has been approximately ten and three-quarters inches, this constituting a one-inch span reduction over earlier steel-ply panels which did not employ angle-type crossbars. To widen the angle flange beyond the present-day one and one-quarter inch transverse dimension would not afford a reduction in plywood facing deflection commensurate with the added width, or with the amount of span reduction, inasmuch as the flange lies flat against the facing and is itself subject to camber deflection in the free edge region thereof, the resistance offered thereby being effective only in such regions as are close to its companion flange which is on-edge with respect to the direction of concrete thrust. Additionally, to thus widen the angle flange beyond the standard one and one-quarter inch width thereof would be to increase the over-all weight of the panel to prohibitive proportions. According to the present invention, the desired decrease in the effective length of the span across a given included opening is accomplished by the use of a two-part composite crossbar consisting of two lengths of angle bar stock disposed in overlapping relationship with their on-edge flanges disposed and secured together in back-to-back relationship so that one end region of each length overhangs an end region of the other length and with the other flanges of the two lengths extending outwardly away from each other in coplanar bilateral fashion. With the two lengths of angle bar stock thus secured together, the effective width of each crossbar in the overlapping central region thereof is equal to the over-all width of the two coplanar flanges, and since each flange is one and one-quarter inches wide, the effective width of the crossbar in the central region thereof is somewhat in excess of two and one-half inches when the thickness of the on-edge flanges which exist in face-to-face relationship is considered. In the overhanging end regions of the composite crossbar, the effective width of each crossbar is only one and one-quarter inches, but plywood deflection is never serious in these regions and a high degree of reinforcement is not needed. Because of the extra width of each crossbar in the central overlapping bilateral flange regions thereof where great strength is needed, the longitudinal span

of all included openings in the marginal rectangular panel frame and in the region where maximum plywood deflection ordinarily occurs, is reduced by at least the width of a crossbar flange, namely, one and one-quarter inches. At the central included opening where, in a conventional steel-ply panel the height is at a maximum, there is a reduction in height commensurate with twice the width of a crossbar flange inasmuch as this opening is bounded by two crossbar flanges which extend toward each other.

The overlapping bilateral flange construction of each crossbar of the improved wall form panel involves some increase in weight, but this increase is slight and limited to the amount of metal included in the overlapping portion of each crossbar only. In any event, the over-all increase in panel weight is well within the limits set for it on the basis of ease of handling in the field .

In addition to a reduction in the height of each included opening in a steel-ply panel by reason of the use of bilateral flanges on opposite sides of each crossbar, a further and very appreciable reduction in the height of the central included opening of a conventional steel-ply panel is attained by a novel disposition of the crossbars in the metallic reinforcing frame. According to the present invention, it is possible to position the various crossbars accurately on one-foot centers in such a manner that the height of all of the included openings is equal. This equality in the size of the included openings between composite crossbars is attained according to the present invention by extending the various crossbars on a slight diagonal across the panel in a generally transverse direction so that the axis of each crossbar intersects the medial point on a line connecting the adjacent pair of opposed slots in the longitudinal frame members. The centers of gravity of the various crossbars will thus fall on twelve-inch centers. One end of each crossbar is disposed between the adjacent slot and one end of the panel. The other end of the same crossbar is disposed between the adjacent slot and the other end of the panel. All of the crossbars extend in parallelism, and the angle of the diagonal is a matter of only a few degrees. As will become more readily apparent as the following description ensues and the nature of the invention is better understood, such diagonal placement of the crossbars in no way interferes with the use of conventional concrete hardware, such as the T-bolts and wedge assemblies which are employed for securing adjacent panels together in their proper edge-to-edge relationship, nor does it prevent end-to-end reversibility of panels in any given installation. One of the principal advantages of such diagonal placement of the crossbars is the reduction in the height of the central or medial included opening, this height being reduced not only by twice the width of a crossbar flange as previously explained, but also by bringing the two adjacent crossbars closer together on a twelve-inch center instead of spacing them on a fourteen-inch center on the remote sides of the attachment slots as is the case with a conventional steel-ply panel.

The provision of a concrete wall form panel of the steel-ply type and in which the height of each included opening within the marginal rectangular reinforcing frame is appreciably reduced and the plywood facing as a whole is more adequately reinforced in the manner briefly outlined above, being among the principal objects of the invention, numerous other objects and advantages not at this time enumerated will become more readily apparent as the nature of the invention is better understood.

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

In these drawings:

FIG. 1 is a fragmentary perspective view of one side of a concrete wall form showing two of the steel-ply panels of the present invention operatively connected together in edge-to-edge relationship, and also showing a standard or conventional steel-ply panel associated with the assembly;

FIG. 2 is a rear or outside perspective view of one of the panels shown in FIG. 1 but with the interconnecting hardware removed;

FIG. 3 is an enlarged fragmentary perspective view of one of the improved crossbars which are employed in connection with the invention;

FIG. 4 is an enlarged fragmentary rear or outside perspective view of a medial portion of the panel that is shown in FIG. 2, such view being in the vicinity of one of the crossbars;

FIG. 5 is a sectional view taken on the line 5—5 of FIG. 4;

FIG. 6 is a sectional view taken on the line 6—6 of FIG. 4;

FIG. 7 is a fragmentary perspective view of the adjacent edge regions of two panels embodying the invention, illustrating the manner in which the panels are drawn together in edge-to-edge relationship by means of conventional T-bolt and wedge assemblies;

FIG. 8 is a comparison chart representing maximum plywood deflection factors in connection with a standard steel-ply panel and a commensurate steel-ply panel constructed according to the present invention; and

FIG. 9 is an outside plan view similar to FIG. 2, but on a reduced scale and showing a standard or conventional steel-ply panel in order that it may be compared with the improved concrete wall form panel.

Because of the fact that the particular concrete wall form panel of the present invention represents an improvement over a specific and recently developed form of steel-ply panel, and because the last-mentioned panel is of an intricate nature involving, as it does, specific cross-sectional shapes for the marginal frame members, specific dimensions that cannot be deviated from, specific crossbar spacing which, if deviated from, renders the panel unsatisfactory in commercial use, and specific facilities for the attachment thereto of various articles of concrete wall form hardware, it is deemed necessary to illustrate in the accompanying drawings an exemplary steel-ply panel as it is currently manufactured, and to describe the same in detail to the end that reference may be had thereto for comparison purposes when a description is made of the panel of the present invention. Such an illustration has been made in FIGS. 1 and 9.

Referring now to FIGS. 1 and 9, a conventional steel-ply concrete wall form panel is illustrated in these views and designated in its entirety by the reference numeral **10**. In FIG. 1, the panel **10** is disclosed as forming a part of one side of a composite wall form **12** and is illustrated with two improved steel-ply panels **14** constructed according to the present invention, the panels **14** forming other parts of the one side of the form **12**. The standard panel **10** and the two improved panels **14** are maintained in their normal edge-to-edge relationship by means of conventional T-bolt and wedge assemblies **16** and the side of the wall form **12** that is partly formed by the panels **10** and **14** is maintained in spaced parallel relationship with respect to the other form side (not shown) by means of horizontal tie rods **18** having looped ends **19**. The T-bolt and wedge assemblies **16** and the tie rods **18** are conventional items of concrete wall form hardware and their nature and function will be set forth in greater detail presently when the character of the various panels **10** and **14** is better understood.

The panel **10** is of the prefabricated steel-ply type, such a panel being of open shallow tray-like design and including a rectangular plywood facing **20** and a marginal rectangular steel reinforcing frame comprising longitudinal frame members **22** and transverse frame members **23**. The panel **10** is shown in FIG. 1 as being positioned with its longitudinal frame members **22** extending vertically and with its transverse frame members **23** ex-

tending horizontally and thus further reference to the panel **10** may be made on the basis of its position in the wall form **12**. At appropriate levels in the panel **10**, intermediate horizontal steel crossbars **24** in the form of angle pieces extend between, and are welded to, the opposed vertical frame members **22**.

The frame members **22** and **23** are in the form of structural steel bars which are of shallow channel shape in cross section, and each bar includes inside and outside outwardly extending marginal ribs **26** and **28**, and a connecting base or web portion **30**. On the side of each web portion that is opposite to the ribs **26** and **28** is a lateral inwardly extending flange **32** on which the adjacent edge of the plywood facing **20** seats with its inside face flush with the inside edges of the frame members **22** and **23**.

At vertically spaced regions along the marginal ribs **26** and **28**, pairs of transversely registering notches **34** are formed and these notches, when the frame members are in contiguity, define therebetween horizontal channel voids which are adapted to receive therethrough the looped ends **19** of the tie rods **18**. A rectangular slot **36** is formed in the web portion **30** of each frame member at the level of each pair of notches **34** and such slot is adapted to receive therethrough the shank portion of the T-bolt of one of the T-bolt and wedge assemblies **16** whereby the contiguous or abutting frame members of adjoining panels are drawn tightly together. The various groups of notches **34** and slots **36** in the vertical frame members **22** are formed on twelve-inch centers and in such a manner as to insure that when end-over-end reversibility of any panel is resorted to, notch alignment between contiguous frame members **22** will be preserved.

Referring now to FIG. 9, it will be observed that in connection with the conventional panel **10**, the various crossbars **24** which, as previously stated, are in the form of angle pieces, include vertical flanges **40** and horizontal flanges **42**. The various horizontal flanges **42** are formed with notches **44** (see FIG. 1) in the end regions thereof to accommodate the wedge parts of the T-bolt and wedge assemblies **16**. Thus, it is essential that the horizontal flanges **42** of each crossbar **24** be slightly offset from the horizontal plane of the adjacent slots **36** so that there will be no interference thereof with the T-bolts. This vertical offsetting of the crossbars **24** from the horizontal level of the slots **36** and the notches **44** precludes accurate placing of the crossbars on twelve-inch centers to attain the optimum condition of equal-sized included openings in the panel frame. Accordingly, and in order to preserve the possibility of end-to-end reversal of the panel in a given wall form installation, the crossbars in the upper regions of the panel are positioned with their vertical flanges **40** projecting upwardly, while the crossbars in the lower region of the panel are positioned with their vertical flanges **40** extending downwardly. In the illustrated form of the panel **10**, there are four crossbars and five included openings in the panel frame. Thus, the two uppermost and the two lowermost included openings, labelled *a*, *b*, and *d*, *e*, respectively, are of equal height, while the medial opening, labelled *c*, is of appreciably greater height.

It is pointed out that the plywood facing that is employed in connection with a conventional steel-ply wall form panel like the panel **10** is invariably in the form of a laminated structure of the five-ply variety with the thickness of the laminating being equal and with the overall thickness of the facing being one-half inch so that the individual plies are each one-tenth of an inch thick. As purchased from the manufacturer for subsequent fitting operations in connection with the installation of the plywood facing in the marginal steel reinforcing frame, the grain structures of the various plies run at right angles alternately in different directions so that the outside or surface plies, as well as the center ply, have their grain structure running in the same direction. Based solely upon numerical superiority, it is obvious that a plywood facing of this character will have greater strength against flexing in one direction than it will in the other. As a matter of fact, when plywood is subjected to bending or flexing stresses across a given span, only those plies which have their grain running lengthwise of the span are considered as carrying the load. The cross plies, being stressed across the grain, are incapable of contributing any significant amount of resistance to such flexing or bending. These considerations are not altered appreciably by the fact that a concrete wall form panel facing of plywood is supported along all four marginal edges since the reinforcement offered at the marginal edges is effective only in the immediate vicinity of the panel members. For these reasons, and in order to attain the greatest resistance to flexing, it is customary to cut and install the plywood facing in the rectangular frame of a steel-ply panel so that the predominance of plywood grain structure runs in the direction of the shortest span associated with each included opening in the frame. This face should be borne in mind in connection with the following considerations which are given to the deflection of the plywood facing across the included openings in the frame of a standard steel-ply panel such as the panel **10** that is illustrated herein, the deflection arising, of course, under the pressure of wet concrete in any given installation.

Still referring to FIG. 9, it has been found in actual practice that the height of the included openings *a*, *b*, *c*, *d*, and *e* in a present-day conventional steel-ply panel is such that under a heavy concrete load, the previously-mentioned "pillow block" or "quilting" effect obtains in the completed concrete wall structure after the panel is removed. Under a more moderate load, this effect may not be noticeable in connection with the included openings *a*, *b*, *d* and *e*, but it is likely to be noticeable in connection with the included medial opening *c* which has an appreciably greater height than the other openings. Theoretical considerations have shown that the maximum deflection of a beam under load across a given span, i.e., the deflection at mid-span, may be represented by the equation

$$\Delta = \frac{KWl^4}{EI}$$

where Δ represents maximum deflection, K is a constant that varies with the type of span, W is the weight per unit of length, l is the length of the span, E is the modulus of elasticity of the beam, and I is the moment of inertia. From this equation, it will be seen that maximum deflection varies as a function of the fourth power of the length of the span and, consequently, any reduction in the length of the span, however small, will effect a material reduction in the amount of beam deflection.

According to the present invention, a reduction equal to the full width of the vertical flange **40** of one of the crossbars **24** is accomplished in the effective height of the included openings corresponding to the openings *b* and *d*, and in the case of the opening which corresponds to the included opening *c*, an additional reduction is effected. These reductions amount to approximately one and three-eighths inches for the smaller openings and approximately three and three-eighths inches for the large medial opening. Comparative tests have shown that maximum deflection has been substantially cut in half. Moreover, the reductions have been accomplished without adding unduly to the over-all weight of the panel. The reductions are made possible by the design and construction of the crossbars and a novel disposition of the crossbars within the panel frame, as will now be set forth in detail.

Referring now to FIGS. 1 to 4, inclusive, wherein the panel **14** of the present invention and its associated novel crossbars are best illustrated, the plywood facing **120** and the marginal frame members **122** and **123** remain substantially the same as in the herein illustrated conventional steel-ply panel **10** and, therefore, in order to avoid need-

less repetition of description, similar reference numerals but of a higher order have been applied to the corresponding parts as between the respective illustrations of the two panels. The wall form hardware, such as the T-bolt and wedge assemblies **16** and the tie rods **18** which are used in connection with the panel **10**, are capable of accommodation by the panel **14** and thus, wherever such hardware has been illustrated in connection with either panel, identical reference numerals have been applied thereto. The only difference between the panels **10** and **14** resides in the novel construction and disposition of the various crossbars **124** which are associated with the improved panel **14**.

Each crossbar **124** consists of two substantially identical angle pieces **125** and **127**, which may be cut from steel angle bar stock and are secured together in overlapping relationship, as shown in FIGS. 2 and 3, to form the composite crossbar. Each angle piece is provided with a substantially horizontal flange **129** and a vertical flange **131**, the two angle pieces **125** and **127** being secured together in overlapping relationship in any suitable manner as by welding or by means of rivets such as have been shown at **133**. The angle piece **125** has its vertical flange **131** projecting downwardly, while the angle piece **127** has its vertical flange **131** projecting upwardly, these two vertical flanges lying in the same common vertical plane. The extent of overlap between the two angle pieces **125** and **127** is approximately one-third the over-all extent of each composite crossbar **124**, although this extent of overlap is not too critical and may be varied within fairly wide limits.

The over-all extent of each crossbar **124** is slightly greater than the distance between the two vertical or longitudinal marginal frame members **122** and the various crossbars **124** are caused to traverse the rectangular frame of the panel in diagonal fashion at a slight angle from a horizontal plane. The six crossbars **124** that are illustrated herein are equally spaced along the longitudinal extent of the panel **14** and all extend in parallelism, thus dividing the rectangular frame into seven included openings, each of which is substantially in the form of a wide angle parallelogram with all of the openings being of equal size and having the same height or vertical mid-span.

The extreme ends of the overhanging portions of the two angle pieces **125** and **127** of each crossbar **124** are provided with notches **144** in the usual manner of conventional crossbars so as to receive the wedges of the T-bolt and wedge assemblies **16**. These notched ends of the crossbars **124** are suitably secured as by welding to the longitudinal frame members **122** at regions which are slightly offset from the level of adjacent groups of bolt-receiving slots **136** and tie rod-receiving notches **134**, the right-hand ends of the crossbars as viewed in FIGS. 2 and 7 being disposed above the groups and the left-hand ends thereof being disposed below the groups. With each crossbar **124** thus positioned, the mid-point or center of gravity thereof lies substantially in the horizontal plane of the adjacent opposed slots **136**.

This diagonal disposition of the crossbars **124** in no way interferes with the use of conventional concrete wall form hardware inasmuch as the various slots **136** are not obstructed, nor are the entrance openings leading thereto on either side of the frame members **122**. The T-bolts of the assemblies **16** may be passed through the slots from either side of the associated longitudinal frame member and the wedges have clearance for insertion through the T-bolts by reason of the notches **144** in the crossbars **124** whether the T-bolt overlies or underlies the adjacent horizontal crossbar flange **129**. The use of such hardware has been illustrated in FIG. 7 wherein the shank part of the T-bolt of the assembly **16** overlies the adjacent horizontal flange **129** of the illustrated crossbar of one panel **14** while the head part of the bolt underlies the adjacent horizontal flange **129** of the illustrated crossbar of the other panel. The installation of the assembly **16** obviously could be made by reversing the T-bolt in the slot **136** and the wedge part could be driven upwardly instead of downwardly. However, for practical reasons, it is preferable that where it is possible, the wedge be driven downwardly through the T-bolt, as shown in FIG. 7.

Referring again to FIG. 2, and comparing the panel thereof with the panel of FIG. 9, it will be observed that the various included openings *a'*, *b'*, *c'*, *d'* and *e'* of the frame of the panel **14** present equal vertical mid-spans, whereas in the frame of the panel **10**, the mid-span of the included opening *c* is appreciably greater than the mid-spans of the other openings *a*, *b*, *d* and *e*. Moreover, the mid-span of any one of the included openings in the frame of the panel **14** is of less extent than is the smallest mid-span of any of the included openings in the frame of the panel **10**. Dimensional considerations are important to the present invention inasmuch as with a panel of any given width, there is an optimum length of mid-span which, if exceeded, will give rise to "pillow block" effects in the finished concrete wall. Since in each of the medial regions of the reinforcement that is offered by the crossbars **124**, there is an increased width of two vertical flanges **129** instead of only one vertical flange in the case of the panel **10**, or of no vertical flanges whatsoever in the case of the included opening *c*, there is a reduction of no less than one and three-eighths inch over the extent of the height of mid-spans of the openings *b* and *d*, and a reduction of three and three-eighths inches over the extent of the height or mid-span of the included opening *c*, these reductions being based solely upon the additional lateral reinforcement that is offered by the vertical coplanar flanges **131**. In the case of the mid-span of the included opening *c* of the panel **10**, there is a sitll further and very appreciable reduction in the mid-span offered by the adjacent crossbars of the panel **14**, this additional reduction amounting to a full two inches by reason of the centers of the two crossbars falling on twelve-inch centers instead of being spaced one inch above and one inch below the horizontal planes of the opposed pairs of slots **136** respectively. Thus, the total reduction in the height or vertical extent of the height of the included medial opening *c'* amounts to three and three-eighths inches in the case of the panel **14**. When it is considered that maximum deflection is a function of the fourth power of the length of the span (disregarding the practically negligible resistance to flexing offered across the direction of grain structure predominance), a reduction of three and three-eighths inches in the vertical span of the opening *c'*, and which to begin with is less than eleven inches, is a very appreciable reduction indeed and results in a marked decrease in plywood facing deflection at the opening *c'*.

In addition to effecting a decrease in the height or vertical extent of all except the two endmost individual included openings of a steel-ply panel, use of the crossbars **124** results in more rigid reinforcing members across the back of the plywood facing **120**, the rigidity of the crossbars being enhanced by the dual on-edge backing of the overlapping portions of the horizontal flanges **129**, as well as by whatever strength is afforded by reason of the overlapping portions of the side-by-side vertical flanges **131**.

The chart of FIG. 8 is based upon comparative tests which have been performed on two similar size panels, one constructed with crossbars **24** of the type shown in FIG. 9, and the other constructed with the novel crossbars **124** of FIG. 2. The abscissae represent the effective concrete load against respective included openings such as the openings *b* and *d* of the panel **10** when compared with the corresponding openings *b'* and *d'* of the panel **14**. The ordinates represent maximum deflection. The abscissae are measured in pounds per square inch, while the ordinates are measured in inches. The upper chart line *x* is for the standard steel-ply panel, while the lower chart line *y* is for the steel-ply panel of the present in-

vention. It is to be observed that the angle subtended between the upper chart line *x* and the axis of the abscissae is approximately twice the angle subtended between the lower chart line *y* and the axis of the abscissae, thus indicating that at all concrete pressures, maximum span deflection is reduced by approximately one-half.

It is to be noted finally that by the use of the present composite crossbars **124**, the only weight that is added to the panel as a whole is the weight contributed by the overlapping extent of a single vertical flange **131** on each crossbar, not to mention the insignificant weight of the rivets **133** or such metal as may be employed if welding between the angle pieces **125** and **127** is resorted to. Speaking in general terms, it should further be noted that the added reinforcement which is offered to the plywood facing **120** by any one of the crossbars **124** takes place in a region of the plywood facing where such reinforcement is most needed, namely, in the medial region thereof midway between the two longitudinal frame members **122**. Furthermore, the decrease in the longitudinal extent of any given included opening offered by a pair of adjacent crossbars **124** takes place at a region where the greatest deflection normally takes place, namely, midway between longitudinal frame members. In the side regions where deflection normally is small, the panel as a whole is not burdened with the weight of additional metal.

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. A concrete wall form panel adapted to be positioned vertically in edge-to-edge relation with like panels for purposes of forming a part of a concrete wall form, said panel comprising a rectangular plywood facing and a rectangular marginal reinforcing frame including vertical opposed parallel side members and horizontal opposed parallel end members, said side members being provided with vertically spaced pairs of opposed bolt-receiving openings at equally spaced horizontal levels, and a series of generally transversely extending plywood-reinforcing crossbars having their ends secured to the side members respectively, there being one crossbar for each pair of openings, each crossbar having one end thereof secured to one of said side members a slight distance below an opening therein and having its other end secured to the other side member a slight distance above an opening therein, all of said crossbars extending in parallelism and defining, in combination with the side members, a series of parallelogram-shaped included openings in the rectangular marginal reinforcing frame and in which the crossbars extend at a small angle to a horizontal plane, each crossbar being of a composite rigid nature and comprising two angle pieces each of which has a substantially horizontal flange and a vertical flange, said angle pieces having their horizontal flanges secured together in overlapping relationship throughout a limited medial region of the crossbar and having their vertical flanges extending in opposite directions and in coplanar relationship, the horizontal flanges of the angle pieces being set on edge against the plywood facing and the vertical flanges being disposed in face-to-face contact with the plywood facing.

2. A concrete wall form panel as set forth in claim 1 and wherein said crossbars have their mid-points disposed at the horizontal level of the associated pair of opposed openings.

3. A concrete wall form panel as set forth in claim 1 and wherein said crossbars have their mid-points disposed at the horizontal level of the associated pair of opposed openings, and wherein the distance between each pair of adjacent crossbars is equal.

4. A concrete wall form panel as set forth in claim 1 and wherein said overlapping medial region of the horizontal flanges of each crossbar is not appreciably greater in extent than one-third of the over-all extent of the crossbar.

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