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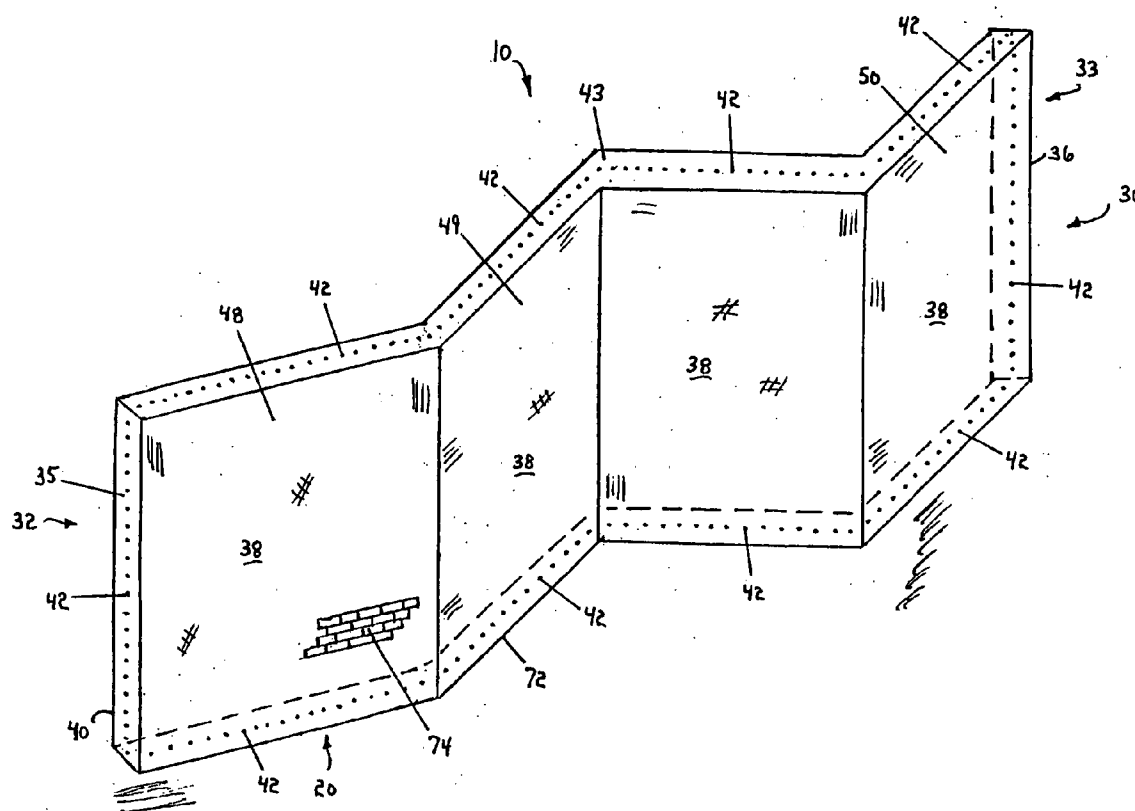
(57) **ABSTRACT**

A self-supporting, modular wall unit apparatus. A wall unit according to one embodiment of the invention is prefabricated from reinforced lightweight for transportation to the construction site. The wall unit then is placed in prepared ground, where it is self-supporting. The modular wall unit incorporates an integral footer component, eliminating the need to place a separate footing in advance of wall placement. The wall unit typically has the general cross-sectional shape (along at least a portion of its length) of an inverted "T," with the footer portion extending laterally from opposite sides of the wall. Alternatively, the wall unit may present a non-planar profile or footprint that zigzags or undulates to depart from a vertical plane, to enhance the wall unit's stability with minimized integral footer.

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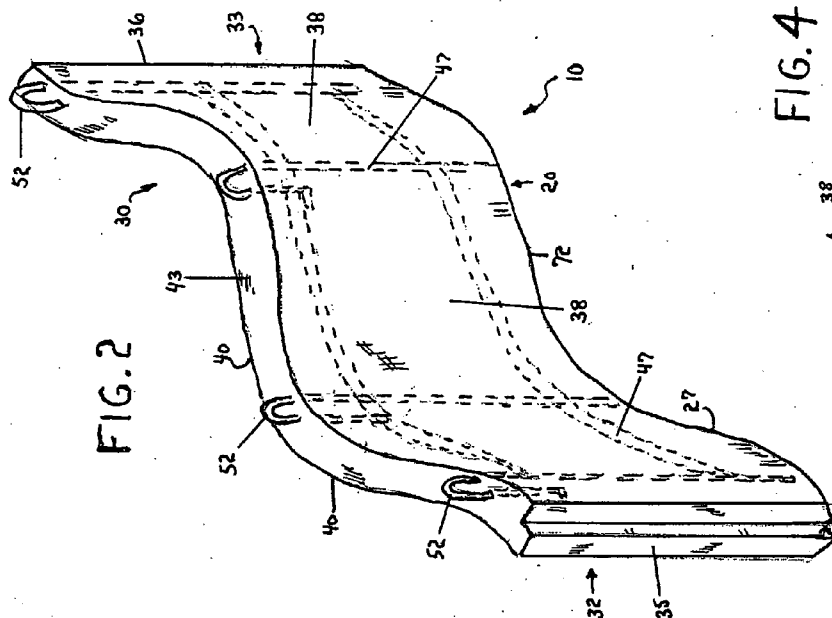


FIG. 2

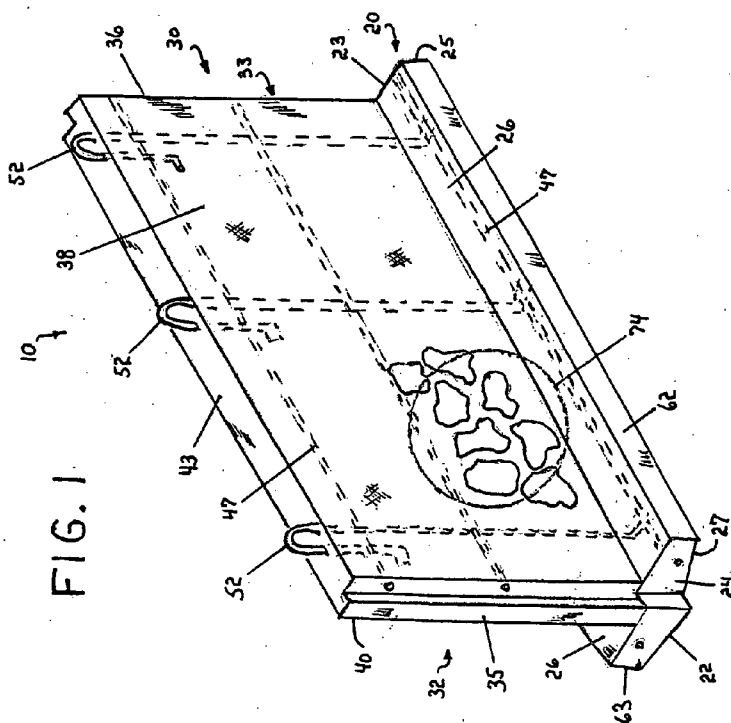


FIG. 1

FIG. 4

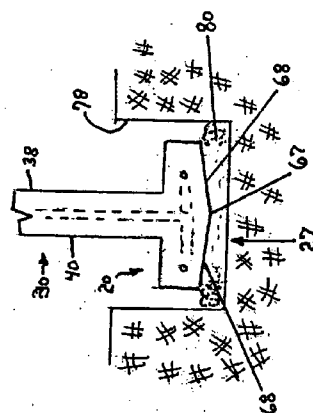
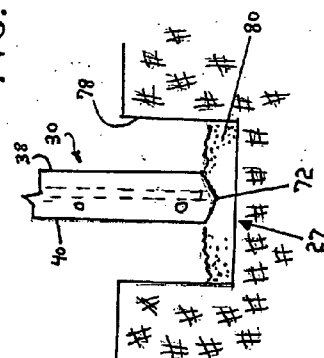


FIG. 3

FIG. 3A

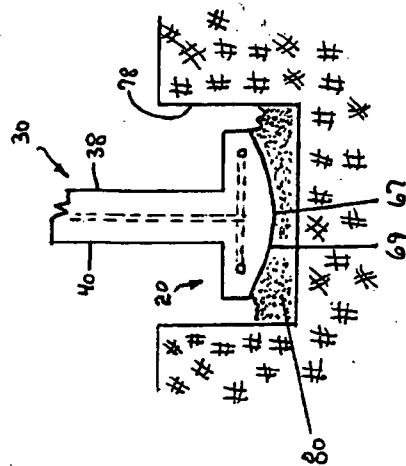
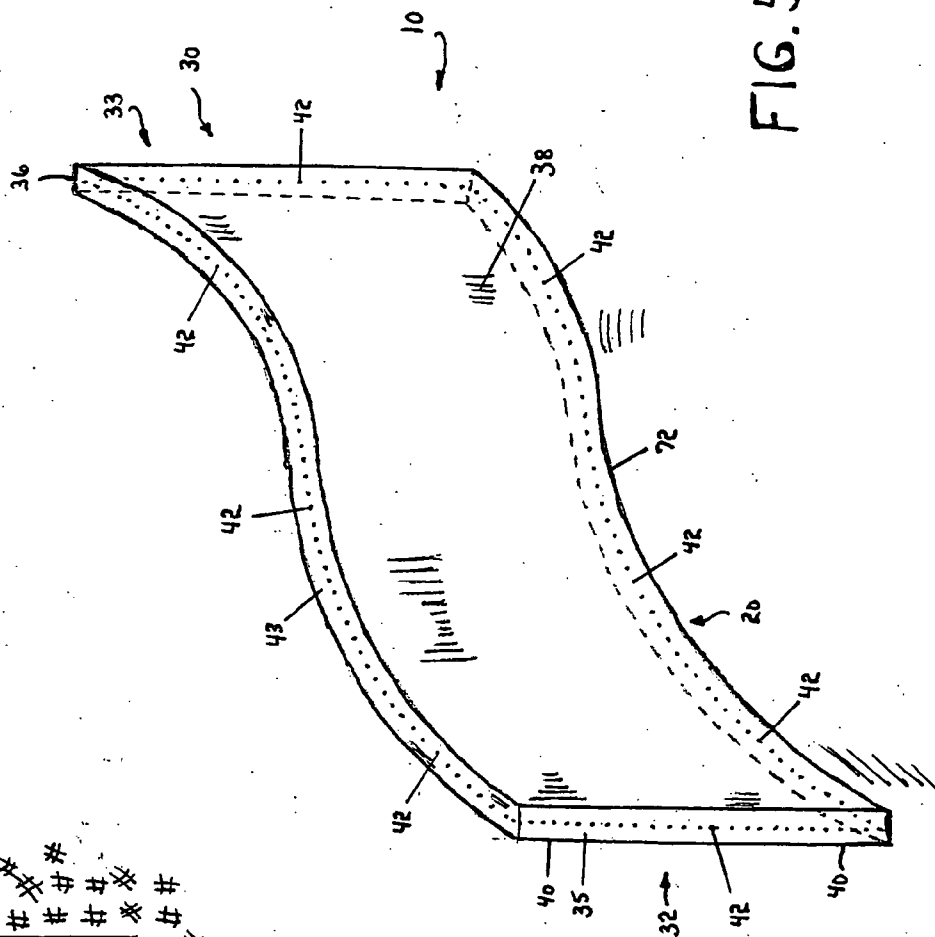
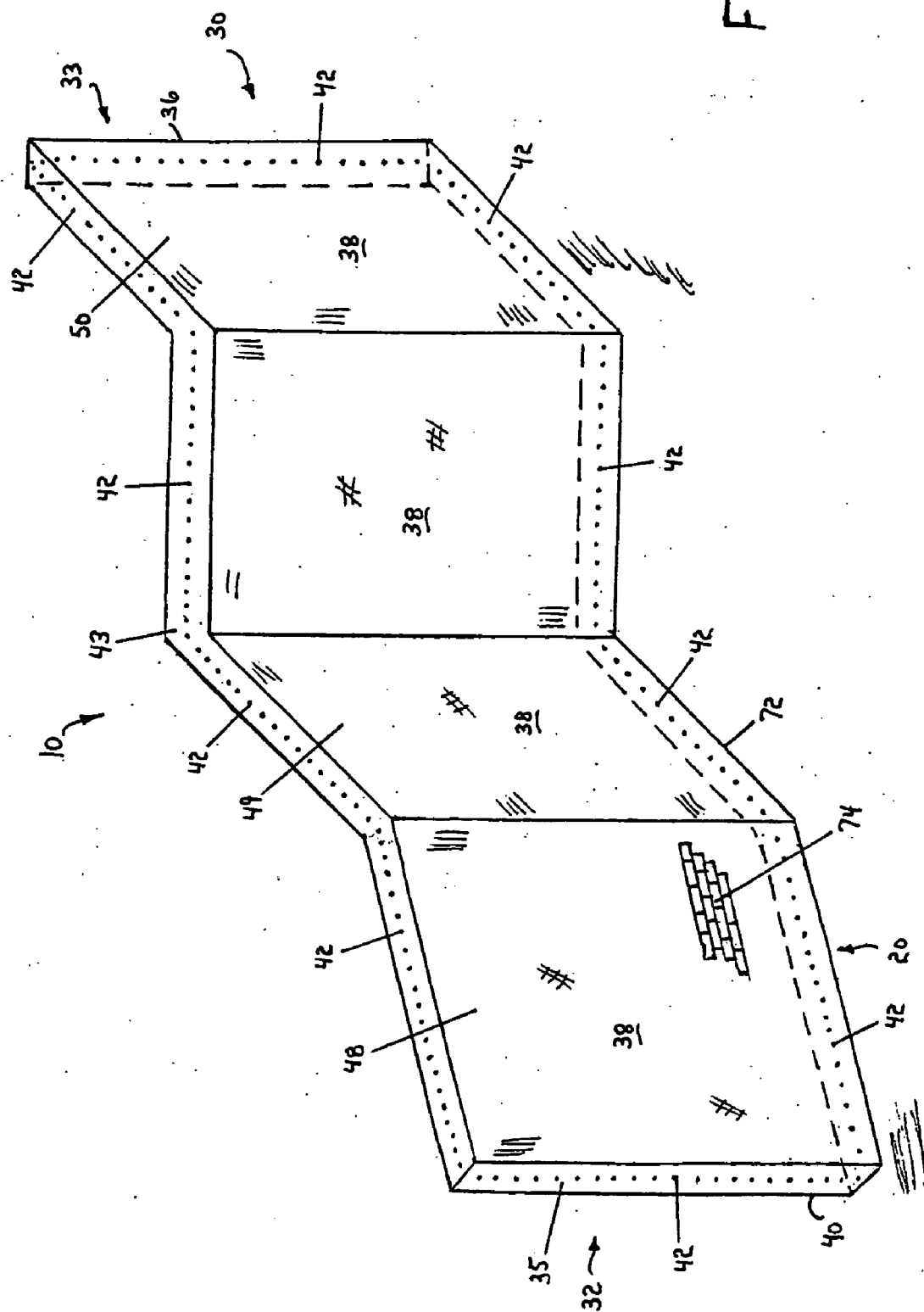


FIG. 5





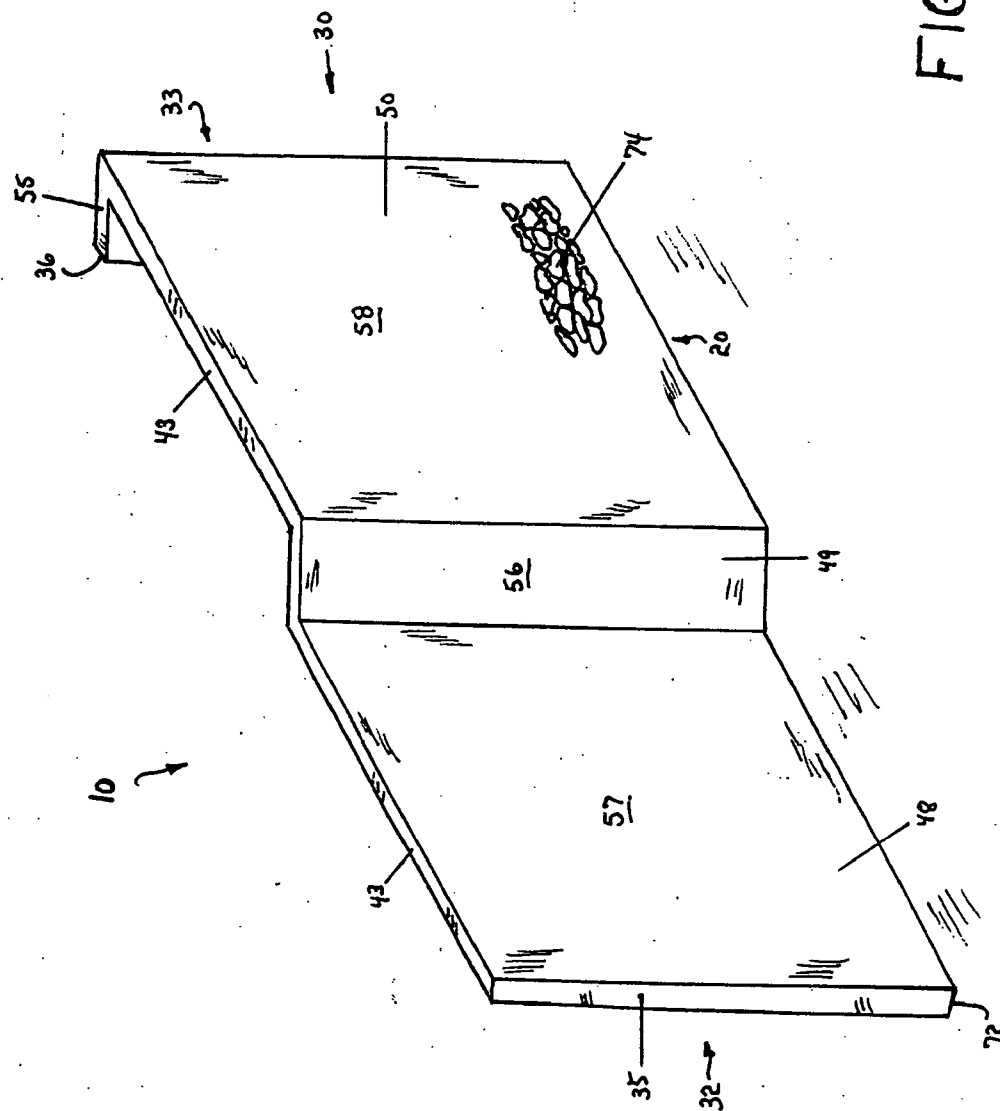


FIG. 7

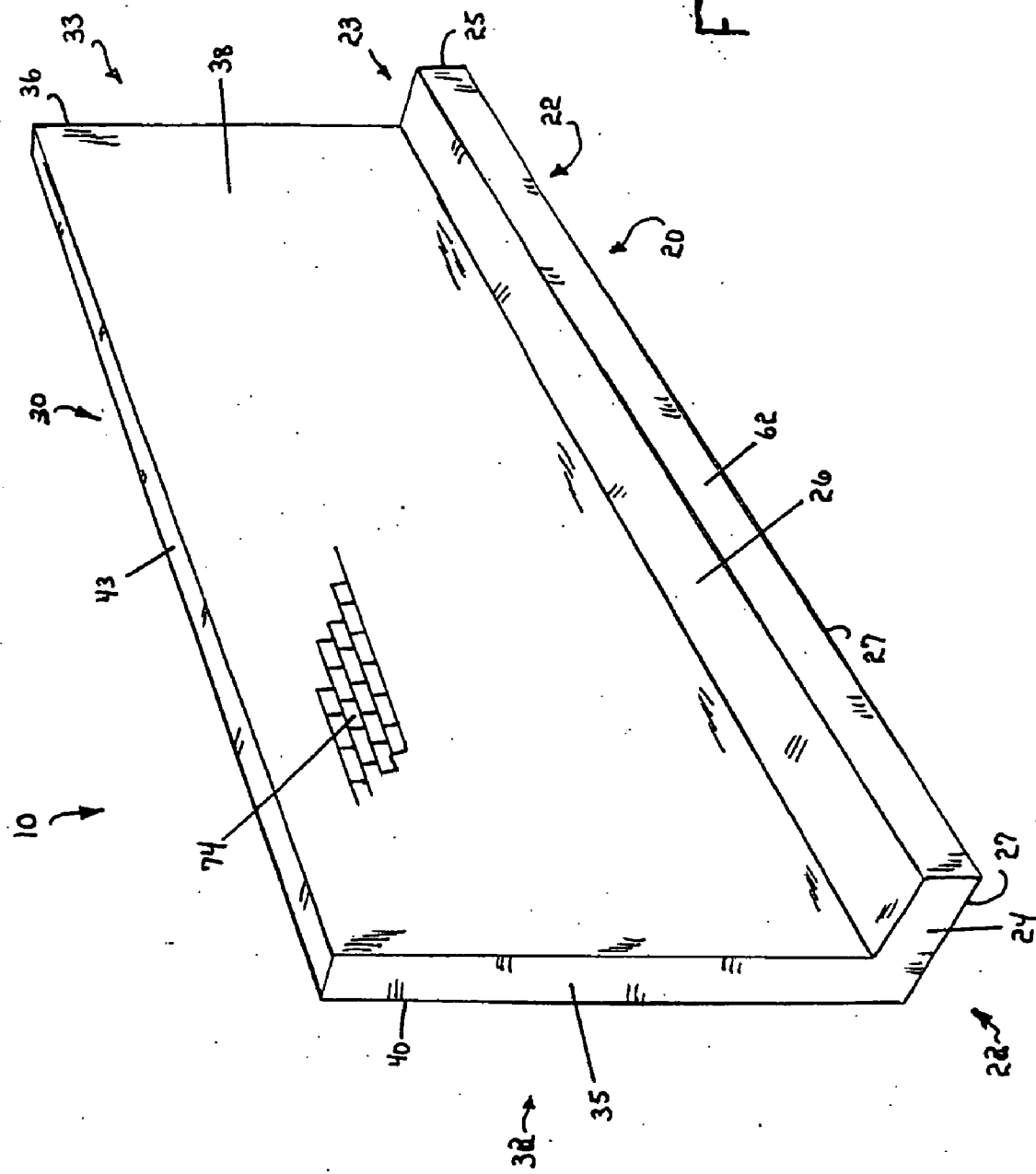


FIG. 8

FIG. 9

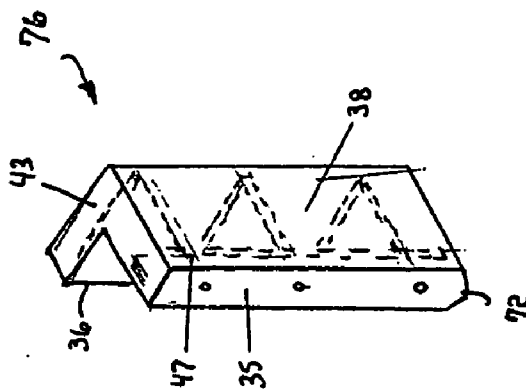
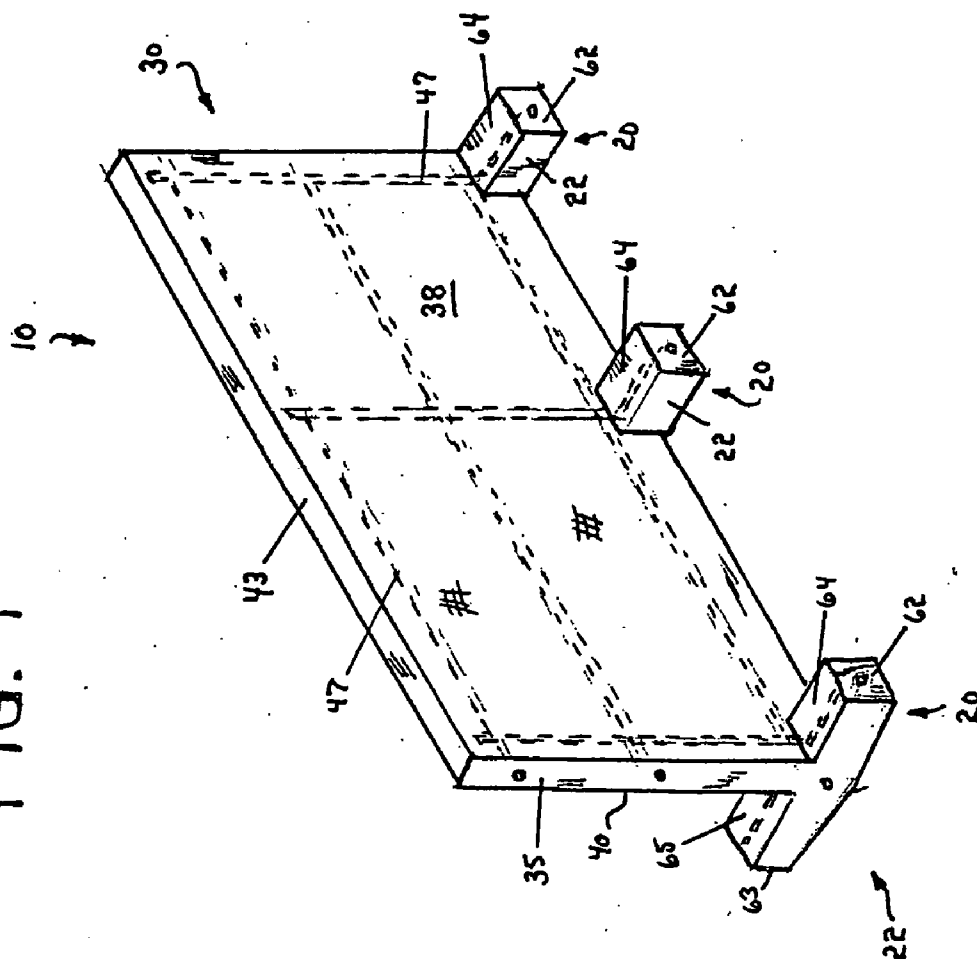


FIG. 10

SELF-SUPPORTING MODULAR WALL

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention (Technical Field)

[0002] The present invention relates to methods and means for constructing and erecting structures, particularly walls, and specifically to a self-supporting modular wall fashioned from concrete.

[0003] 2. Background Art

[0004] Masonry wall construction has changed little in decades, and commonly involves the mortaring and stacking of bricks, stones, or blocks in vertically aligned rows. The development of the mass-produced concrete masonry unit (CMU) in the twentieth century advanced the art of masonry wall construction by providing standard-sized, comparatively inexpensive building blocks from which walls could be built. Concrete masonry units, commonly also referred to as "cinder blocks," are stacked and mortared to build walls of all sorts and types, both for enclosed buildings as well as walls. Vertical and horizontal passages in the CMUs also permit CMU walls to be reinforced by placing rebar and poured concrete in columns and channels formed by vertically and horizontally aligned channels in the blocks. Typically, the reinforcing rods in the CMU wall are anchored into an underlying reinforced concrete footing.

[0005] Such traditional concrete or block walls or fences are built on site and in place, requiring that forms be provided for a poured reinforced concrete footing, and the footing allowed to cure. Additional parts or forms must be brought to the site, and the wall assembled in the field. This traditional method is labor intensive and time consuming. Not only must the footing be provided, but the construction of the wall requires the talents of trained laborers competent to place and mortar hundreds, thousands, or even tens of thousands of individual blocks imported to the job site.

SUMMARY OF THE INVENTION (DISCLOSURE OF THE INVENTION)

[0006] A self-supporting, precast modular wall unit apparatus is disclosed. A wall unit according to one embodiment of the invention is prefabricated from reinforced lightweight concrete for transportation to the construction site. The wall unit then is placed in prepared ground, backfilled and compacted to provide resistance to overturning, whereby it becomes permanently self-supporting. The modular wall unit incorporates an integral footer component, eliminating the need to place a separate footing in advance of wall placement. The wall unit typically has the general cross-sectional shape (along at least a portion of its length) of an inverted "T," with the footer portion extending laterally from opposite sides of the wall. Alternatively, the wall unit may present a non-planar profile or footprint that zigzags or undulates to depart from a vertical plane, thus to replace the need for a large comparatively bulky integral footer.

[0007] A primary object of the present invention is to provide a precast modular wall unit that is self-supporting.

[0008] A primary advantage of the present invention is that walls may be erected quickly and more economically than present methods of construction.

[0009] Another advantage of the invention is that the wall unit apparatus may be mass produced and stored at a central location, and then distributed to individual job sites for installation.

[0010] Yet another advantage of the invention is that the apparatus combines in an integrated wall unit a vertical wall portion and a footer portion, which when installed is stable and self-supporting.

[0011] Other objects, advantages and novel features, and further scope of applicability of the present invention will be set forth in part in the detailed description to follow, taken in conjunction with the accompanying drawings, and in part will become apparent to those skilled in the art upon examination of the following, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and attained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The accompanying drawings, which are incorporated into and form a part of the specification, illustrate several embodiments of the present invention and, together with the description, serve to explain the principles of the invention. The drawings are only for the purpose of illustrating a preferred embodiment of the invention and are not to be construed as limiting the invention. In the drawings:

[0013] FIG. 1 is a perspective view from above of an embodiment of a modular wall unit apparatus according to the present invention;

[0014] FIG. 2 is a perspective view of an alternative embodiment of a modular wall unit apparatus according to the present invention;

[0015] FIG. 3 is an end view of a footer portion of a modular wall unit according to the present invention;

[0016] FIG. 3A is an end view of an alternative version of a footer portion of a modular unit according to the present invention;

[0017] FIG. 4 is an end view of still another alternative version of a footer portion of a modular unit according to the present invention;

[0018] FIG. 5 is a simplified perspective view of the apparatus of the invention depicted in FIG. 2;

[0019] FIG. 6 is a simple perspective view, from above, of another embodiment of the wall unit apparatus according to the present invention;

[0020] FIG. 7 is a simple perspective view of still another embodiment of the wall unit apparatus according to the present invention;

[0021] FIG. 8 is a simple perspective view of yet another embodiment of the wall unit apparatus according to the present invention;

[0022] FIG. 9 is a perspective view, from above, of yet another embodiment of the wall unit apparatus according to the present invention; and

[0023] FIG. 10 is a perspective view of a typical corner unit useable in connection with the apparatus of the present disclosure.

DESCRIPTION OF THE PREFERRED
EMBODIMENTS (BEST MODES FOR
CARRYING OUT THE INVENTION)

[0024] There is disclosed herein a self-supporting, modular wall unit apparatus. A wall unit according to one embodiment of the invention is prefabricated from lightweight reinforced concrete for transportation to the construction site. A wall unit then is placed in prepared ground, and then backfilled and compacted, where it thereafter is self-supporting. The unit will resist horizontal forces, such as wind loading. Wall units according to the present disclosure are contemplated to serve chiefly as privacy walls or fences, rather than load-bearing walls for enclosed buildings. Currently, it is common in middle-class and upscale residential subdivisions of medium to high lot density, to demark the individual real estate lots and/or perimeter with privacy walls of a selected height. These walls often are erected from stacked and mortared cinder block. The present wall unit apparatus admirably serves as a replacement for such costly lot boundaries. Assembled collections of the wall unit apparatus according to this disclosure offer the privacy and security of CMU walls, but at reduced expense and quicker installation. Also, the aesthetics of the wall unit may be enhanced by means of designs cast into one or either of its faces, designs such as faux stone or brick facades.

[0025] Fence walls generally are erected to define a boundary and/or to provide security (keeping people and animals in or out), and persons normally do not have a direct interaction or contact therewith. It is, however, desirable in many instances to make a fence or wall aesthetically pleasing, an object satisfied by the presently disclosed wall unit.

[0026] Further, it is contemplated that properly engineered wall units according to the present disclosure may also serve as earth retaining walls. Particularly those embodiments of the disclosed apparatus having integral laterally extending footer portions can be placed so to serve to hold in place a volume of earth, e.g., on a hillside.

[0027] Traditional concrete or block walls and fences are built on site and in place. The conventional mode of construction requires that a reinforced concrete footing be placed first, and then after the footing concrete cures, additional parts or forms must be brought in and the wall assembled on the footing. These known methods of wall construction are labor intensive and time consuming. It is contemplated that the presently disclosed wall apparatus is mass manufactured in a central location, using reusable forms filled with concrete or light weight concrete, and then transported to the job site for installation in a prepared trench. The invention thereby exploits advantages of central manufacturing efficiencies. The disclosed wall apparatus, being essentially self-contained and self-supporting, permits off-site manufacture for on-site installation. The wall units according to this disclosure may be stored in bulk quantities at the location of manufacture, for transport elsewhere when needed.

[0028] Notably, the number of workers (or perhaps more pointedly, the total number of man-hours of labor) and materials transportation trips to the installation site can be dramatically reduced by the practice of the invention. The total cost, per linear foot installed, of walls built in accordance with the present invention is dramatically less than conventional mortar-and-CMU walls, due to decreased labor

and transportation costs, as well as the economic advantages of centralized mass production, with the added benefit of a decorated face.

[0029] Accordingly, the disclosed wall apparatus and method replaces traditional site-built cement or concrete block walls or fences. This modular wall unit incorporates its own footing component, eliminating the need to place a separate footing in advance of wall placement. Thus, one embodiment of the wall unit typically has the general cross-sectional shape (along at least a portion of its length) of an inverted "T," with the footer portion extending laterally from opposite sides of the wall. Other embodiments of the wall unit preferably present a non-planar profile or footprint (e.g., as one proceeds along the length of a wall unit, the unit zig-zags or undulates to depart from a vertical plane), to enhance the unit's stability. Embodiments having a zigzag or serpentine footprint have minimized integral footers, as the configuration of the vertical wall portion provides enhanced wall unit stability.

[0030] Integral modular wall units according to this disclosure preferably are prefabricated off-site, and then shipped to the building site and lowered into place. The advance preparation at the installation site may consist primarily of providing a modest trench, partially filled with stabilizing material such as a selected sand mix, to receive the footer portion of the wall unit.

[0031] The structure and reinforcing of the wall units may vary according to local building codes, but the innovative design incorporates the self supporting footing, and preferably features a serpentine or modified zigzag plan profile. A wall unit according to this disclosure may be cast in different lengths and heights, and may reflect the use of shaped form liners to provide decorative facades on either or both faces of the wall. Wall units of modest height, according to this disclosure, also may be installed as a minor earth retaining wall. Although intended primarily to be a permanent structure, a wall unit according to this disclosure potentially could be moved, relocated, or replaced if needed—certainly much more readily than a conventional mortared CMU wall.

[0032] Reference is made to the drawing figures collectively, in which like elements of the apparatus are denoted with the same numeral labels in the various views. The modular pre-cast wall unit **10** of the various embodiments features a footer portion **20** and a wall portion **30** integral with, and extending vertically from, the footer portion **20**. The footer portion **20** may be variously configured, even minimal in extent, and various versions of it will be further described.

[0033] A wall unit **10** according to this disclosure may be, by way of example and not limitation, from about 12 feet to about 32 feet in overall length, from approximately 6 to approximately 15 feet in height, and from 4 to about 24 inches in wall thickness. The actual dimensions of any given unit **10** are determined largely from known engineering applied to specific wall unit needs. A single wall unit according to the invention may weigh, for example, approximately 3,000 pounds.

[0034] The footer portion **20** is cast integrally with the wall portion **30** such that these two portions physically are a single physical unit. Reinforcing means, such as wire mesh, "geogrid," fiber mesh admixtures, or rebar generally in

compliance with known principles of reinforced concrete design, is provided to enhance the structural integrity of a wall unit 10. Reinforcing means common to both the wall portion 30 and its integral footer portion 20 join these portions.

[0035] The wall portion 30 has a wall first end 32 and a wall second end 33, and each respective wall end 32, 33 defines a wall end surface 35, 36. Also manifest on the wall portion 30 is a wall first face 38 in spaced relation with, and in opposing position, to a wall second face 40. These elements of the wall portion 30 are according to known understandings.

[0036] Characterizing the wall portion 30 is an imaginary centersurface 42 (FIG. 5) defined intermediately and substantially equidistantly between the first face 38 and the second face 40. The centersurface 42 is denoted by dotted lines in FIGS. 5 and 6, although all versions of the apparatus have a centersurface as described herein. The centersurface 42 is not a tangible element of the wall portion 30; rather, it is a geometric abstract useful for describing the wall unit apparatus according to the present disclosure. The centersurface 42 is not a surface in the ordinary sense of being the outside of a solid body. Centersurface 42 is a surface in the purely geometric sense, that is, a set of points that has length and breadth but no thickness. Thus, the imaginary centersurface 42 according to this disclosure is within the interior of the wall portion 30, and may be defined as a set of points, each point being situated halfway between the wall faces 38, 40, i.e., equidistant from each face 38, 40.

[0037] Each wall portion 30 also has a wall top surface 43 extending between the wall first end 32 and the wall second end 33. Wall top surface 43 also extends laterally between the wall faces 38 and 40.

[0038] As thus generally described, both the footer portion 20 and the wall portion 30 are fabricated from pre-cast reinforced concrete.

[0039] Combined reference is made to FIGS. 1 and 8, depicting one version of the footer portion 20 of the wall unit 10 apparatus. In this first embodiment, the footer portion 20 features a footer first end 22 and a footer second end 23, wherein each respective footer end defines a footer end surface 24 and 25. There is at least one top surface 26, which may be generally planar, extending longitudinally between the first footer end 22 and the second footer end 23. The footer bottom 27 extends longitudinally between the first footer end 22 and the second footer end 23. The bottom 27 is the underside of the wall unit 10, and rests directly upon the ground when the unit 10 is installed in place.

[0040] An aspect of the footer portion 20 is the configuration of its bottom 27 to facilitate the installation of the overall wall unit 10 firmly upon the ground in a substantially vertical orientation. It is advantageous that the bottom 27 be configured such that the wall unit 10 can be lowered onto a prepared ground surface, such as a pre-placed bed of clean sand 80 (FIG. 3), and then gently rocked to and fro to seat firmly the footer portion 20 upon the ground. This initial placement preferably is followed by a deliberate shifting and tilting of the wall unit 10 until it is vertical, and then allowing the engagement of the footer portion bottom 27 with the ground (or sand bed) to maintain and support the wall unit 10 in proper position pending a back-filling operation.

[0041] Attention is invited to FIG. 3. To facilitate the foregoing mode of installation, the footer bottom 27 preferably is non-planar, having a lowermost center portion 67 (which may be essentially an edge or ridge), at the intersection of a lateral surface 68 inclined upwardly away from the center portion 67 on either side thereof. In one version of the footer bottom 27 therefore, the bottom features a centerline 27 and a pair of substantially flat surfaces 68 inclined upwardly away from the centerline. The flat lateral surfaces 68 extend at an angle upward from the centerline of the bottom 27 until they intersect with the respective sides 62, 63 of the footer portion 20. In an alternative embodiment of the footer bottom 27, depicted in FIG. 3A, instead of defining flat surfaces, the bottom defines a convex curved surface 69.

[0042] Referring to FIGS. 1 and 3, it is seen that the footer portion 20 extends laterally outward from the wall portion 30 a distance (as engineered for the conditions) beyond either one of the wall faces 38, 40. Preferably, the footer portion 20 extends laterally from both, opposing, sides of the wall portion 30; thus, as seen in FIGS. 1 and 3, the footer portion extends a first distance beyond the first wall face 38, and a second (possibly equal) distance beyond the second wall face 40. Alternatively, the footer portion 20 may extend from only one side of the wall portion 30, as seen in the embodiment depicted in FIG. 8.

[0043] FIG. 9 shows and alternative embodiment of the footer portion 20 integral with a wall portion 30 of a wall unit 10 according to the present disclosure. The reinforcement means, such as steel rebars 47, reinforce the wall portion 30, and may be generally situated on the centersurface (42 in FIG. 6). In this embodiment, there is a plurality (three seen in FIG. 9) of footer portions 20 at spaced locations along the length of the wall portion 30. The size and location of the individual footer portions 20 is according to engineering principles known in the art. Description of one footer portion 20 serves generally to describe the plurality. Also, it is known in the art of concrete design to provide alternative means of reinforcing a concrete panel, such as with fiber mesh (a synthetic fiber that intertwines with itself to add tensile strength). Also, the need for or quantity of rebar may be reduced or eliminated by using polymer reinforcement nets, geo-grid products, and the like known in the art.

[0044] With continuing reference to FIG. 9, it is seen that each footer portion 20 has a footer first side 62 and a footer second side 63, while the wall portion 30 (and thus the centersurface of the wall portion) is between the footer sides 62 and 63. A footer first top surface 64 extends between the first wall face 38 and the footer first side 62; similarly, a footer second top surface 65 extends between the second wall face 40 and the footer second side 63. A bottom 27 extends laterally between the footer first side 62 the footer second side 63. Thus in this embodiment, the footer bottom 27 is non-planar, exhibiting a lowermost center portion or centerline and lateral surfaces inclined upwardly away from the center portion, generally in accordance with FIGS. 3 or 3A. Further, a footer bottom 27 defining a convex curved surface likewise is an acceptable alternative.

[0045] Attention is now invited to FIGS. 2 and 4-7, illustrating embodiments of the wall unit apparatus 10 that are specially configured to reduce to a minimum the need for

a footer portion. In these embodiments, the wall unit **10** is configured to be “self-propping” without the need for a laterally extending footer. Rather, the footer portion of the wall unit **10** is effectively the bottom of the wall portion; the wall portion has a wandering footprint, such that it stands on its own. In these versions of the apparatus, the “offset” character of the wall unit’s footprint eliminates the need for a laterally spreading footer portion of comparatively large bulk.

[0046] Rather than having faces each defining a single rectangular plane, the faces of each unit **10** are non-planar. In this disclosure and in the claims, “non-planar” does not mean “not flat.” Rather, “non-planar” means that all the points of the surface are not in the same plane. Thus, the face **38** or **40** of a modular wall unit **10** may define two, or preferably four or more, separate flat surfaces, but a face, **38** or **40**, of a wall unit is not contained within or defined by a single geometric plane, i.e., a wall face of a modular wall unit **10** is not defined within a single square or rectangular plane.

[0047] Accordingly, the footer portion of this embodiment of FIGS. 2 and 5-7 comprises the bottom surface **72** of the wall portion **30**, as suggested in FIG. 4. The bottom **72**, which may be planar, peaked, or convex curved, defines the footer portion of the wall unit **10** and is rested in a shallow trench **78**, optionally on a prepared bed of sand or aggregate **80**. The trench **78** is then backfilled to cover the bottom **72** and the lower reaches of the faces **38**, **40**, thus securing the wall unit **10** to the ground. Again, however, this serves to connect the wall unit **10** to the ground; the wall unit is self-supporting and nearly impossible to tip over due to its meandering or zigzag plan profile. The unit **10** when installed with the lower portions backfilled and compacted in a placement trench, has structural resistance to overturning moments resulting from forces applied to the faces **38**, **40** of the wall.

[0048] Particular reference is made to FIGS. 5 and 6. The imaginary centersurface **42** identified by a dotted line in the figures, is defined intermediately and substantially equidistantly between the first face **38** and the second face **40** of a wall unit **10**. The centersurface **42** extends from the top wall surface **43** down to the bottom **72**. Further, it extends continuously from the wall first end **32** to the wall second end **33**. But, being non-planar, the length dimension (parallel to the ground) of the centersurface **42** (and the faces **38** and **40**) is substantially greater than the straight-line distance from one end **32** of the wall unit **10** to the other end **33**. The wall faces **38**, **40** of the wall unit **10** cross back and forth at least twice through an imaginary plane extending between the ends **32**, **33** of the wall unit.

[0049] The centersurface **42** is not to be confused with a centerline, which customarily refers to a straight horizontal line running directly between one end of a wall panel and the other end (as viewed from above). Such a centerline is contained within an imaginary vertical center plane, which in an ordinary wall is within the volume of the wall. In the present disclosure, by contrast, at least portions of such a center plane, preferably nearly all, are outside the volume of the physical wall portion **30**. Rather, the wall portion **30** of a wall unit **10** according to the present disclosure perhaps may cross back and forth across the centerline any number

of times (FIG. 6), and some segments of the wall portion **30** may be parallel to the imaginary centerline (e.g., the embodiment seen in FIG. 7.)

[0050] Accordingly, while perhaps including a plurality of flat segments, the wall faces **38** and **40**, and the centersurface **42** are non-planar. As depicted in FIGS. 2 and 5, the wall faces **38**, **40** and the centersurface **42** are serpentine. The wall faces **38**, **40** and centersurface **42** are not necessarily, but preferably are, mutually parallel as seen in the drawing figures.

[0051] Alternatively, and as shown in FIGS. 6 and 7, the wall faces **38** and **40** include or are defined by at least two angularly intersecting, substantially flat, surfaces **48**, **49**, **50**. The intersection of the face surfaces **48**, **49**, **50** may be characterized by a regular and uniform zigzag plan profile or footprint, or may zigzag in a more or less irregular manner. The sizes—particularly the lengths—of the surfaces face surfaces **48**, **49**, **50** need not be uniform on a given wall unit **10**, but may vary if desired. Likewise, the angles of intersection between adjacent surfaces **48**, **49** can vary or be uniform within a particular modular unit **10**. In a preferred embodiment, but not necessarily, the terminal face surfaces **48**, **50** of a given wall unit **10** are aligned to be substantially coplanar. Such a configuration promotes the installation of a series of wall units **10** in registration along a real estate boundary or other surveyed or demarked property line. In all embodiments, the wall faces **38**, **40** and the centersurface **42** preferably are mutually parallel, as suggested in the drawing figures.

[0052] FIG. 7 offers one of a myriad of possible configurations for a zigzag type of wall unit **10**. In plan profile, a terminal panel **55** at the wall second end **33** projects approximately perpendicularly from the unit. A short, intermediate, angled panel **56** links two comparatively lengthier main panels **57**, **58** which are within parallel imaginary planes. A pair of the wall units **10** seen in FIG. 7 can be readily installed adjacent to one another by the simple expedient of abutting the first wall end surface **35** of one unit against the outside surface of the terminal panel **55** of the other unit, near its second wall end surface **36**. Alternatively, the wall second end surface **36** can be placed flush against the face first main panel **57**, near the wall first end **32**. In either configuration, by stationing two or more wall units **10** end to end, a self-supporting wall may be erected along a straight property or other line with panels **57**, **58** on alternating sides of the line.

[0053] The embodiment of FIG. 7 may characterize a preferable version of a wall unit **10**. Because the first main panel **57** is offset from the second main panel **58**, the unit is self-supporting and difficult to overturn when the bottom of the unit **10** is buried in a trench, and the backfill material is compacted. The offset distance may be, for example, about twenty-four inches, depending on the selected length of the intermediate panel **56** and the (preferably equal) angles defined between the intermediate panel **56** and either of the main panels. The included angles of intersection between the intermediate panel **56** and the panel(s) on either side thereof preferable are obtuse, because right or acute angles may complicate the removal of forms after curing. However, the main panels **57**, **58** nevertheless are parallel, so that a series of wall units may arranged end-to-end along a property or

other line, without significantly encroaching (e.g. more than eighteen inches, approximately) onto the real estate on either side of the line.

[0054] In all embodiments of the invention, and as specially illustrated in FIGS. 1 and 2, the wall end surfaces 35, 36 at either or both ends of a unit can be configured to provide for lap joints, or other types of joints, to better register and engage the ends of adjacent wall units at the time of installation. Lap or other joint configurations at the wall end surfaces 35, 36 may be cast into the wall portion 30 at the time of concrete cast and cure fabrication. As seen in FIG. 1, the footer end surfaces 24 also can manifest a contour for a lap or similar joint. Optionally, horizontally oriented complementary pin-and-socket connection means (not shown) or other suitable types of mechanical fastening may be provided at the wall end surfaces 35, 36 to better and more securely interconnect adjacent wall units. By way of example only, relatively short lengths of small-diameter PVC pipe may be cast in place in the end surfaces 35, 36 at regularly spaced heights proceeding up along each surface. During installation, corresponding pipe sockets on the ends of adjacent wall units are aligned, and short lengths of rebar inserted into the co-registered sockets to maintain their alignment when the wall units are abutted. Uniformly incremental spacing (e.g., six inches) of such fastening means permits adjacent wall units to be installed on different ground elevations, with the elevation difference corresponding to multiples of the fastener separation distance.

[0055] It is preferred in all embodiments that there be provided reinforcing means, such as steel reinforcing rebars 47 disposed vertically and horizontally within the wall portion 30 in accordance with engineering principals known in the art. In the preferred embodiment, and as depicted in FIGS. 1 and 2, the rebars 47 or other reinforcing means project from the wall top surface 43, and are bent or otherwise disposed into sturdy hooks or loops 52, so that the wall unit 10 may be lifted and lowered by the loops. As seen in FIGS. 1 and 2, the loops 52 may be provided at the time of casting of the wall unit 10, whereby the rebar 47 projects from, and then is recurvate to return into, the wall portion 30. A hook with a free end that does not have a re-entry through the top surface 43 of wall portion 30 alternatively may be provided. Alternative to loops 52 fashioned directly from the reinforcing means in the wall, certain commercially available cast-in-place cleat devices may be installed. Such cleats (typically composed of steel alloy) may have a rigid box element within which an integral, strong, hook element is provided. The box or cleat is placed within the top surface 43 of a wall at the time the concrete is poured, and may be connected to internal reinforcement elements. The in some types of such cleats, certain supporting or protective elements are removed after the concrete has cured, and in all versions a hook-like portion is available by which the cured module can be lifted and manipulated.

[0056] The vertically disposed reinforcing means preferably is interconnected with reinforcement horizontally arranged according to known art. The stresses induced by lifting or lowering a wall unit 10 by the loops 52 or other cast-in-place hook connectors accordingly may be distributed throughout much of the wall unit, because all the reinforcing means may tensioned throughout to perform as a network.

[0057] Because a wall unit 10 is pour cast into re-useable forms at the fabrication facility, the forms can be fashioned to mold ornamentation into either or both the wall faces 38, 40. The insides of the forms (not shown) may be crafted to define ornamental patterns, such as faux stacked brick, stacked stone, or the like. Such patterns or features may be presented in "negative" relief on the form interior, so that the positive relief or bias is evident on the face 38 or 40 of the wall when the forms are removed from the cured concrete. In the preferred embodiment of the apparatus, at least one of the wall faces 38, 40 thus includes or manifests decorative features 74 cast therein, as seen in FIGS. 1, 7, and 8.

[0058] FIG. 10 illustrates that a corner unit 76 may be provided in accordance with this disclosure. A corner unit 76 is prefabricated in accordance with all the foregoing discussion regarding wall units, including the provision therein of reinforcing means 47 with top-projecting loops 52, lap-joint end surfaces, and footer portions and the like. Corner units 76 may have a pair intersecting portions or segments defining a right angle, or any of an assortment of other angles. A corner unit 76 interposed between two wall units 10 allow the erection of a wall that turns a corner.

[0059] The embodiment of the corner unit 76 depicted in FIG. 10 is an illustrative example. A person of skill in the art will quickly appreciate that corner units may be fabricated in any of a variety of configurations for permitting the juncture of two or more adjacent wall units. For example, while FIG. 10 shows a corner unit defining a right angle, alternative corner units may be fabricated to define other than right angles. Further, the version in FIG. 10 has legs of approximately equal length, but alternative embodiments may have unequal legs, defining an "L" shape in plan profile. Corner units 76 also may have cross-shaped plan profiles to conjoin four intersecting wall units, or "T"-shaped profiles to join three intersecting wall units. Curved corner units may also be provided to permit two wall units to effective round a bend, rather than define a sharp corner. Thus, the plan profile or footprint of a corner unit 76 according to this disclosure may present practically any geometric shape for use between two or more adjoining wall units 10.

[0060] The difference between the present apparatus and traditional designs is not necessarily the construction materials, but rather the one-piece shape that, when assembled, permits a self contained, self supporting module 10 that traditional walls can not duplicate. The modular unit 10 may have a slightly beveled bearing area or bottom, which facilitates placing the wall in a sand bed to foster the horizontal earth support for the wall unit. The invention includes a self supporting corner unit 76 to be cast, which matches associated wall units 10 in appearance. By varying the lengths of wall units 10, it is possible to compensate for grade changes by setting individual wall units at different base heights. The ends of adjacent wall units can be abutted, as with a tongue-and-groove or shiplaps molded into the ends, or other similar modes, and may incorporate mechanical fastener means.

[0061] Other structural differences between the present wall apparatus and other traditional wall designs are the placement of the structural reinforcing, and the integral design. The reinforcing must be adequate to allow a modular wall unit 10 to maintain its integrity while suspended for final placement, and at the same time be adequate to support the structural footing of the design in its final position

[0062] There are several advantages of this apparatus over traditional designs, including but not limited to:

- [0063] a. efficient modular construction
- [0064] b. self supporting qualities
- [0065] c. speed of installation
- [0066] d. ability to adapt to grade changes
- [0067] e. ease of installation
- [0068] f. prefabricated to meet ridged construction schedules

[0069] A structural basis for all of the above advantages is that the footing required to support the wall unit vertically is included in the one-piece design. The integral design allows construction off-site and efficient wall installation.

[0070] This same self supporting design could be manufactured in molded polyurethane shell or other suitable material, leaving the interior of the wall unit empty. The hollow interior may then be filled with a denser material such as sand or water. Such a version of the apparatus allows for a durable, reusable and effective temporary wall or fence.

[0071] The methodology of the invention is reasonably evident from the foregoing, but may usefully be recapitulated here. Various shaped and sized forms, in assorted configurations for fabricating wall units **10** (including corner pieces **76**) of selected heights and ornamental surface designs **74**, are provided at a central facility remotely located from a wall construction job site. (Wall units alternatively may be fabricated at or near the job site, but the preferred process is to mass produce modular wall units at a permanent facility and then ship completed units to the installation site.) Forms suitable for use in practicing the invention are available from, for example, ARCH-CRETE Forms, Inc. of Detroit, Mich.

[0072] Reinforcement **47**, such as steel rebar, is predisposed within the forms according to known principles of engineering, and the lightweight concrete mix is poured into the forms and around the reinforcement. In one embodiment, the preferred concrete mix is from about 15% to about 20% (by weight) Portland cement, and from about 20% to about 40% clean sand, water in weight percents known in the art, and from about 40% to about 70% cellular foam known in the art for preparing very lightweight concrete products. Additional and other convention lightweight concrete products may be utilized. Alternative embodiments may also employ vermiculites and the like to provide a concrete that when cured is relatively lightweight, yet strong enough that wall units can be lifted and transported without structural failure.

[0073] Reinforcement loops **52** extend from within the tops of the forms, so that such loops protrude from the top surface **43** of the poured wall unit **10**. The concrete is allowed to cure (e.g. 1 to 3 days), at which point the forms are removed. The removed forms are then available for re-use. The decorative design **74**, if any, manifest on the form interiors is reflected and apparent on the face **40** or faces **38**, **40** of the wall portion **30** of the unit. The wall unit **10** is permitted to cure for an additional period of time according to known directives (for example, covered for seven additional days) until it has obtained adequate strength to be transported.

[0074] Cured wall units **10** may be inspected and further finished, as desired, and then loaded onto flatbed trucks (or railcars) for transportation to job sites. Loading and unloading of wall units **10** upon and from transportation vehicles may be accomplished in any suitable manner. For example, the lifting, movement, and lowering of the units may be by means of powered booms, small wheeled cranes, or other powered lifting machines having hooks or cables secured through the reinforcement loops **52** on the wall units.

[0075] Prior to the arrival of the wall units **10** at the job site, footing trenches **78** are excavated at the site in those locations and orientations where the units are to be placed. The trench **78** is dug to a width to receive the footer portion **20** of a wall unit, and adequate at least to permit the footer portion to be completely buried by the backfilling of the trench. Preferably, the wall unit **10** is pre-leveled through the use of wooden shims (not shown). Shims of suitable size/shape combinations are placed between the bottom of the wall unit and the bottom of the trench **78**, and manipulated to level the wall unit longitudinally, and in an adequately vertical orientation. Clean sand **80**, earth, or other suitable material is then washed or otherwise placed into the trench, in and around the shims and footer portion **20**. The sand or earth is backfilled and compacted until the trench **78** is filled to engineering specifications, and the footer portion **20** of the wall unit rests directly and securely upon the sand or earth bed. The wall unit **10** thereafter is uniformly supported by the backfilled sand or soil.

[0076] Vehicles move each unit to a position adjacent to the trench where the unit **10** is to be placed, and a powered crane or boom lowers the unit into the trench, with the bottom of the unit's footer portion resting upon the bottom of the trench and/or shims predisposed therein. The wall unit **10** is lowered and shifted to be aligned in the exact compass direction desired. (The amount of locational shifting may be minimal in instances where the footing trench **78** has been carefully located and dimensions, so as to accurately determine the placement of the wall unit.) The wall unit **10** may be carefully shifted laterally minor distances to adjust its position and to settle its bottom firmly in the trench or on the shims, and the unit is temporarily braced and maintained in an approximately vertical position while the trench is back-filled. The weight and lateral pressing of the backfilled gravels and soils around and upon the footer portion of the wall unit maintains the unit securely in place and vertically oriented.

[0077] Thus to summarize this method, the footer portion **20** of the unit **10** is lowered onto shims that have been placed within the trench **78**. The shims are sized properly to support the wall unit **10** in a generally vertically, and horizontally along the unit's longitude. The bottom of the footer portion is spaced by the shims a predetermined distance above the bottom of the trench **78**. While the wall unit is temporarily maintained vertical, clean sand is then placed (using, e.g., a wet sand mix) into the trench **78** to form a tight sand base upon which the wall unit is secured.

[0078] Alternatively, suitable dry earth, sand, or gravel mixes according to known engineering principles may simply be shoveled into the trench, and compacted to the specified depth, to provide the backfill of the wall unit.

[0079] The process is repeated to install a series of wall units end-to-end at the job site. The ends of adjacent wall

units are placed in registration so to exploit complementary lap joints, key-and-groove features, or other connecting means at the respective ends of the wall portions (and if provided thereon, the respective ends of the footer portions) of contiguous units. Notably, a serial row of wall units (including corner units as needed) can first be placed in end-to-end adjacency to comprise a complete wall or fence, and subsequently then be backfilled collectively and all at once. Thus, many wall units can in a first step be placed according to plan, and then in a second step be backfilled by the same crew that lowered the units into place.

[0080] Although the invention has been described in detail with particular reference to these preferred embodiments, other embodiments can achieve the same results. Variations and modifications of the present invention will be obvious to those skilled in the art and it is intended to cover in the appended claims all such modifications and equivalents. The entire disclosures of all references, applications, patents, and publications cited above are hereby incorporated by reference.

I claim:

1. A modular pre-cast wall unit comprising:
 - a footer portion; and
 - a wall portion integral with and extending vertically from said footer portion, said wall portion comprising:
 - a wall first end and a wall second end, each respective wall end defining a wall end surface;
 - a wall first face in spaced relation with a wall second face;
 - an imaginary centersurface defined intermediately and substantially equidistantly between said first face and said second face; and
 - a wall top surface extending from said wall first end and said wall second end and between said faces;
 - wherein said footer portion and said wall portion comprise pre-cast reinforced concrete.
2. An apparatus according to claim 1 wherein said footer portion comprises:
 - a footer first end and a footer second end, each respective footer end defining a footer end surface;
 - at least one top surface extending between said first footer end and said second footer end; and
 - a bottom extending between said first footer end and said second footer end.
3. An apparatus according claim 2 wherein said footer bottom is non-planar, comprising a lowermost center portion and a lateral surface inclined upwardly away from said center portion on either side thereof.
4. An apparatus according to claim 3 wherein said footer bottom defines a convex curved surface.
5. An apparatus according to claim 3 wherein said footer bottom comprises a centerline and a pair of substantially flat surfaces inclined upwardly away from said centerline.
6. An apparatus according to claim 3 wherein said footer portion extends laterally from said wall portion a distance beyond either one of said wall faces.
7. An apparatus according to claim 3 wherein said footer portion extends laterally from said wall portion a first

distance beyond said first wall face, and a second distance beyond said second wall face.

8. An apparatus according to claim 1 wherein said footer portion comprises:

- a footer first side and a footer second side, said centersurface of said wall portion being between said footer sides;
- a footer first top surface extending between said first wall face and said footer first side;
- a footer second top surface extending between said second wall face and said footer second side; and
- a bottom extending laterally between said footer first side and said footer second side.

9. An apparatus according claim 8 wherein said footer bottom is non-planar, comprising a lowermost center portion and a lateral surface inclined upwardly away from said center portion on either side thereof.

10. An apparatus according to claim 9 wherein said footer bottom defines a convex curved surface.

11. An apparatus according to claim 9 wherein said footer bottom comprises a centerline and a pair of substantially flat surfaces inclined upwardly away from said centerline.

12. An apparatus according to claim 1 wherein said footer portion comprises a bottom surface of said wall portion.

13. An apparatus according to claim 12 wherein said wall faces and said centersurface are non-planar.

14. An apparatus according to claim 13 wherein said wall faces and said centersurface are serpentine.

15. An apparatus according to claim 14 wherein said wall faces and said centersurface are mutually parallel.

16. An apparatus according to claim 15 wherein at least one of said wall faces comprises decorative features cast therein.

17. An apparatus according to claim 13 wherein each of said wall faces comprises at least two angularly intersecting substantially flat surfaces.

18. An apparatus according to claim 17 wherein said wall faces and said centersurface are mutually parallel.

19. An apparatus according to claim 18 wherein at least one of said wall faces comprises decorative features cast therein.

20. An apparatus according to claim 1 further comprising means cast within said wall portion by which said wall unit may be lifted and lowered.

21. An apparatus according to claim 20 further comprising reinforcing means disposed vertically within said wall portion, ends of said reinforcement projecting from said wall top surface, and wherein said lifting and lowering means comprises loops or hooks on said reinforcement means.

22. A modular pre-cast wall unit comprising:

a footer portion, wherein said footer portion comprises:

- a footer first end and a footer second end, each respective footer end defining a footer end surface;

at least one top surface extending between said first footer end and said second footer end; and

a bottom extending between said first footer end and said second footer end, said bottom being non-planar to comprise a lowermost center portion and a lateral surface inclined upwardly away from said center portion on either side thereof; and

a wall portion integral with and extending vertically from said footer portion, said wall portion comprising:

a wall first end and a wall second end, each respective wall end defining a wall end surface;

a non-planar wall first face in spaced relation with a non-planar wall second face;

an imaginary centersurface defined intermediately and substantially equidistantly between said first face and said second face; and

a wall top surface extending from said wall first end and said wall second end and between said faces;

wherein said footer portion and said wall portion comprise pre-cast reinforced concrete.

23. A modular pre-cast wall unit comprising:

a footer portion; and

a wall portion integral with and extending vertically from said footer portion, said wall portion comprising:

a wall first end and a wall second end, each respective wall end defining a wall end surface;

a wall first face in spaced relation with a wall second face;

an imaginary centersurface defined intermediately and substantially equidistantly between said first face and said second face; and

a wall top surface extending from said wall first end and said wall second end and between said faces;

wherein said footer portion and said wall portion comprise pre-cast reinforced concrete.

24. An apparatus according to claim 23 wherein said wall faces and said centersurface are mutually parallel.

25. An apparatus according to claim 24 wherein said wall faces and said centersurface are serpentine.

26. An apparatus according to claim 25 wherein each of said wall faces comprises at least four substantially flat surfaces, each said flat surface having an angular intersection with at least one adjacent other one of said flat surfaces.

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