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(54) **SYSTEMS AND METHODS FOR SHORING CONCRETE**

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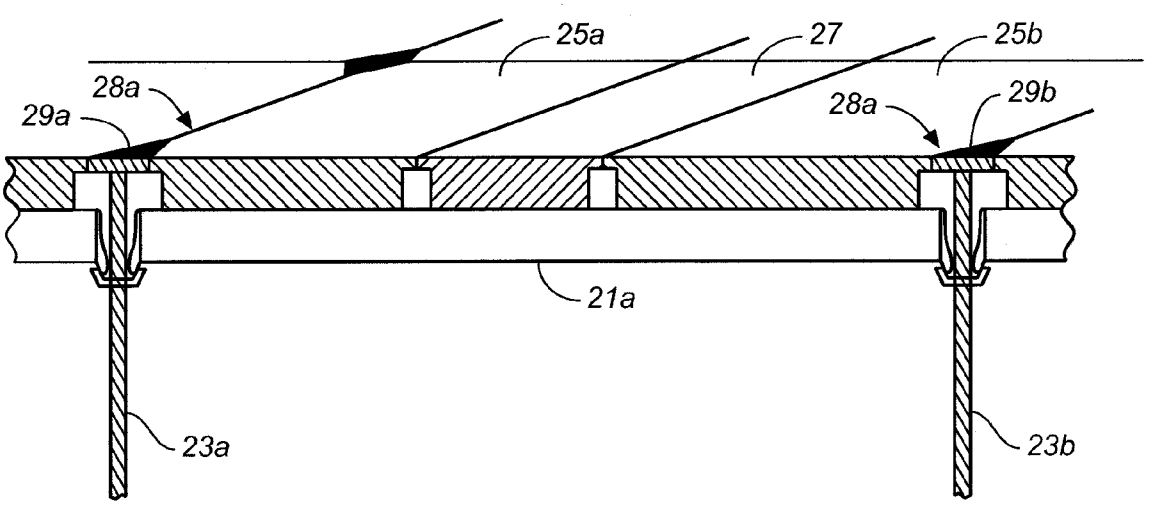
(57) **ABSTRACT**

A shoring system includes posts that provide direct support for poured concrete through top plates. The posts also provide support for ledgers, which support forming panels, which in turn support poured concrete. Ledgers and forming panels are removed without removing posts, so that posts provide continued support until concrete is set.



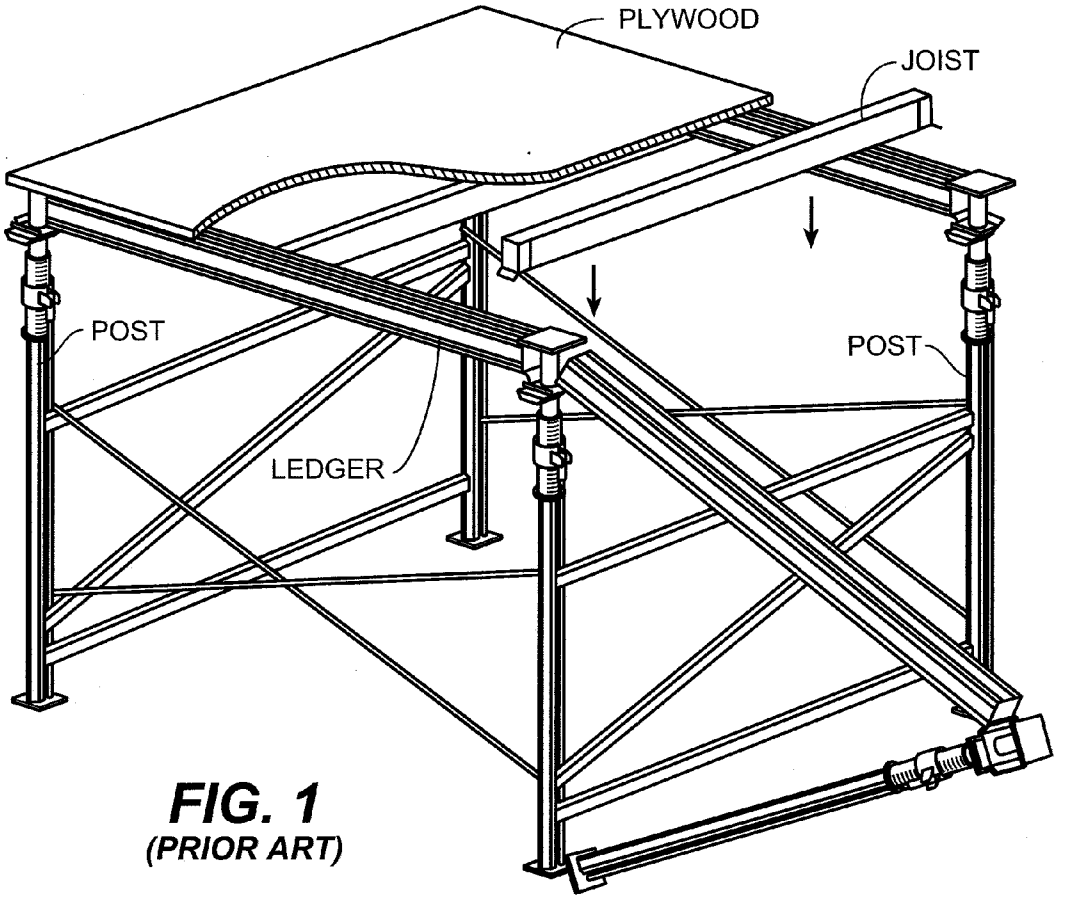


FIG. 1
(PRIOR ART)

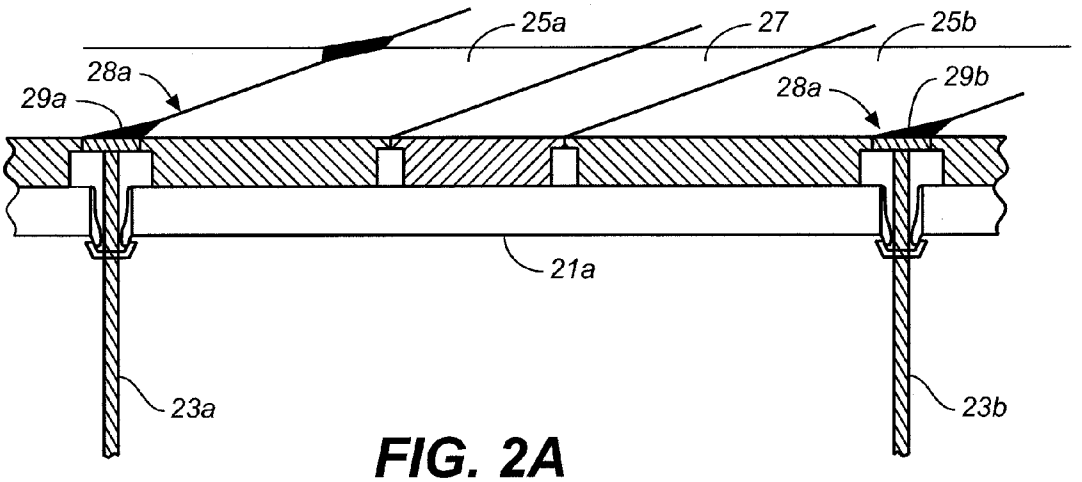


FIG. 2A

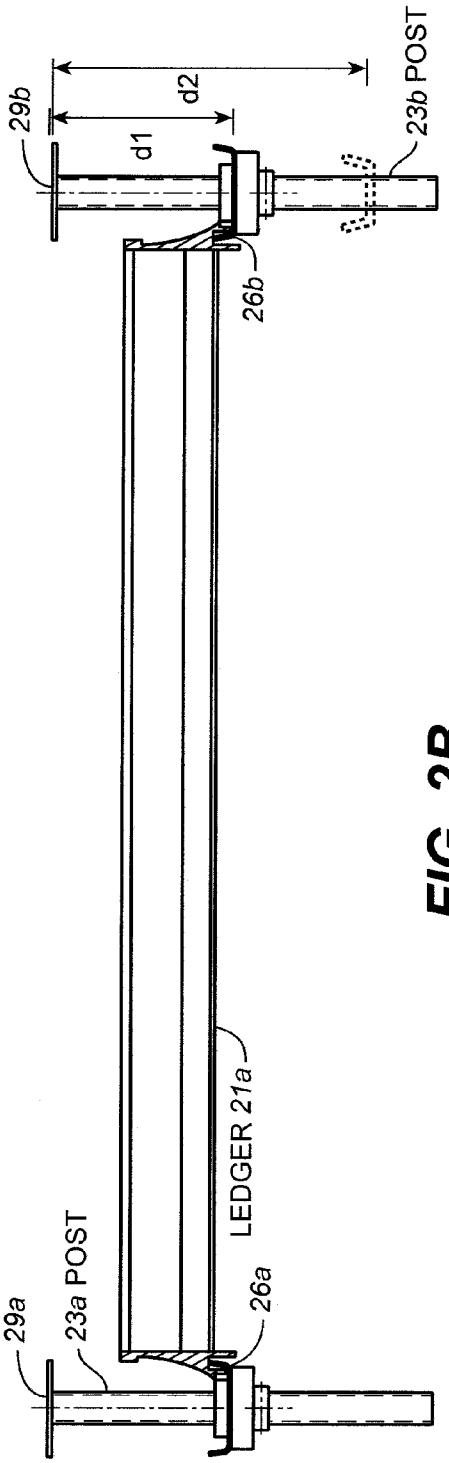


FIG. 2B

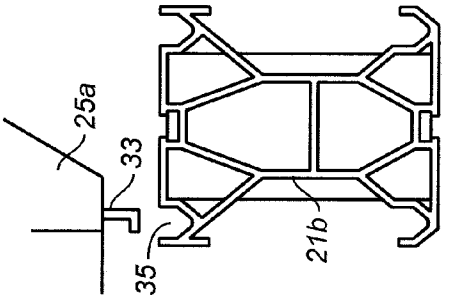


FIG. 3B

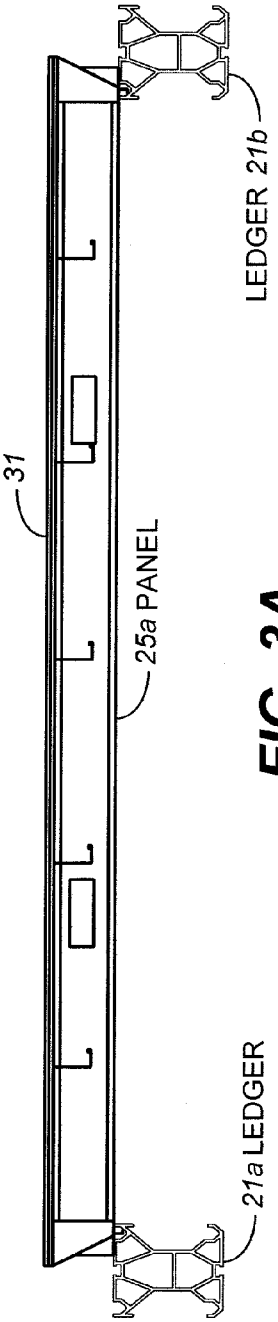


FIG. 3A

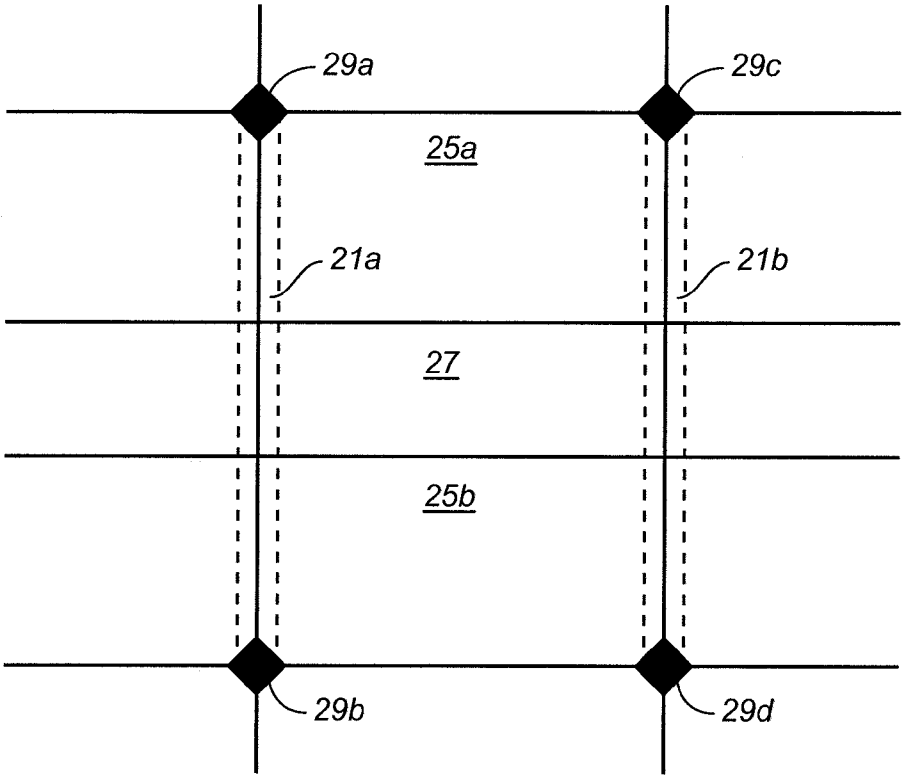


FIG. 4

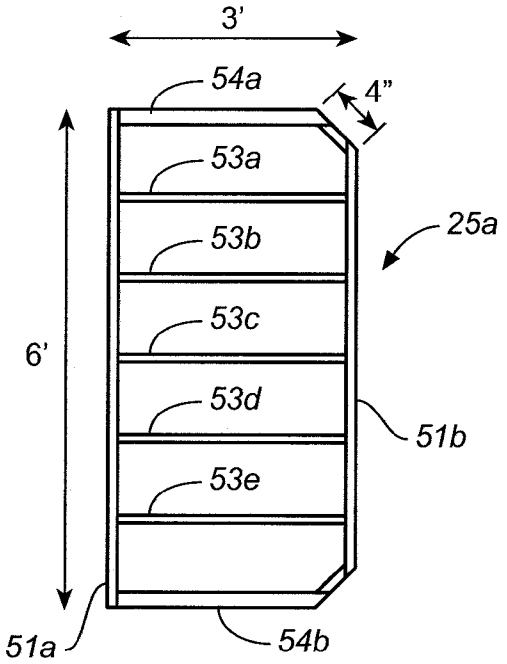


FIG. 5A

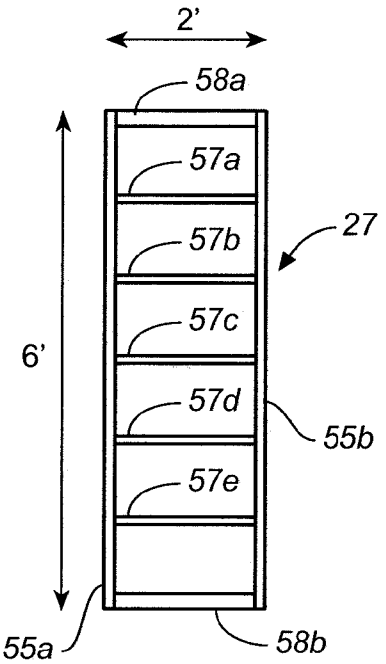


FIG. 5B

SYSTEMS AND METHODS FOR SHORING CONCRETE

BACKGROUND OF THE INVENTION

[0001] This application is related to construction of concrete structures and in particular to shoring systems and methods for forming structures using poured concrete.

[0002] Concrete is commonly used in construction of buildings. In some applications, concrete is poured into a volume that is defined by shoring (or "shuttering") and allowed to set before the shoring is removed. This technique is particularly useful for construction of concrete floors such as used in commercial or residential buildings and in parking structures. In such an application, the shoring must adequately contain the poured concrete without leaks and must support the weight of the concrete until it sets. In addition, it is desirable that shoring be quick and simple to set-up and take-down so that costs are not excessive.

[0003] In most shoring systems, a series of vertical supports, also known as "legs" or "posts" are used to support the poured concrete on a structurally sound base. For example, in a multi-story building, a previously constructed floor may be used as the base for supporting a subsequent floor. Posts generally have a base plate to distribute any load on a base surface. Posts may be come in a range of lengths depending on the spacing required between the base and the bottom of the poured concrete structure being formed. In addition, posts may be adjustable in length so that a range of spacing can be achieved with an individual post. Neighboring posts may be connected by support members to create a framework that is strong and does not deform under load. Such support members may be attached at various locations along posts to form horizontal or diagonal support members. In addition, posts may support horizontal components (horizontal supports) that in turn support the poured concrete.

[0004] In one example, posts support horizontal components, also known as "beams" or "ledgers." Such ledgers are generally supported at each end by a post. Between parallel ledgers, joists may extend and attach to ledgers. The tops of ledgers and joists may be on the same level (and on the same level as the tops of posts). Subsequently, a layer of plywood or similar material is laid over the ledgers and joists. The plywood layer is laid so that there are no significant gaps and when concrete is poured it is contained by the plywood. The plywood is supported by the joists and ledgers, which in turn are supported by the posts. One example of such a system is provided in U.S. Pat. No. 6,871,454, which patent is hereby incorporated by reference in its entirety. This example is illustrated in FIG. **1**, which shows posts supporting ledgers and ledgers supporting joists. Tops of posts, ledgers and joists define a surface across which plywood is laid. Concrete is then poured on and contained by the plywood.

[0005] In many applications, concrete structures must be supported for some time after pouring so that the concrete has sufficient structural strength and does not collapse. The time period before shoring may be removed can vary depending on the structure and the type of concrete used. In some cases, after an initial period, some shoring may be removed as long as the concrete structure is still supported at a certain number of points. For example, after 1-2 days it may be possible to remove plywood sheets that contain the concrete, as the concrete is solid at this point. However, the concrete does not have sufficient strength to be entirely unsupported at this stage, so it is desirable to use posts to provide support at certain points distributed across the lower surface of the concrete structure. In one example, posts are withdrawn to allow removal of ledgers and joists for use elsewhere. The posts are then reinstalled to support the concrete structure. In another example, posts are removed and then different posts are installed to provide support until the concrete has fully set. However, such a procedures are time consuming and labor intensive.

[0006] In order to avoid having to take down and replace posts, certain posts have a drop head that allows removal of some shoring components while posts remain in place. Posts with a drop head generally remain in contact with the surface of the concrete from the time the concrete is poured until it reaches an adequate strength to be self-supporting and are not moved during removal of other shoring components. In one example of such a system, a surface is defined by the tops of the posts and horizontal supports, but instead of laying plywood over this surface, panels are attached to horizontal supports so that the panels extend along the same surface as the tops of the posts and horizontal supports. Concrete is then poured over this surface. However, in this case, concrete directly contacts the horizontal supports adding to the difficulty of removal and cleaning of such components. Also, attachment of panels and horizontal supports may be complicated in this case.

[0007] Some shoring systems do not use horizontal supports and attempt to support poured concrete using posts and panels alone. However, such systems may lack structural strength or, in order to achieve necessary structural strength, may have heavy panels that are difficult to position. Also, such systems generally support panels only at corners, which may cause considerable stress at these points, which may cause failure.

[0008] Therefore, there is a need for an improved shoring system that allows removal of certain shoring components without moving posts, while being simple and cheap to manufacture, install and remove.

SUMMARY OF THE INVENTION

[0009] A shoring system includes vertical posts that extend from a base to a top plate. Ledgers extend between neighboring posts in at least one direction at a height below the top plate. The ends of ledgers have features that attach to corresponding attachment features on posts in a secure manner. Forming panels are placed so that their ends overlie and are supported by ledgers. Forming panels are purpose-made panels of predetermined size and shape. In addition, interlocking features are provided on the bottom of forming panel ends and on the tops of ledgers so that these components are secured together from lateral movement. Forming panels are placed so that they are in close contact with neighboring panels along their sides and ends. Certain forming panels have cut-off corners that are placed so that they are in contact with top plates. In this way, panels and top plates define a surface that is formed by prefabricated components to have no significant gaps that would allow poured concrete to escape. Concrete is poured over the surface defined by forming panels and top plates and is allowed to dry.

[0010] After a first period of time (typically 1-2 days, though sometimes longer) forming panels and ledgers are

removed. The attachment features holding ledgers to poles are dropped to a lower position by withdrawing a pin that previously supported them in an upper position. Alternatively, some other mechanism is used to hold the attachment features in an upper position at one time and a lower position at another time. With the attachment features in the lower position, there is sufficient space so that forming panels may be moved with respect to ledgers so that their interlocking features are separated. Forming panels and ledgers may be moved out of position as a result. The forming panels and ledgers can then be used elsewhere. Forming panels and ledgers are removed without moving posts, so posts continue to support the concrete without interruption or the need for additional shoring. At a later time, after the concrete has sufficient structural strength (up to a month later), posts are removed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. **1** shows components of a shoring system of the prior art including posts, ledgers between posts, and joists extending between ledgers, with plywood sheets overlying posts, ledgers and joists.

[0012] FIG. **2**A shows a cross section of a shoring system according to an embodiment of the present invention including posts, ledgers and forming panels having predetermined sizes and shapes so that top plates on posts and forming panels form a continuous surface for containing concrete.

[0013] FIG. **2**B shows how a ledger of FIG. **2**A is attached at either end to attachment features on posts.

[0014] FIG. **3**A shows how the ends of forming panels of FIG. **2**A overlie and are supported by ledgers and have interlocking features to secure forming panels to ledgers.

[0015] FIG. **3**B shows a detailed view of interlocking features of the forming panel and ledger of FIG. **3**A.

[0016] FIG. **4** shows a top-down view of the shoring system of FIG. **2**A showing a continuous surface formed by top plates and forming panels.

[0017] FIG. **5**A shows a more detailed view of a first shoring panel that has ribs for structural strength and cut-off corners to fit with top plates.

[0018] FIG. **5**B shows a more detailed view of a second shoring panel that has regular corners and does not contact top plates.

DETAILED DESCRIPTION OF EMBODIMENTS

[0019] FIG. **2**A shows a cut-away view of a shoring system according to an embodiment of the present invention. Posts are shown supporting ledgers. Specifically, ledger **21***a* is supported by posts **23***a* and **23***b*. Forming panels **25***a*, **25***b* and **27** are supported by ledger **21***a* at one end. Forming panels **25***a*, **25***b* and **27** are placed together so that little or no gap exists between them. Forming panels **25***a*, **25***b* and **27** form one portion of a repeated pattern of panels that extends across a surface that is used to form a concrete structure. Thus, forming panels **25***a*, **25***b* and **27** are in contact with other panels also. Forming panels **25***a* and **25***b* have identical dimensions in the present example and are therefore interchangeable.

[0020] Posts **23***a* and **23***b* have top plates **29***a* and **29***b* respectively. Top plates **29***a* and **29***b* are square in shape but are oriented at 45 degrees to the sides of forming panels **25***a*, **25***b* and **27**. Forming panels **25***a* and **25***b* have cut-off corners **28***a* and **28***b* respectively, that abut top plates **29***a* and **29***b*. In one example, cut-off corners **28***a* and **28***b* of forming panels **25** and **27** are four inches (4") in length and extend at 45 degrees to the sides they connect. The sides of top plates **29***a* and **29***b* are four inches (4") or just under four inches, for example three and thirty-one thirty-seconds inches ($3^{31}/_{32}$") so that a top plate is fractionally smaller than the opening formed between forming plates.

[0021] FIG. **2**B shows a more detailed view of ledger **21***a* and its attachment to posts **23***a* and **23***b*. Posts **23***a* and **23***b* both have attachment features **26***a* and **26***b* respectively that provide support for ledger **21***a*. Attachment features may include a support plate that is mounted to a post so that it extends laterally and provides support for corresponding features on the ends of a ledger. Ledger **21***a* has end features that attach to the support plate so that when the ledger is lowered into place it cannot fall out of position or be easily disturbed. In general, ledger **21***a* can only be separated from attachment features **26***a* and **26***b* by vertically separating ledger **21***a* and attachment features **26***a* and **26***b*. This may be achieved by moving ledger **21***a* up or moving attachment features **26***a* and **26***b* down.

[0022] In order to facilitate removal of ledger **21***a* after concrete is set, attachment features **26***a* and **26***b* are designed to be moved down. In one example, a pin extends through a post and attachment features **26***a* and **26***b* are maintained in an upper location by the pin. Attachment features **26***a* and **26***b* may include a support plate, which is a metal plate with an opening extending around a post. The support plate extends in a plane perpendicular to the axis of the post and may have features that mate with corresponding features on ends of ledgers. A support plate may also be keyed to be in a particular rotational orientation with respect to a post. When the pin is removed, attachment features **26***a* and **26***b* drop to a lower location. An alternative system with movable attachment features is described in U.S. Pat. No. 6,871,454. FIG. **2**B shows ledger **21***a* in an upper location when attachment features **26***a* and **26***b* are at a distance d**1** from top plates **29***a* and **29***b*. In this upper location, ledger **21***a* supports forming panels **25***a*, **25***b* and **27** so that their top surfaces are at the same level as the top of top plates **29***a* and **29***b* as shown in FIG. **2**A. FIG. **2**B also shows a lower location for attachment features **26***b* a distance d**2** from top plate **29***b*. When attachment features **26***a* and **26***b* are in the lower position, there is sufficient distance (d**2**) between attachment features **26***a* and **26***b* and the bottom of a poured concrete structure overlying top plates **29***a* and **29***b* to allow ledger **21***a* to be moved up and out of attachment. Thus, the upper portion of posts **26***a* and **26***b* may be considered as drop heads. Such drop heads may be permanently attached to the remainder of the posts or may be detachable and replaceable.

[0023] Ledgers extend between neighboring posts in one direction so that a pair of ledgers run parallel to each other, spaced apart by the same spacing as between posts. For example, FIG. **3**A shows a cross sectional view of two ledgers **21***a* and **21***b* running parallel (in a direction perpendicular to the plane of the page). Ledgers **21***a* and **21***b* are supported by posts as previously described. Partially over-

lying ledgers **21***a* and **21***b* at either end is forming panel **25***a*. Forming panel **25***a* is supported at either end by ledgers. **21***a* and **21***b*.

[**0024**] Panel **25***a* and ledgers **21***a* and **21***b* have interlocking features that cause panel **25***a* to be retained in position once it is correctly located. FIG. **3**B shows panel **25***a* separated from ledger **21***b* to show interlocking features. In particular, panel **25** has a flange **33** extending downwards into a corresponding groove **35** in ledger **21***a*. In general, panel **25***a* may not be removed from ledgers **21***a* and **21***b* without separating panel **25***a* from ledgers **21***a* and **21***b* in the vertical direction. This may be achieved by lowering ledgers **21***a* and **21***b* as previously described. Unlike certain prior systems that use more complex arrangements for attaching shoring components together, end portions of forming panel **25***a* directly overlie ledgers **21***a* and **21***b* and are thus directly supported by ledgers **21***a* and **21***b* without the need for special attachment components. Ledger **21***a* is below the level of poured concrete and is therefore not exposed to poured concrete. This makes removal easier and may make cleaning unnecessary.

[**0025**] Panel **25***a* is formed to have a predetermined size and shape, unlike certain prior systems that used plywood sheets that were not always of any specific size or shape. Panel **25***a* is formed of aluminum for light weight and strength, although other materials may also be used. In some cases, a covering layer may be used on the upper surface **31** of Panel **25***a*. For example, a covering layer of plastic may assist in removal of panel **25***a* from concrete. In other examples, a forming panel may be made of a combination of aluminum and plywood or other materials. As shown, panel **25***a* has considerable thickness (in excess of five inches in one example) in comparison to a sheet of plywood and as a result, panel **25***a* has rigidity that plywood alone lacks. Therefore, panel **25***a* does not require additional joists between ledgers **21***a* and **21***b*. Panel **25***a* only requires support at edges. Panel **25** tapers inwards from upper surface **31**, so that the bottom of panel **25** is narrower that the top. This facilitates removal of panel **25***a* when neighboring panels are still in place. Tapering of panel **25***a* allows panel **25***a* to be rotated away from a concrete structure without interference from a neighboring panel.

[**0026**] FIG. **4** shows a top-down view of the shoring structure including forming panels **25***a*, **25***b* and **27**. Also shown are top plates **29***a* and **29***b* as previously shown, and top plates **29***c* and **29***d*. As can be seen in FIG. **4**, forming panels and top plates form a continuous surface without significant gaps (at least without gaps that would allow significant leakage of poured concrete). The positions of ledgers **21***a* and **21***b* under forming panels are shown by dotted lines. Posts are located eight feet (8') apart in one direction and six feet (6') apart in the other direction. In another example, posts are placed six feet (6') apart in both directions. In yet other examples, different spacing may be used and the present invention is not limited to any particular spacing. Thus, ledgers **21***a* and **21***b* measure a little less than eight feet in length and are spaced six feet apart. It should be noted that FIG. **4** and other drawings of the present application are not intended to be drawn to scale. FIG. **4** shows one portion of a repetitive pattern that may extend over a great area. Only four principal components are used in constructing a shoring structure according as shown, posts including drop heads with top plates, ledgers and two types of panels (forming panels **25***a* and **25***b* are identical but forming panel **27** is different from forming panel **25***a*). In other examples, panels may be designed so that only a single type of panel is needed.

[**0027**] FIG. **5**A shows a view of forming panel **25***a* from underneath so that its structure is visible. In particular, side flanges **51***a* and **51***b* are shown extending along either side of forming panel **25***a* and end flanges **54***a* and **54***b* are shown at either end of forming panel **25***a*. In addition, ribs **53***a*-**53***e* are shown extending across panel **25***a* from one side to the other to provide stiffness and structural strength to panel **25***a*. The dimensions of forming panel **25***a* are approximately six feet (6') by three feet (3') with two cut-off corners measuring four inches (4"). In one example, forming panel **25***a* is made fractionally less than these dimensions, for example less by 1/32 of an inch in each dimension. This gives dimensions of five feet, eleven and thirty-one thirty-seconds inches (5' 11 31/32") by two feet, eleven and thirty-one thirty-seconds inches (2' 11 31/32"). The dimensions of panel **25***a* are such that it has sufficient strength to support concrete while being light enough to be easily handled.

[**0028**] FIG. **5**B shows a view of forming panel **27** from underneath so that its structure is visible. In particular, side flanges **55***a* and **55***b* are shown extending along either side of forming panel **27** and end flanges **58***a* and **58***b* are shown at either end of forming panel **27**. In addition, ribs **57***a*-**57***e* are shown extending across panel **27** to provide stiffness and structural strength to panel **27**. The dimensions of forming panel **27** are six feet (6") by two feet (2") without cut-off corners. As with forming panel **25***a*, dimensions may be made fractionally smaller than these nominal lengths.

[**0029**] While the above description refers to pouring concrete for forming horizontal structures such as floors of a building that extend along a horizontal plane, in other examples, concrete may be used for non-planar structures. A shoring system according to embodiments of the present invention may also be used to define a non-planar surface by adjusting poles to different heights so that forming panels are inclined from the horizontal.

[**0030**] Using a shoring system according to an embodiment of the present invention is simpler than many prior systems. Posts and ledgers are put in place, with poles being adjusted in height so that the top plate is at the level desired for the bottom surface of the concrete structure being formed. Ledgers are located so that features on ledgers interlock with corresponding attachment features on poles. The attachment features are in an upper position at this point. Forming panels are placed so that their ends overlie and are supported by ledgers. Forming panels having cut-off corners are placed so that the cut-off corner edges are in contact with top plates. When a surface has been defined by forming panels and top plates extending to an outer perimeter (a wall or barrier extending vertically), concrete is poured to cover the surface and occupy the volume defined by the surface and the outer perimeter. After the concrete has dried (typically 1-2 days, sometimes longer), attachment features on posts are dropped to their lower positions and with them ledgers drop also. This leaves room to separate forming panels from ledgers and to separate ledgers from attachment features. Forming panels may be separated from ledgers and removed at this point. Once all the panels supported by a ledger are removed, the ledger itself may be

removed. Removal of forming panels and ledgers may be done without moving or adjusting the posts. In some cases, posts are loosened at this point and then tightened into place to allow some sagging in a concrete structure. This is particularly important for large floors and where multiple floors are built in rapid succession with each floor supported by a previous floor. At a later time, when the concrete has gained sufficient structural strength (up to a month later), posts are removed. In the intervening period, ledgers and forming panels may be reused elsewhere.

[0031] While the above described examples are illustrative of certain embodiments of the present invention, they are not intended to limit the scope of the present invention. Various modifications, which would be readily apparent to one skilled in the art, are intended to be within the scope of the present invention. The only limitations to the scope of the present invention are set forth in the following claims.

What is claimed is:

1. A shoring system for establishing a lower surface of a volume for forming concrete, comprising:

a plurality of posts that extend in a vertical direction, each of the plurality of posts having a top plate that defines a portion of the lower surface of the volume;

a plurality of horizontal supports, each of the plurality of horizontal supports extending horizontally between two of the plurality of posts are attached to the two of the plurality of posts at a first distance below the lower surface of the volume in a first position and at a second distance below the lower surface of the volume in a second position; and

a first plurality of forming panels of a first predefined size and shape, and a second plurality of forming panels of a second predetermined size and shape, the first and second pluralities of forming panels partially overlapping ones of the plurality of horizontal supports, each of the first plurality and each of the second plurality of forming panels having an upper surface that extends along the lower surface of the volume when the plurality of horizontal supports are in the first position, the upper surface displaced from the lower surface of the volume when the ones of the plurality of horizontal supports are in the second position.

2. The shoring system of claim 1 wherein the predefined shape of the first plurality of forming panels is rectangular with two adjacent cut-off corners and the predefined shape of the second plurality of forming panels is a rectangle.

3. The shoring system of claim 2 wherein one of the first plurality of forming panels is in contact with other ones of the first and second pluralities of forming panels along four sides and is in contact with ones of the plurality of top plates at its cut-off corners.

4. The shoring system of claim 3 wherein the first and second pluralities of forming panels and the plurality of top plates form a continuous surface.

5. The shoring system of claim 4 wherein the continuous surface is a horizontal surface.

6. The shoring system of claim 3 wherein a first two opposing sides of each of the first and second pluralities of forming panels extend in a first direction and a second two opposing sides of each of the first and second pluralities of forming panels extend in a second direction that is perpendicular to the first direction, each of the plurality of top plates being square in shape and having sides that extend at 45 degrees to the first and second directions.

7. The shoring system of claim 6 wherein each of the first plurality of forming panels measures 6 feet by 3 feet with cut-off corners measuring approximately 4 inches and each of the plurality of top plates is square and measures approximately 4 inches on a side.

8. The shoring system of claim 1 wherein the first and second pluralities of forming panels are made of Aluminum with built-in supporting ribs.

9. The shoring system of claim 1 wherein the first and second pluralities of forming panels have features that interlock with corresponding features on the plurality of horizontal supports.

10. The shoring system of claim 1 wherein each of the first and second pluralities of forming panels is widest at its upper surface and is narrower where it is supported by ones of the horizontal supports.

11. A method of making a concrete structure, comprising:

placing a plurality of posts on a supporting surface and extending the plurality of posts so that a top plate of each of the plurality of posts extends along a surface of a forming volume;

placing a plurality of horizontal ledgers between ones of the plurality of posts so that they are supported by the plurality of posts at a first distance from the surface of the forming volume;

placing a plurality of forming panels of predefined dimensions on ones of the plurality of horizontal ledgers so that they are supported by the ones of the plurality of horizontal ledgers, each of the plurality of forming panels abutting neighboring ones of the plurality of forming panels and abutting ones of the plurality of top plates to form the surface of the forming volume;

pouring concrete into the forming volume;

subsequently, dropping the plurality of horizontal ledgers so that they are supported by the plurality of posts at a second distance from the surface of the forming volume that is greater than the first distance; and

subsequently removing the plurality of horizontal ledgers and the plurality of forming panels while maintaining the plurality of posts in position.

12. The method of claim 11 wherein the plurality of horizontal ledgers are placed so that attachment features on ends of each of the plurality of horizontal ledgers attach to corresponding features on ones of the plurality of posts.

13. The method of claim 11 wherein the plurality of forming panels are placed so that attachment features on each of the plurality of forming panels attach to corresponding features on ones of the plurality of horizontal ledgers.

14. The method of claim 11 wherein the plurality of forming panels of predefined dimensions are rectangular with two cut-off corners and that measure 6 feet by 3 feet.

15. The method of claim 14 wherein a cut-off corner forms an edge extending at 45 degrees to sides of a forming panel, the edge extending 4 inches.

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