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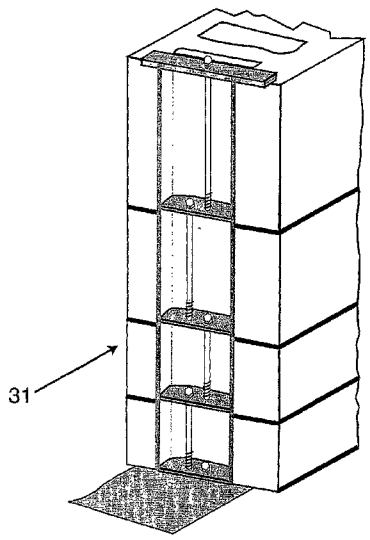
(54) **Title:** BOLT-A-BLOK - A SYSTEM FOR UNITIZED, POST-TENSIONED MASONRY STRUCTURES



(57) **Abstract:** A mortar less masonry structure comprising a plurality of regular masonry blocks and/or bricks connected to each other by a plurality of metal bars and a plurality of standard metal threaded fasteners thereby forming a post tensioned structure. Preferably, the blocks are operatively connected to each other as a structure by simple mechanical tools. Each interconnection results in a unitized post tensioned member that, when interconnected to the adjacent members, forms a comparatively higher strength structure than systems made of mortar and reinforced mortar. The method used to create this structure is a simple, waterless, mortar less interconnection process that is completed by a series of simple individual steps of fastening the blocks and bars into a strong and durable structure. Once connected the structure is strong and durable. If desired, the structure may be disassembled and the components be re-used.

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BOLT-A-BLOK - A SYSTEM FOR UNITIZED, POST-TENSIONED MASONRY STRUCTURES

FIELD OF INVENTION

[0001] This invention relates to a unitized masonry structure, particularly structures with post tensioned reinforcement. The present invention relates generally to all general construction where a common mortar and hollow block or brick combination is utilized and to other construction means for structures as well.

BACKGROUND-FIELD OF INVENTION

[0002] The new unitized masonry structure described in this specification is a construction system that is designed to easily and quickly install in any location without the need for mortar, water, or power. In the United States alone there are over 4000 block manufacturing companies. Traditionally, building blocks and bricks are attached to each other by either of two methods. The first is by gravity, which includes stacking, arches, and flying buttresses. The second is by mortar and mortar equivalent methods, such as various types of mortar, epoxy, or blocks having their cores concrete filled, with or without reinforcing steel bars (rebars). This attachment includes mortar with reinforcing wire in the joints and also includes attachment between masonry units with concrete and rebars in such shapes as bond beam blocks and pier blocks.

[0003] Normally when reinforcement means have been used with block, it is accomplished with either long rebars or long steel rods placed in the cavities. Post tensioning has only been used with a complete stack of block in conjunction with the mortar between each layer. Specialty block systems with rods and plates require complex design and skill.

A. INTRODUCTION OF THE PROBLEMS ADDRESSED

[0004] Since most masonry structures use mortar, several things are required. First, the mortar requires water. Second, in most cases, the laying of block requires a skilled block or brick mason. Third, a means of power to mix the mortar is normal. Fourth, elaborate bracing 38 and reinforcement is needed until the mortar cures and reaches its strength (Fig. 3B). The overall structure is "fragile" to wind, severe temperatures, and other natural weather and environmental conditions. During this time, occupation and use of the structure is unwise.

Also, scaffolding 37 often remains in place awaiting cure before additional blocks are added (Fig. 3A). If proper preparation and care are not provided to reduce the environmental impacts, the mortar and overall structure may result in cracking and diminished structural strength. Reinforcing means 35 are often provided to improve strength (Fig. 2D), but the need to have bracing and other protection in place for many days and weeks is still needed. Finally, once built, the traditional masonry systems become a fixed structure. Unless very special provisions are added to the normal block, rebar and mortar system, the structure is not re-useable and must be "demolished" to be removed.

[0005] These stated requirements each limit the use of the traditional masonry with mortar system. The Bolt-A-Blok system facilitates a clear improvement to traditional construction systems and their limitations. Accordingly, it would be advantageous to have a system that does not require special skills to construct; does not need water and power; does not require elaborate bracing; is useable immediately and needs no curing time; and, is re-useable if desired and is not destroyed when disassemble and moved. This improvement would decrease the time to build or rebuild areas and would minimize the restriction of skilled labor. Importantly without the bracing and exposure to weakening by disturbing the mortar, the Bolt-A-Blok system provides a far superior and more consistent strength to the mortar constructed structure.

B. PRIOR ART

[0006] Historically, few patented devices have attempted to address the problem as stated. The building industry has made little progress for a unitized, post tension system. Even so, blocks have required special configurations to even handle rods and plates and then the have taught only limit rods in special blocks. One such device is described in U.S. Pat. No. 5,511,902 (1996) issued to Center which teaches an Instant levy block system. This is a complex, specially made block for constructing a levy, comprising a plurality of blocks, a plurality of connecting pegs, and a plurality of stakes. Each part is uniquely designed and made whereas the Bolt-A-Blok system utilized standard, readily available components.

[0007] Another block device is described in A U.S. Patent 5,809,732 which was issued to Farmer, Sr. et al (1998) which teaches a masonry block with an imbedded plate. The concrete masonry block has an external plate or plates that are anchored through the concrete masonry block. The external plates are cast into the concrete masonry block in the mold

during casting. These are not regular hollow core blocks available globally as used with the Bolt-A-Blok system.

[0008] Another device for construction is taught by U.S. Patent 6,098,357 issued to Franklin et al. (2000). This art discloses a modular pre-cast construction block system with a wall subsystem and a foundation subsystem. The wall subsystem has a number of wall units having cavities and pre-stressed tension cables are cast therein the cavity. This teaches precast walls and through cable which are special made, require water, and are not readily re-useable like the Bolt-A-Blok system.

[0009] A re-useable system 32 is taught in the U.S. Patent 6,178,714 issued to Carney, Jr. (2001)(Fig. 2A and 2B). The rods go through apertures in the special block and the precast structures. The configuration of special length rods, special blocks, special plates and a complex system that requires powered equipment to construct is unlike the simple, available components of the Bolt-A-Blok system.

[0010] A Mortar less wall structure is taught in U.S. Patent 6,691,471 issued to Price (2004). Here a wall structure comprising of columns of preformed, lightweight, stacked blocks, with the columns of blocks connected to each other by elongated, vertically oriented, support beams. Preferably, the wall structure is operatively connected to a structure by one or more brackets. The beams and blocks are special configuration, not readily available and with limited uses.

[0011] Traditional masonry structures which use mortar have several characteristics which merit brief discussion as prior art. Most are constructed such that the roof structure 34, 39 is attached to a top plate which is anchored by bolts into the hollow cavities (Fig. 2C and Fig. 3C). The corners 40 and straight sections 41 often are staggered and have wire mesh and an occasional rebar (Figs. 3 D and E). Finally, openings for doors and windows are often breached by pre-cast lintels 42 (Fig. 3F).

[0012] Other prior art applicable to a thorough understanding of the significant technological advantages and improvements offered by the Bolt-A-Blok system need some discussion of the post tensioning technology used in construction today. Simply put, Post-Tensioning is a method of reinforcing concrete, masonry, and other structural elements. Post-tensioning is still state-of-the-art engineering, but up to now it has only been possible to attach multiple concrete units directly to each other with rods and cables. The Bolt-A-Blok

system makes possible the post-tensioning of a single masonry unit in a manner that makes it possible to attach additional single post-tensioned masonry units while at the same time combining and maintaining the post-tensioning of all the units.

[0013] Traditional post-tensioned units 36 may have various configurations (Fig. 2E). To date this technology has been unobvious as being applied at a unitized configuration. Individual blocks are attached to each other and now, as a new combination, perform as if it were all one post-tensioned beam, bridge, wall, or structure. This Bolt-A-Blok system works equally well with all size masonry units.

[0014] Traditional Post-Tensioned reinforcing consists of very high strength steel strands or bars. Typically, strands are used in horizontal applications like foundations, slabs, beams, and bridges; and bars are used in vertical applications like walls and columns. A typical steel strand used for post-tensioning has a tensile strength of 270,000 pounds per square inch. This actually teaches against the Bolt-A-Blok system use of individual, standard bolts and simple fasteners. Post-tensioning using plates, or bars, between the masonry units is a totally new way of combining steel and concrete and is sound engineering practice.

[0015] None of the prior art teaches all the features and capabilities of the Bolt-A-Blok system. As far as known, there are no systems at the present time which fully meet the need for a unitized, post-tensioned masonry block structure as well as the Bolt-A-Blok system. It is believed that this system is made with standard parts, is built with simple tools, needs no mortar, provides a much stronger structure than mortar structures, and is ready for immediate use and occupation upon construction.

SUMMARY OF THE INVENTION

[0016] A Bolt-A-Blok system has been developed for use in constructing various types of structures. Bolt-A-Blok system is a building system that demountably couples each individual hollow cored block or brick by use of a bar and bolt system. This coupling results in stronger, faster, and cheaper construction of buildings. While the three main components – a bar, a bolt and a block - are securely connected, the means of attachment is capable of full disassembly if desired. The Bolt-A-Blok system can be accomplished by unskilled persons with a simple wrench. There is no need for water, no special tools (a simple wrench will suffice), no bracing, and the structure made by the Bolt-A-Blok system is ready for

immediate use. The newly invented Bolt-A-Blok system features readily available hollow core masonry units with a fastener (bolt) and a plate.

OBJECTS, ADVANTAGES AND BENEFITS

[0017] There are many, many benefits and advantages of the Bolt-A-Blok system. There currently exist no construction systems that use readily availably parts and are so easy to perform. However, by having the unitized post tensioning technology, the structure is a far stronger unit than one built by traditional mortar-using techniques. See TABLE A for the list of advantages and benefits.

TABLE A – ADVANTAGES AND BENEFITS

ITEM	DESCRIPTION
1	Is Waterless
2	Requires no wait time to get structural strength
3	Requires no temporary support while mortar cures and gains strength
4	Uses simple hand tools
5	Is Useful with/ without footer
6	Has greater final tensile and compressive strength than mortar construction – is much stronger
7	Is Environmental friendly - Uses less wood, hence there is less deforestation required to support construction
8	Has a reasonable total cost – material and unskilled labor
9	Permits rapid build.
10	Can be easily disassemble and components re-used.
11	Does not require skilled labor
12	Has Global/worldwide/universal applications
13	Uses Existing, standard materials
14	Can be built on soil or standard foundation
15	Spans greater distances between vertical double blocks
16	Uses standard product available throughout the globe in all countries
17	Is easy to learn the build concept and start building with non-skilled workers. With this easy learning curve, it is simple to learn and simple to use. So simple that multiple workers may be in the same area – not "laying" block but assembling a structure
18	Provides perfect spacing which means more attractive walls. Blocks have perfect alignment and correct placement before tightening
19	Reduces fire insurance and wind insurance costs
20	Uses existing modular sizes, worldwide.
21	Is an all weather construction. All kinds of weather, rain, snow, wind, cold, hot, underwater, even in a diving bell or caisson
22	Is a Unitized construction. If one stops or anything interrupts the build at any point, one can resume immediately without the former problems of mortar drying out and the other messy problems.
23	May provide Electrical grounding through metal bars

ITEM	DESCRIPTION
24	Provides many additional methods to attach materials using the joint spaces – such as through bolts, carriage bolts, and toggle bolts for adding of bolts. There is no hole drilling in blocks needed.
25	May build a wall by working from either side. Inside or outside.
26	Works with one or more core block, brick, and other building units
27	Requires less scaffolding, ladder jacks and walk boards because the walls are immediately at full strength.
28	Permits electrical wire and cable (such as Romex™ to go through the intermediate spaces and may fasten external boxes or recess in drywall, etc,
29	Can pour concrete in cores and even add vertical rebar's.
30	Can pour insulation or spray foam in cores.
31	Resists flying debris.
32	Resists Earthquake and Hurricane/ tornado.
33	Is fire resistant.
34	Is not dependent on mortar strength
35	Requires no power or gasoline to build
36	Uses with standard block, worldwide
37	Is useable with other construction techniques – door and window frames, roof and ceiling joists and trusses; metal and asphalt/fiber/ rubber ?? roofing;
38	Is useable with standard plumbing, electrical, communications and lighting packages
39	Has the ability to construct several block layers at one time - speeds overall construction
40	Adapts to regular interior (plaster, boars, panel, paint) and exterior wall surfaces (siding, brick, stucco, etc)
41	Provides perfect plumb and level alignment
42	Does not require poured foundations
43	Is a Unit by unit construction
44	The simple bar and bolt is easily mass produced using existing materials and equipment.
45	Is possible for the builder to leave out a small portion of the foundation wall so that trucks and backhoes can easily cross into the structure to grade, spread stone, unload concrete or do whatever is necessary. As soon as the heavy inside work is completed, the wall is quickly bolted into place and is ready to go, at full strength.
46	Provides a mass is so strong, and the total weight of a Bolt-A-Blok system building is of such significant weight, that below ground freezing may largely only push sideways.
47	May be combined with a pre-constructed bath and/or kitchen unit.
48	Is termite and carpenter aunt proof.

[0018] For one skilled in the art of construction of structures, especially masonry, concrete, and steel structures, it is readily understood that the features shown in the examples with this system are readily adapted to other types of construction improvements.

DESCRIPTION OF THE DRAWINGS

A. FIGURES

[0019] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate an embodiment of the Bolt-A-Blok system that is preferred. The drawings together with the summary description given above and a detailed description given below serve to explain the principles of the Bolt-A-Blok system. It is understood, however, that the Bolt-A-Blok system is not limited to only the precise arrangements and instrumentalities shown.

[0020] FIG. 1 is a sketch of the general Bolt-A-Blok system.

FIGS. 2 A through 2 E are sketches of prior art for masonry and post tensioned structures.

FIGS. 3 A through 3 F are additional prior art depictions.

FIG. 4 are sketches of the main components for Bolt-A-Blok system, namely blocks, bars, fasteners and a wrench.

FIGS. 5 including 5 A and 5 B are Bolt-A-Blok systems that show the specific parts and characteristics of the system.

FIGS. 6 A through 6 G provide details of the Bolt-A-Blok system with detailed sketches and photographs of prototype structures.

FIGS. 7 A through 7 C show the details of the Bolt-A-Blok system and several of the features that may accompany the system.

FIGS. 8A through 8 D are Photograph of a method to securely attach a roof structure to the Bolt-A-Blok system wall.

FIGS 9 A through 9 E show sketches of possible structures made by the Bolt-A-Blok system.

FIGS 10 A through 10 G provide photographs of attachment devices which are examples shown with the Bolt-A-Blok system prototype wall.

FIGS 11 A through 11 M show sketches of bars and attachments for the Bolt-A-Blok system.

FIGS 12 A through 12 D show sketches of a possible deck structures made by the Bolt-A-Blok system.

FIGS 13 A through 13 D show photographs of tools used in the original prototype of Bolt-A-Blok system.

FIGS 14 A through 14 E show sketches of typical hollow core masonry blocks and bricks useful when utilized with the Bolt-A-Blok system.

FIGS 15 A through 15 D show photographs of a construction process using the Bolt-A-Blok system.

B. REFERENCE NUMERALS

[0021] The following list refers to the drawings:

31	general assembly of the Bolt A Blok – stacked soldier configuration
31A	general assembly of the Bolt A Blok – stacked running or offset configuration
32	prior art special block and through rods
34	prior art wood truss on block system
35	prior art rebar in block system
36	prior art post tension cables in concrete
37	typical scaffolding and wall build for "mortar" masonry systems
38	typical temporary bracing for water and mortar systems
39	typical mortar and block wall cross section
40	typical mortar and block wall corner
41	typical mortar and block wall section
42	typical mortar and block window and door lintels
43	fastener (bolt)
44	bar
45	tool (wrench)
46	hollow core block - typical
46A	hollow core block – stacked soldier configuration
46B	hollow core block – stacked running or offset configuration
47	starter fastener
48	base means device (foundation, board, plate, etc.)
49	masonry block cavity
49A	space between adjacent block (46)
50	clear aperture through bar (44)
51	threaded aperture through bar (44)
52	prototype stacked bolt a blok system
53	bar and bolt system with blocks removed

54 prototype wall assembly
55 extended bar
56 beam on extended bar
57 insulation matter between block (46)
58 siding and insulation panel (interior or exterior)
59 pipe interior to block cavity (49)
60 top plate for truss support
61 roof joist/truss system
62 plastic sheet vinyl such as (Visqueen™ or Tyvek™)
63 furring strip for mounting panels, gyp board, etc.
64 extended tie rod or bar
65 means to attach (truss to wall) such as a band clamp
66 electrical wiring
67 stabilizing shim
68 door jamb
69 wall mounting fastener
70 earthwork near foundations
71 foundation concrete
72 non linear or irregular block configuration
73 radii block for curved configurations
74 general lintel application
75 door or window perimeter
76 soldier block for lintel
77 door or window aperture
78 standard two hole bar
79 "H" bar for joining block
80 "Double H" for high strength applications
81 lintel plate and connector
82 double extended bar
83 turning bar for corners and nonlinear connections
84 connector bar
85 double row bar
86 base plate bar
87 winged base plate bar - metal or non-metal
88 door frame connection configuration
89 brick bar
90 tee-handle connector or fastener
91 lateral deck configuration
92 deck support
93 deck load – people or equipment, etc.
94 hand socket driver
95 powered impact driver
96 means to manufacture through hole/aperture in bar (44)
97 means to manufacture threads in the bar (440 to receive the fastener (43)
98 typical hollow cavity block
99 ornamental or decorative hollow core block
100 hollow core brick
101 fasteners for brick
102 non-skilled worker assembling the system

DETAILED DESCRIPTION OF PERFERRED EMBODIMENT

[0022] The present device is construction system called a Bolt-A-Blok system 31. This system is comprised of only a few different types of components - a hollow core block 46, fastener (such as a through bolt) 43, and a simple bar 44 with some additional features. The system configures the adjacent block 46 and demountably couples the blocks by means of the bolts 43 and bars 44. This coupling results in a structure that is formed from a plurality of unitized, post tensioned blocks or bricks that collectively are far stronger than an ordinary block structure built with mortar and standard reinforcing. A person having ordinary skill in the field of construction, especially with reinforced masonry structures, appreciates the various parts that may be used to physically permit this Bolt-A-Blok system 31 to be produced and utilized. The improvement over the existing art is providing a construction system that has many advantages and benefits as stated in the previous section entitled Objects, Advantages, and Benefits.

[0023] There is shown in FIG. 1 and FIGS. 4 through 15 a complete operative embodiment of the Bolt-A-Blok system 31. In the drawings and illustrations, note well that the FIG. 1 and FIGS. 4 through 15 demonstrate the general configuration of this invention. The preferred embodiment of the system is comprised of only a few parts as shown. Various important features of these components are delineated in FIG. 1 and FIGS. 4 through 15 of the drawings and are described below in appropriate detail for one skilled in the art to appreciate their importance and functionality to the Bolt-A-Blok system 31.

[0024] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate an embodiment of the Bolt-A-Blok system 31 that is preferred. The drawings together with the summary description given above and a detailed description given below serve to explain the principles of the Bolt-A-Blok system 31. It is understood, however, that the Bolt-A-Blok system 31 is not limited to only the precise arrangements and instrumentalities shown.

[0025] FIG. 1 is a sketch of the general Bolt-A-Blok system 31. One should note that FIGS. 2 A through 2 E are sketches of prior art for masonry and post tensioned structures. Also a person should note that FIGS. 3 A through 3 F are additional prior art depictions. These are discussed in the prior art section above. However, a knowledge of those prior

configurations and building methods serve an important background for one skilled in the art to fully appreciate the unique characteristics provided by the Bolt-A-Blok system 31. For many decades, and in fact a full century, masons and builders, architects and engineers, have had hollow masonry blocks and bricks to use. Likewise, steel bars and various fasteners have been readily available. However, no one taught or developed this unique, simple combination as an obvious extension of the construction technology.

[0026] In FIG. 4 are sketches of the main components for using and creating structures with the Bolt-A-Blok system 31, namely blocks 46, bars 44, fasteners 43 and a tool 45 (such as an open ended wrench).

[0027] FIGS. 5 including 5 A and 5 B are Bolt-A-Blok systems 31 and 31A that show the specific parts and characteristics of the system. Note there is a series of typical blocks 46 stacked as a soldier configuration 46A or stacked in a staggered/overlap configuration 46B. In either case, the structure "extends" through the hollow cavities 49 of the blocks 46. The system consists of a bar 44 placed at the base on top of the base means 48 (a board, a foundation, rock or firm ground, etc). The lowermost bar 44 is secured by a starter fastener 47 such as a short bolt, a spike, a concrete anchor or the like. Then the through fasteners 43 alternate locations and extend through an open aperture 50 (not shown) and are removably connected to the lower bar 44 by means of the threaded aperture 51 (not shown). A plurality of bars 44 and fasteners 43 continue to build upward with each layer or course of the masonry block 46. On the top block 46 the last fastener is placed and the demountable coupling of the blocks 46 is complete.

[0028] FIGS. 6 A through 6 G provide details of the Bolt-A-Blok system with sketches and photographs of prototype structures. FIG. 6 A repeats the general Bolt-A-Blok system 31 for easy reference. FIG. 6 b is a top drawing that highlights the free and open aperture 50 and the threaded aperture 51 in the bar 44. Note the placement over the block 46 in the location of the hollow cavity 49. The bar 44 materials may be of various metals including but not limited to steels, iron, aluminum, and the like, etc. or from composite materials such as plastics, fiberglass and other rigid materials that will permit the fasteners 43 to be torqued to sufficient pressure to hold the block 46 rigidly in place. Likewise, depending on the material and process used to create the bar 44, there are various means of producing the through aperture 50 and threaded aperture 51 such as, for example and not as a limitation, drilling, tapping, rolling, casting, etc. FIGS. 6 E shows a photograph of a prototype Bolt-A-Blok

system 52. FIGS. 6 D is a photograph of the bar 44 and fastener 43 system with the blocks 46 removed. FIGS. 6E is a photograph of the cross section of a single cavity 49 with the bar 44 and fastener (bolt) 43. FIGS. 6 F and G are top view photographs of the prototype Bolt-A-Blok system 52 looking down into the cavity 49.

[0029] FIGS. 7 A through 7 C show the details of the Bolt-A-Blok system 31 and several of the features and components that may accompany the system in a structure such a a building wall. FIG. 7 A is a photograph of the prototype wall assembly 54. Here a base means 48 is a simple board on top of a concrete slab. The blocks 46 are in a staggered configuration but a soldier stack would also work. In between the adjacent blocks FIGS. 6 A is a very small space 49A created by the separation of blocks 46 caused by the location of the bars 44. This space 49A permit many features and components to be used with the Bolt-A-Blok system 31. For example, this photograph shows insulation matter 57 in the space 49A between the block 46. Also, the space 49A allows for extended bars 55 to protrude beyond the face of the block 46. This has helpful characteristics such as permitting a beam 56 to mount in the extended bar 55. Furring strips 63 may be placed and attached in the space 49A to permit panels 58 and wallboard or the like to be attached to the wall 54 on the interior or exterior surface. On the uppermost course of block 46, a top plate 60 may be installed. This will then receive a roof truss 61 or ceiling joists. Finally shown as one of the various other features a wall 54 like this permits is a layer of plastic 62 to aid in wind infiltration and heating or cooling the structure. FIG. 7 B is a close-up photograph of the wall 54 showing a better view of the furring strip 63 and the panel 58. FIG. 7 C is a perspective photograph of the wall 54 giving a clearer view of the beam 56 and the truss 61. Also one notes the potential for plumbing pipes 59 to be placed inside the cavity 49. One note the extended tie rod 64 near the base that demonstrates the ability to connect the lower portion of a wall using the Bolt-A-Blok system 31 to an adjoining structure or other portion of a foundation.

[0030] FIGS. 8A through 8 D are several Photographs from different perspectives that demonstrate a method to securely attach a roof structure 61 to the Bolt-A-Blok system 31 wall 54. The top plate 60 rests on the upper surface of the block 46. The roof truss or joist structure 61 is contiguous to and in contact with the top of the top late 60. There is a means to attach 65 the truss 61 to the block 46. Here the means 65 is a steel clamp surrounding the truss 61 and securely connecting the truss 61. This security is accomplished by having the

steel clamp 65 being interposed into the hollow cavity 49 and surrounding a secured bar 44, thereby rigidly and removably connecting the truss 61 to the bar 44 and hence the wall 54.

[0031] FIGS 9 A through 9 E show sketches of possible structures made by the Bolt-A-Blok system 31. In FIG. 9A, a wall made of blocks 46 is placed interior to an earthwork 70 and surrounded by a concrete foundation 71. One notes the extended tie rods or bars 64(one or more) for securing and attaching the Bolt-A-Blok system 31 wall to the foundation. In FIG. 9B a series of courses of staggered blocks 46B is demonstrated. In FIG. 9C a non-linear or irregular shaped structure 73 is demonstrated. Here the individual blocks 72 have a radii for the curvature creation. In FIG. 9D a general lintel 74 is formed by the Bolt-A-Blok system 31 by using a series of soldier blocks 76 secured together over the door opening 77. One may note the block 46 are staggered and surround the opening at the perimeter 75. In FIG. 9 E a step system is shown to demonstrate how, operationally, the Bolt-A-Blok system 31 might be used to provide rigid stairs to doorways and openings 77 in a Bolt-A-Blok system 31 structure. The blocks 46 are connected by various bars 44 such as described below in FIG. 11.

[0032] FIGS 10 A through 10 G provide photographs of attachment devices which are examples shown with the Bolt-A-Blok system 31 prototype wall. Most of these have been described in the paragraphs above so only additional items are explained here. In FIG. 10A an example of an electrical wire or cable 66 is shown projecting from the face of the block 46. The wire 66 has traversed interior to the block 46 in the hollow cavity 49 and is interposed through the space 49A. In FIG. 10C, a door jamb 68 is attached to a space 49A by means of fasteners. In FIG. 10D shims 67 are highlighted. Even though the Bolt-A-Blok system 31 provides an extremely level and plumb system, one skilled in the art of masonry appreciates the need to have a means to correct irregularities. This is expected to be especially helpful in third world locations and in disaster relief situations where the materials may be used or somewhat damaged and will need the ability to allow for the imperfections. In FIG. 10F a wall mounting fastener 69 is shown. One skilled in the art of fasteners appreciates well the plethora of different fastener such as those shown, closed eye bolts, hooks and the like that may be utilized with the Bolt-A-Blok system 31.

[0033] FIGS 11 A through 11 M show sketches of bars and attachments for the Bolt-A-Blok system 31. These bars and attachments are exemplary and not limitations of the type of accessories appropriate for the Bolt-A-Blok system 31. The sketches include a standard two

hole bar 78; the "H" bar for joining block 79; the "Double H" bar 80 for high strength applications; a lintel plate and connector 81; a double extended bar 82; a turning bar 83 for corners and nonlinear connections; a connector bar 84; double row bar 85; a base plate bar 86; a winged base plate bar 87 - metal or non-metal which helps align the block; door frame connection means 88; a smaller version bar for a brick 89; and a tee handled fastener 90 that in theory would not require any tools. In Table B these, the types of blocks and other accessories are further discussed.

TABLE B – ACCESSORIES

ITEM	DESCRIPTION
1	Blocks in general Use Different type blocks - Use Bolt-A-Blok system with any hollow cavity masonry shape, block shape, standard shape or special shape building units. Blocks and Bricks, 4" 6" 8" 12", 2 core, 3 core, etc., are typical units. Most all use differing length bars and bolts.
2	Bolts Use Grade 2 hex head, square, or other type heads useable preferably with a standard or alternatively with a special wrench with minimum tensile strength, 74,000 pounds per square inch Grade 5 hex head cap screw, minimum tensile strength, 120,000 pounds per square inch
3	T-Bolts Use T bolts to be placed in the spaces. Insert the T bolt crossbar into the core of the block, turn a quarter turn, tighten the washer and nut against the outside of the block. Then attach desired items to the T bolt using another nut. The exterior end (the bolt part that sticks out of the block) of the T bolt must have a screwdriver slot that is exactly parallel to the T bolt crossbar of the T bolt. The T bolt crossbar should have a height of not to exceed 5/16" so it will go thru the spaces in the blocks. Bolt diameters can vary from large to small depending on the load to be attached. Show T bolt drawing. Use extra long thru bolts as necessary Use carriage and toggle bolts
4	Bar Stock Use Bar stock that can be sheared and have holes punched or manufacture specifically with through or threaded apertures. Threads may be tapped or manufactured into the small hole. Bars can be Zinc Chromate or galvanized coated for military, or whenever needed if necessary to prevent corrosion when they not made of a non-corroding material such as plastic or fiberglass. Bars may be made from flat stock or from hot rolled steel. Example of a typical bar material stock size, for a regular bar for an eight inch block, 3/8 x 1 ½ x 20' Typical weight for a regular bar for an eight inch block, 1.06 # Bars may also be made from plastic and other metals, in all sizes, to use with different size building unit materials.

ITEM	DESCRIPTION
5	Bars Use bars made in all sizes and materials such as metal such as steel, aluminum, rust limiting steel and iron bars, composite materials such as plastic and fiberglass, wood, ETC Bars for every block and material unit size. Typical bar size, 6 15/16" long, for a regular bar for an eight inch concrete block. Extended bar sizes 8" long and up. Extension bars for high strength attachments. Use to connect to other walls including 45 degree connectors at corners and diagonals. Ledger bars Connecting bar, about 16" x 2" Takes the place of two bars. Lintel bar – may have smaller drilled holes to put down-pointing bolts into, to attach wood header to. 2" wide flat bar lintel. Pairs of holes about every 7 13/16 inches, as necessary for lintel length. Holes go crosswise of bar. Typical for a regular lintel bar for an eight inch concrete block. Some smooth bolt holes could have slightly slotted ends, as the bar spans the opening. Bars to change from a 12 "block to an 8" block, and to change from other sizes to other sizes. Connecting bars and H bars for bottom and starter rows. Connecting bars and H bar for foundation. Connecting bars and H bars for spanning across bottom openings and top openings. For short lintels And for single horizontal rows. Turning bars for corners, right and left. J bars for corners. T bars for t walls. Y bars to attach wall ties and angle ties to Bolt-A-Blok system walls. Cross configuration or Plus shaped bar for corners. Recess bars for top row or any plate row. Extension bars with hinges on them. Military bars may be full block width but also made with "seals" 3/16 x 1 x15 5/8, connected with 5/16 square bar stock, welded into block size trays, 3 cross supports. Military blast tray mortars, galvanized. Cross supports also 3/8 diameter rods. Typical for an eight inch concrete block. Steel extensions bars to attach vault, prison, or heavy doors. Wood bar with nut insert. Bars of plastic, and can be thicker and/or wider in size. Galvanize or zinc-chromate plated the bars and shims. Military bars may be galvanized. Thicker bars, wider bars, Plastic bars, and Plated bars. Use a plastic threaded hole in a plastic bar. Double length bars for side by side walls. Welded on sleeve nut on bars if smooth bottom bar needed, such as in starting row. Use a threaded unit made of stainless steel, steel, brass, etc. sleeve molded, or cast, into a plastic or pressed into a wood bar. Use regular plastic bars, or use combination plastic bars, or bar, along with the frames, thus combining the bars and fills together. All in one piece. Use two or more extra bolts in plastic frames, if desired

ITEM	DESCRIPTION
	Dual or triple or more bolt and bar system for 12" or larger blocks, or 8" blocks needing extra strength. Smaller size bolts for small units like bricks. Any threaded rod okay in place of bolts. Hook bolts. Expanding rivet bolts. Moly and toggle bolts. Very large bolts for use with large material units, small bolts for small material units. Steel and plastic bolts. Bolts for every block and material unit size.
6	Brick ledges. – 12 inch blocks, changing to 8 inch blocks on the next course up, create an ideal starting ledge for brick. Extended bars also work well for starting brick ledges.
7	Aluminum tape, which is weatherproof, can be easily applied to the spaces. Also, ordinary duct tape could be used under furring strips if tyvek is not used and an air seal is desired. Duct tape is typically used on small area wall sections.
8	Starter plates or boards Use Anchor Spikes, generally called spikes, to every so often secure the bottom bars to the ground. Therefore one is securing the blocks and the entire block wall to the ground. Spikes can be driven through the smooth hole in the bar directly into the ground. Spikes are 3/8 diameter rods with a one inch head on them. These spikes vary in length from 2 to 8 feet. Spikes look like oversize nails. The surface of Spikes can be smooth or rebar configured. Spikes are useful for landscaping as well as for securing foundations. Lightweight channel beams. - In place of a starter board, an inverted light weight metal channel could be used, tapped out appropriately so that a one inch hex head cap screw could attach each of the several bars to the channel beam.
9	Spaces The spaces are the clear areas between the building units or blocks. One option is to leave the spaces open. However the spaces are very useful in attaching anything to the unit block walls. The spaces may also be closed for decorative purposes or closure purposes.
10	Fills Fills are slightly oversize rectangular pieces of wood or plastic, that, after assembling the wall, is driven into the spaces that are located between the bars. There is a slight taper on the long edge of the fill that is driven into the spaces. This helps start the fill into the space. A fill is what most things fasten to, such as furring strips or anything. A fill can be any size to accommodate the building unit sizes, spaces, and the materials to be attached.

ITEM	DESCRIPTION
11	Soft Fills Soft Fills are soft materials that, after assembling the wall, are placed into the spaces, for looks or closure purposes. Soft fills need no glue or adhesive properties, only enough adhesion and cohesion to hold itself in place. Regular mortar, Thin Mortar, Caulk, Rope caulk, Drywall mud Any trowel, caulk gun, hand, or finger applied paste.
12	Furring strips Furring strips are strips of wood, plastic, or other kinds of materials that are attached to the fills, usually with stainless steel or drywall screws. Furring strips have many purposes, but mainly decorative, closure, and attachments. Furring strips can be plastic or wood; can be different lengths; can be colored, grooved, and decorated with ridges and designs.
13	Trims Trims finish the spaces on one side of the wall. Trims are decorative furring strips that have fills attached to them. Trims can simply be attached by driving them into the spaces. Trims could have half round, oval round, or rectangular shaped faces. Trims could be all colors and decorated. Trims could be different materials, wood, plastic, etc. Trims for corners Precut lengths
14	Seals Seals finish the spaces on both sides of the wall. Seals are like trims except they do not have attached fills. Seals are two decorative furring strips that are attached to each other with long small rods or square shapes. These rods go through the building units or blocks within the spaces. Seals by themselves have a ladder like appearance. Seals can be made of plastic wood, or steel. Seals made of plastic are for decorative and closure purposes. Being all in one piece, seals provide for quick wall assembly and completion. Seals made of steel provide blast protection, and are often galvanized.
15	Frames Frames are bars with fills attached. Frames are made of steel, plastic, or wood.
16	Shims Shims are small squares of steel or plastic. Shims are put under bars to raise and level building units. Shims are used below the bar ends as needed. They are secured in place when the bar is tightened. Use two or more shims for additional thickness. Wafers Wafers are thin adhesive sheets placed in vertical joints for end of block sealing, if desired. Core materials Expanding foam, use as insulation, termite protection, etc. Poured concrete Poured concrete with rebars
17	Miscellaneous 3/8 rebars, if a Bolt-A-Blok system wall is used with a poured concrete foundation

ITEM	DESCRIPTION
	Use Joist brackets, Truss brackets, Brick ties bolted directly to Bolt-A-Blok system walls
18	Apply Tyvek™, sheet poly, or other sealing membrane.
19	Provide Support stands (out rigging) for wall stands for military and regular purposes, supporting one side or both sides with additional buttress structures
20	Use stainless steel bands to attach the trusses to the bars at the top of the walls. Attach to the bottom chord and/or to the top chord, or both. Whenever possible, use stainless steel bands to attach the trusses to the bars at the top of any of the partition walls. Multiple bands may be used if desired.
21	Use extended bars to: safely and securely attach ladders to the inside or outside of walls. safely and securely support interior and exterior fire escapes safely and securely support interior and exterior balconies. attach conduit to walls – all directions and sizes attach architectural embellishments, such as foam block, wood, plastic, decorative roof elements, and other. attach and support bar joists. attach lights and lighting. attach downspouts
22	Use bolted soldier courses when long and shorter lintels are needed, like over doors, windows, and overhead doors.
23	Use with curved blocks, typical 2 core, based on different radii, different faces such as split, different colors, and more. Bay windows, landscaping, turrets, silos, round piers, decorative bollards, towers, and other structures. Round towers are now possible with Bolt-A-Blok system. Show curved block drawings.
24	Use stainless steel and/or fiberglass for food tanks, acid tanks, breweries, and more.
25	Provide Door and window frames that are installed immediately to secure the building

[0034] FIGS 12 A through 12 D show sketches of a possible deck structures made by the Bolt-A-Blok system 31. Simplistically, in FIG 12 A a photograph of a simple lateral deck 91 is shown supported by some means 92. In this example photograph the Bolt-A-Blok system 31 is used with a series of blocks 46 in a soldier formation. FIG. 12 B shows the support 92 and highlights the simple bar 44 and bolt 43 components along with the block 46. FIG. 12 C is a photograph from a side view. FIG. 12 D is a photograph demonstrating a person or load 93 being supported by the deck 91. One skilled in the art appreciates the many ways a deck like this might be used. For example, with bridges, roadways, roofs, and the like. Additionally a skilled masonry or construction person appreciates the soldier layout is an example. Obviously, a staggered pattern offers additional ways to lay out a deck.

[0035] FIGS 13 A through 13 D show photographs of tools used in the original prototype of Bolt-A-Blok system 31. They are self explanatory. One skilled in completing prototype build recognizes the original bars 44 having the apertures 50 and 51 being prepared with the means 96 to provide the clear aperture. Likewise a means to provide threads 97 is shown in the photographs. Finally, various hand drivers 94 and powered drivers are shown. While these are helpful and increase productivity, the Bolt-A-Blok system 31 still only technically needs the wrench 45 to build the system once a person has the blocks 46, the bars 44 and the fasteners 43. Other useful tools that may aid are shown in Table C

TABLE C - TOOLS

ITEM	DESCRIPTION
1	Open Hand wrench
2	Ratchet
3	Power or impact Wrench
4	Grout applicators
5	Tie wire pliers/cutters
6	Levels – simple hand held; Laser; Rotating Laser level that can be moved up & down on a rod.
7	Grout Bags - Grout Bags are what are used to easily put mortar in spaces should that be desired for the finished look. Grout bags hold about 6 to 10 pounds of mortar and typically have a 3/8 tip on them. Grout Bags are easy to use. Grout Bags are used in a similar manner as if one were icing decorations on a cake. Grout Bags cost 5 to 7 dollars retail. Use regular mortar, post fill the spaces and rake the spaces if desired.
8	Power caulking gun - Use power caulking gun, typically air operated, to apply caulk in spaces, should that be desired.
9	

[0036] FIGS 14 A through 14 E show sketches of typical hollow core masonry blocks 46, decorative blocks 99, bricks 100, and a chart 98 of various configurations of hollow cavity blocks. All these types of masonry units are complementary and useful when utilized with the Bolt-A-Blok system 31.

[0037] The details mentioned here are exemplary and not limiting. Stated again and well appreciated by one skilled in the art of construction materials, all the examples of the materials may be substituted with other plastics and composite materials that have similar properties and still be within the scope and spirit of this Bolt-A-Blok system 31. Other components specific to describing a Bolt-A-Blok system 31 may be added as a person having

ordinary skill in the field of construction as being obvious from the above described embodiment.

OPERATION OF THE PREFERRED EMBODIMENT

[0038] The new Bolt-A-Blok system 31 has been described in the above embodiment. The manner of how the device operates is described below. Note well that the description above and the operation described here must be taken together to fully illustrate the concept of Bolt-A-Blok system 31.

[0039] FIGS 15 A through 15 D show photographs of a construction process for a prototype using the Bolt-A-Blok system 31. In FIG 15 A the first block 46 is placed on the base 48 and the bars 44. A non-skilled worker 102 begins the construction process. In FIG 15 B the build continues as a second block 46 is added. Here the worker 102 uses a power driver 95 but could easily use just a standard wrench 45 (not shown). In FIGS 15 C the worker 102 places a third block in a staggered configuration. The build continues until the desired length and height of the wall is realized. Additional workers could work directly along side and near the first worker 102 since no bracing or cure time is required. Once the structure is completed, occupancy is immediate.

[0040] There are many, many examples of how the Bolt-A-Blok system 31 may work in different structures. The following Table D is offered as exemplary and not limiting as to how this unique Bolt-A-Blok system 31 can be used.

TABLE D – EXAMPLES OF USES

ITEM	DESCRIPTION
1	All general construction.
	Building Walls, fences, and construction partitions
	Foundations
	Piers under floors and bridges
	Fireplaces and Flues
	Retaining Walls
	Decorative Panels – straight or curved
	Vertical, horizontal, flat and curved wall
	Self supporting columns
	Use Bolt-A-Blok system for constructing partition walls
	Construct segments that can be pre-assembled to any size or shape. Then set in place with a crane, especially in areas where it is not safe to lay building units in a regular manner, such as atop buildings
	Use with all standard lintels.

	Roof deck
	Steps for entry ways and multi-level buildings
	Assemble Bolt-A-Blok system walls in any configuration, silos, piers, boxes, walls, ell-walls, t-walls, u-shape walls, and square walls
2	Bridge, levy and highway
	Levy/Dams Repair broken levies, make new levies, piers. Box shape, solid shape, U-shape , could nest larger and larger square piers or rectangle piers. Strengthen existing levies by putting Bolt-A-Blok system made piers in front of existing walls. Re-enforcement can be positioned under water and need not show. Pre make and drop long units in place for levy control. Pull out with cable.
	Bridge Structures Breakwater forms. Ultra strong forms for pouring concrete into. Bridge forms and piers.
3	Disaster and terrorism prevent/relief
	Entrance Barriers – Such as Gates and vehicle control points
	Safe room, Safe or Vault – easy builds in high rise structures
	All structures that require more fire resistant, wind resistant, and attack resistant buildings.
	Military use for blast protection, quick guard houses, quick prisons
	Quick construction in third world countries, disaster areas, anywhere. Use Bolt-A-Blok system for rapidly replacing buildings in disaster areas
	Wind and water resistant - Hurricane, Tornado Tsunami resistant
	Anti-terror barricades at public buildings
	Earthquake resistant
4	Other
	Store and garden commercial display units
	Tank walls – such as Swimming pools, fire water tanks, waste water tanks
	Mobile and/or Manufactured home Building skirts
	Sound-proof or noise attenuation walls and structures
	Paint and hazardous material containment structures
	Desert application, below freezing applications, below water applications, mines. Use in caissons, for underwater construction.
	Surveyor monuments, mail box posts. bases for equipment such as propane tanks and air conditioning units, wing walls, retaining walls, motels, fire walls, storage unit buildings, schools.

[0041] With this description of the detailed parts and operation it is to be understood that the Bolt-A-Blok system 31 is not to be limited to the disclosed embodiment. The features of the Bolt-A-Blok system 31 are intended to cover various modifications and equivalent arrangements included within the spirit and scope of the description.

What is claimed is:

1. A construction system for building a masonry structure, the system comprising:

a) a plurality of standard masonry units, each unit with at least one cavity, each unit having an uppermost and lowermost plane with the hollow cavity therein, and each unit having the planes being essentially parallel to one another;

b) a series of pairs of bars, each bar with a threaded aperture and a comparatively larger non-threaded aperture, the first bar placed contiguously to the first plane having the hollow cavity of the masonry unit and the second bar placed contiguously to the uppermost top plane having the hollow cavity of the masonry unit wherein the first bar and second bar are placed essentially parallel to each other with the apertures aligned such that the non-threaded aperture of the uppermost bar is aligned with the threaded aperture of the lowermost bar;

c) a plurality of fasteners with a means to rigidly and removably connect each of the bars first to the bar aligned above, if any, and secondly to the bar below with the masonry unit interposed between the connected bars;

d) a simple tool to facilitate the connection of the fasteners to the bars; and

e) various accessories to complete the masonry structure with equal and superior function as compared to a standard masonry with a mortar structure

whereby the system and combination of components provides an easily built structure which has comparatively superior structural strength to a mortar and masonry unit structure; which is made from common and available materials; and which provides a structure that may be assembled and disassembled for reuse of its components by means of a simple tool by unskilled workers.

2. The construction system according to Claim 1, wherein the masonry unit is a hollow core masonry block.

3. The construction system according to Claim 1, wherein the masonry unit is a hollow core masonry brick.

4. The construction system according to Claim 1, wherein the fastener is a through bolt.

5. The construction system according to Claim 4, wherein the material composition of the through bolt is metal.

6. The construction system according to Claim 5, wherein the metal of the through bolt is steel.

7. The construction system according to Claim 6, wherein the steel composition of the through bolt is stainless steel.

8. The construction system according to Claim 1, wherein the fastener is a tee bolt with a slot at the threaded end and a bar attached at the opposite end of the threads whereby the fastener may be inserted interior to the hollow cavity of a masonry unit and adjusted for a secure connection by use of the slot at the opposite threaded end of the tee bolt.

9. The construction system according to Claim 1, wherein the material composition of the bar is metal.

10. The construction system according to Claim 9, wherein the material composition of the metal is steel.

11. The construction system according to Claim 10, wherein the material composition of the steel is of stainless steel.

12. The construction system according to Claim 10, wherein the material composition of the steel is of a high strength alloy steel.

13. The construction system according to Claim 9, wherein the material composition of the metal is iron.

14. The construction system according to Claim 9, wherein the material composition of the metal is aluminum.

15. The construction system according to Claim 1, wherein the easily built structure is a wall with a lowermost and uppermost course of masonry units.

16. The wall structure according to Claim 15, wherein a roof truss is attached by a means to the uppermost course of the wall.

17. The wall structure according to Claim 16, wherein the means to attach is a metal band clamp encircling the metal bar of the wall structure and the roof truss members.

18. The metal band according to Claim 17, wherein the metal is steel.

19. The steel according to Claim 18, wherein the steel is stainless steel.

20. The steel according to Claim 18, wherein the steel is a high strength alloy steel.

21. The wall structure according to Claim 16, wherein the means to attach is a band clamp comprised of a high strength composite material wherein the band encircles the metal bar of the wall structure and the roof truss members such that the encircling forms the attachment means.

22. The construction system according to Claim 1, wherein the easily built structure is a foundation.

23. The construction system according to Claim 1, wherein the easily built structure is a retaining wall.

24. The construction system according to Claim 1, wherein the easily built structure is a deck.

25. The construction system according to Claim 24, wherein the deck is a roof deck.

26. The construction system according to Claim 24, wherein the deck is a bridge deck.

27. The construction system according to Claim 24, wherein the deck is a road deck.

28. The construction system according to Claim 1, wherein the easily built structure is a decorative store display panel.

29. The construction system according to Claim 1, wherein the easily built structure is at least one self supporting column.

30. The construction system according to Claim 1, wherein the easily built structure is a pier for floors and bridges.

31. The construction system according to Claim 1, wherein the easily built structure is a barricade.

32. The construction system according to Claim 1, wherein the easily built structure is a storage safe and vault structure.

33. The construction system according to Claim 1, wherein the easily built structure is a sound proof enclosure.

34. The construction system according to Claim 1, wherein the easily built structure is a levy and damming structure.

35. The construction system according to Claim 1, wherein the easily built structure is a blast resistant building.

36. The construction system according to Claim 1, wherein the easily built structure is a fire, wind and blast resistant building structure.

37. A construction system for building a masonry structure, the system comprising:

a) a plurality of standard hollow cavity masonry units placed in staggered courses;

b) a series of pairs of bars about 6-3/4 inches by 1-1/2 inches and approximately 3/8 inch thick with a single 7/16 inch diameter smooth drilled through aperture and with a second threaded aperture with threaded features for a 3/8 inch with 16 TPI National Coarse 16 TPI threaded through bolt;

c) a plurality of 3/8 inch threaded Grade 2 through bolts approximately 8-1/2 inches in length with 16 TPI National Coarse threads ;

d) a simple open end box wrench that fits a hex head of a 3/8 inch through bolt;

e) various accessories to complete the masonry structure with equal and superior function as compared to a standard masonry with a mortar structure whereby the system and combination of components provides an easily built structure with superior strength, from common and available materials, which is stronger and more durable than structures built of mortar and masonry and provides a structure that may be assembled and disassembled for reuse of its components by means of a simple tool by unskilled workers.

Fig. 1

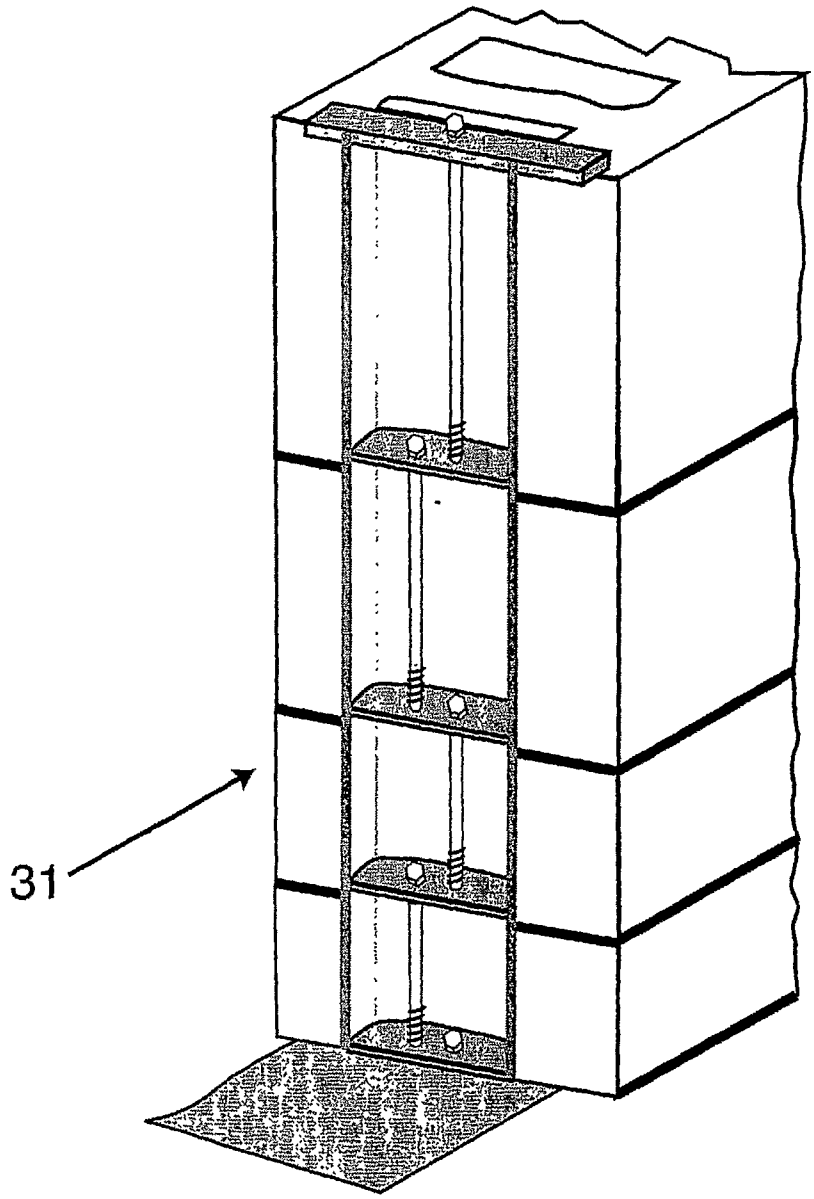

Fig. 2

Fig. 2A

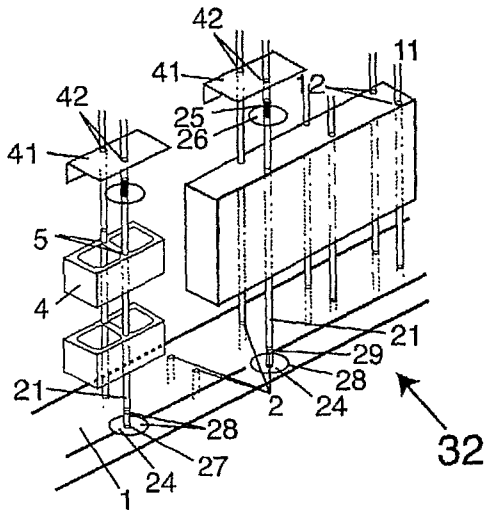

Fig. 2B

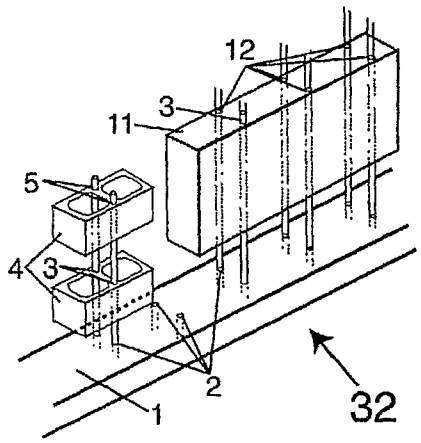

Fig. 2C

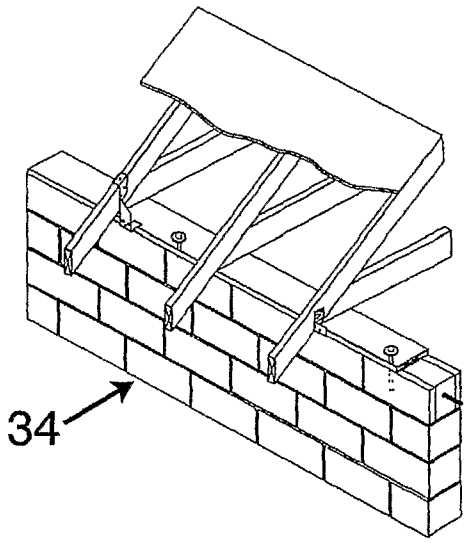

Fig. 2D

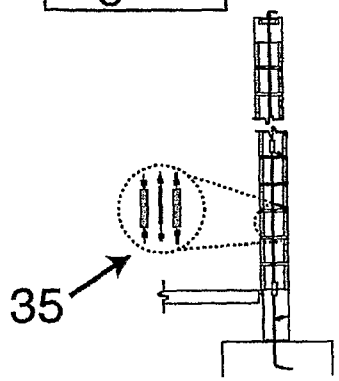

Fig. 2E

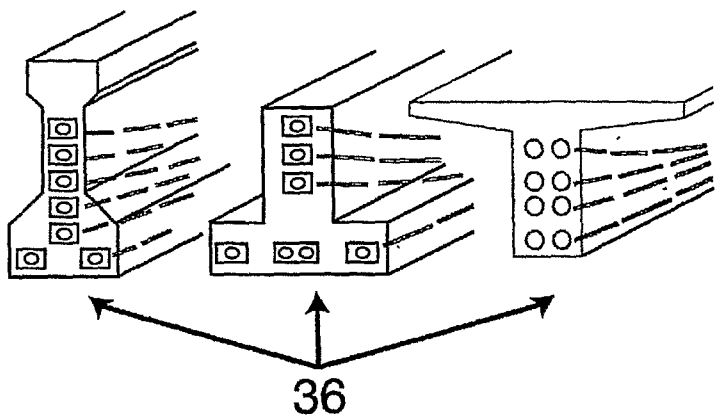

Fig. 3

Fig. 3A

Fig. 3B

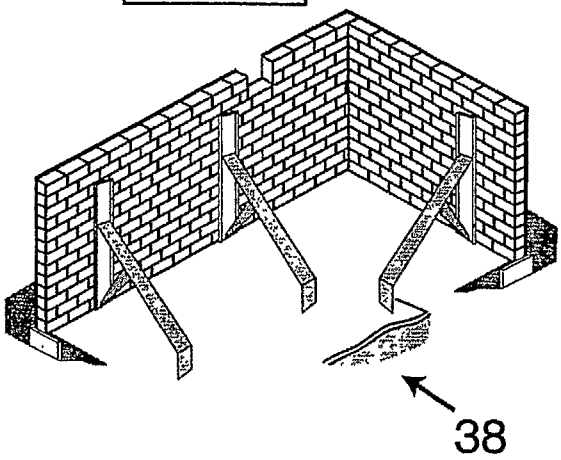

Fig. 3C

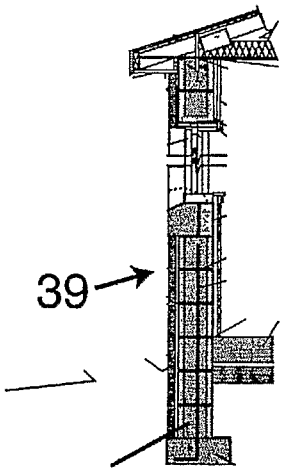

Fig. 3D

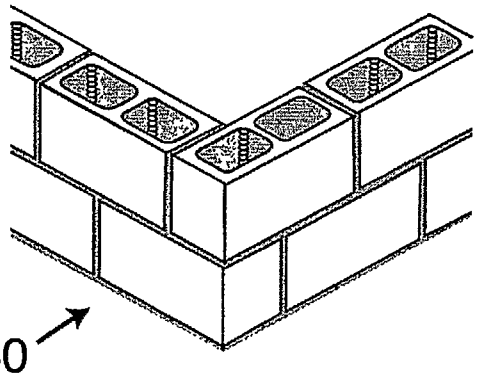

Fig. 3E

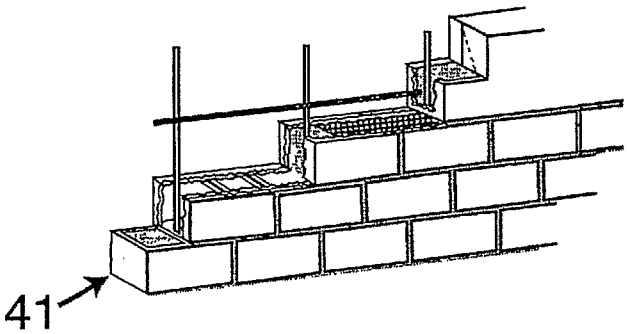

Fig. 3F

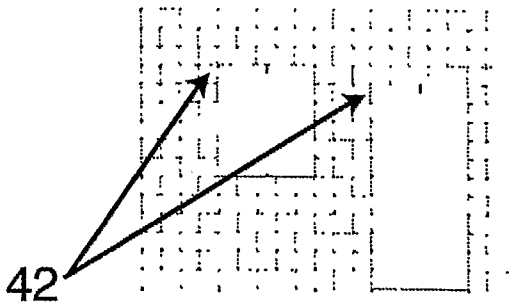

Fig. 4

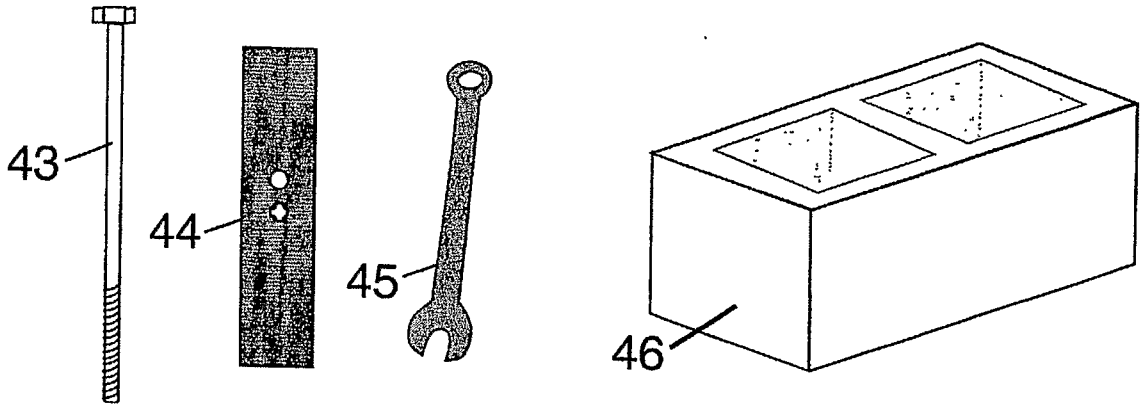
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Fig. 5

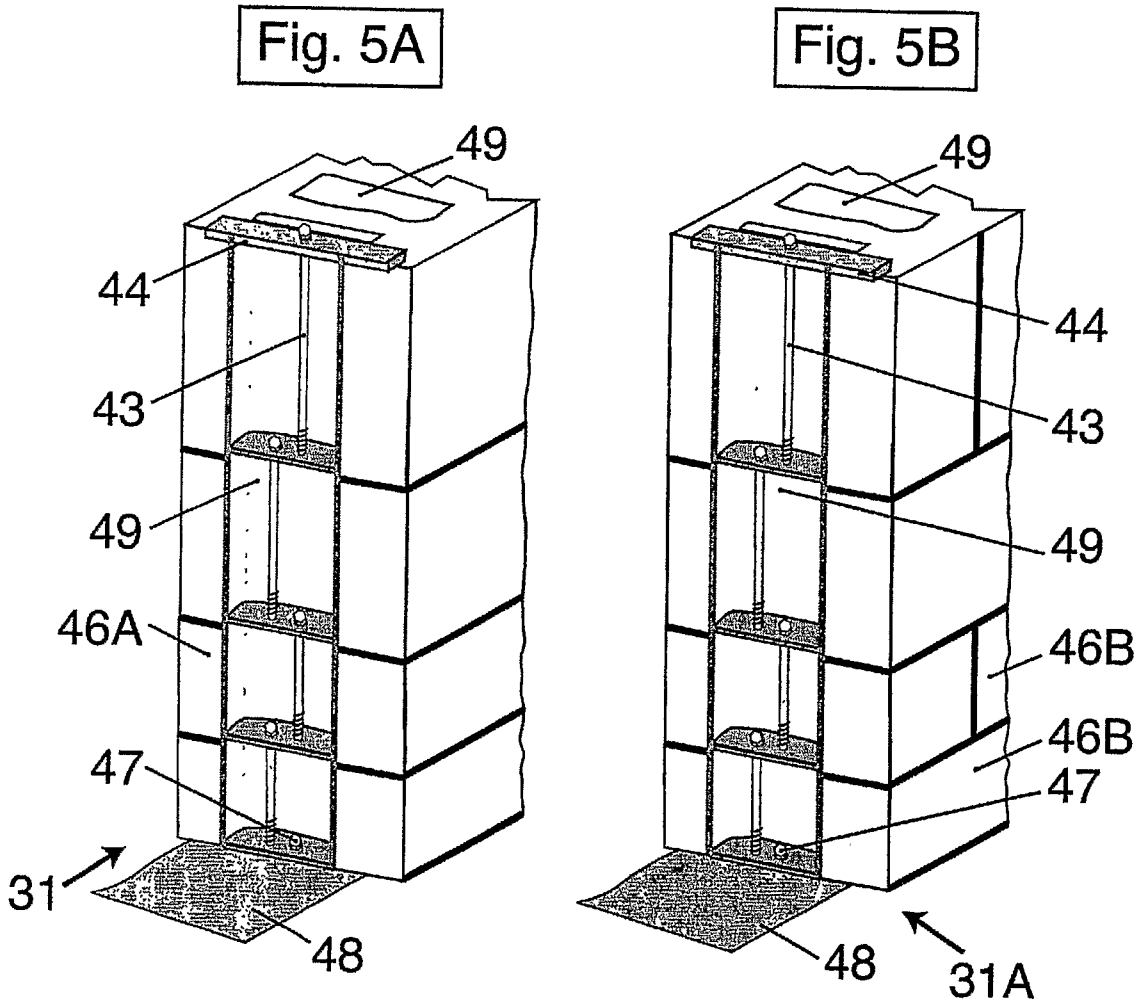
Fig. 5A
Fig. 5B
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46A
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46B
46B
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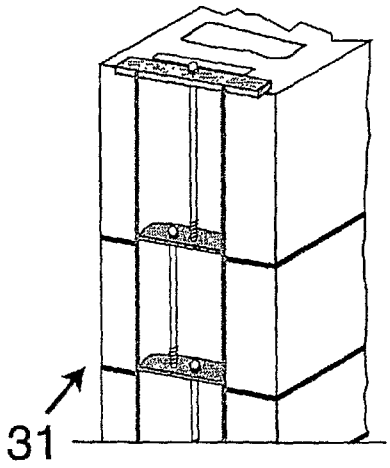
31A

Fig. 6

Fig. 6A



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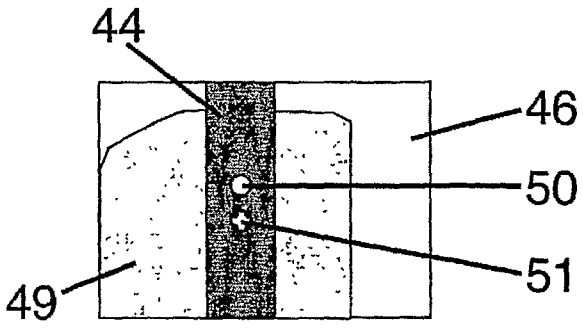


Fig. 6C

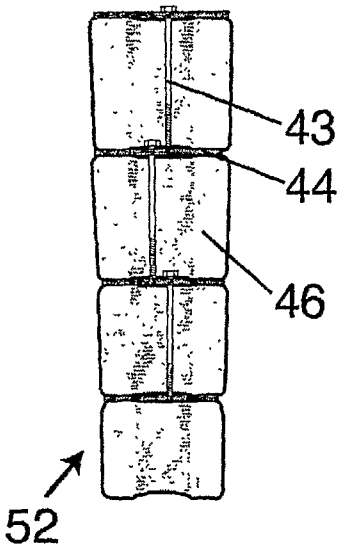
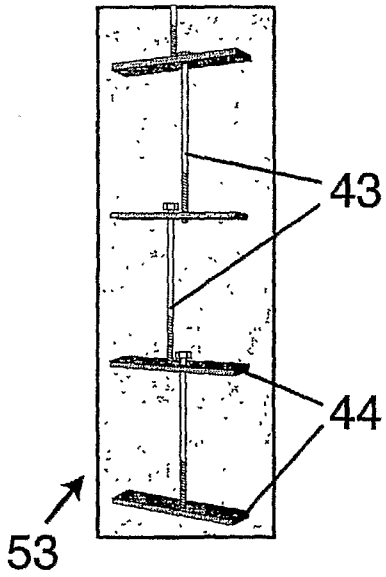


Fig. 6D



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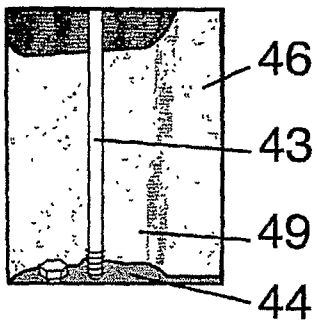

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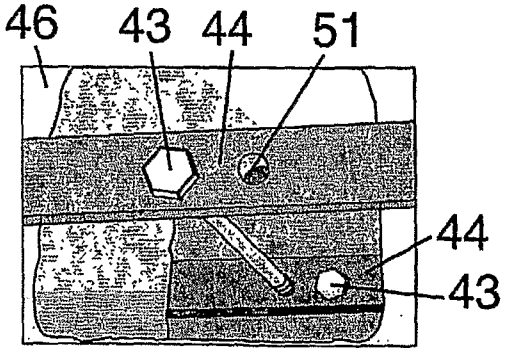


Fig. 6G

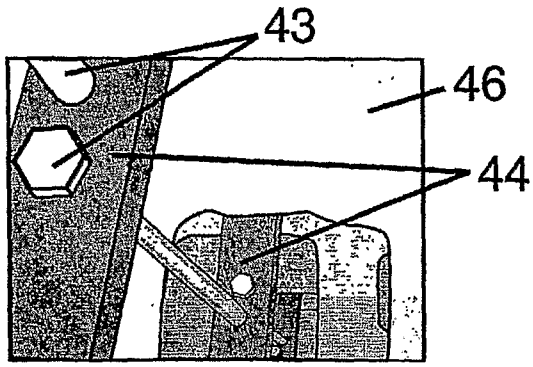


Fig. 7

Fig. 7A

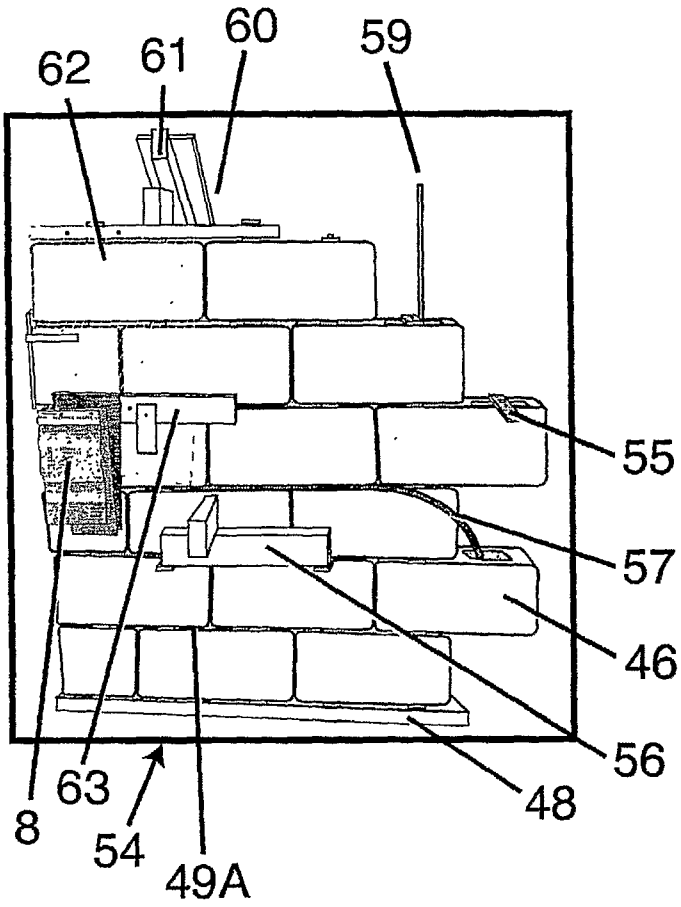


Fig. 7C

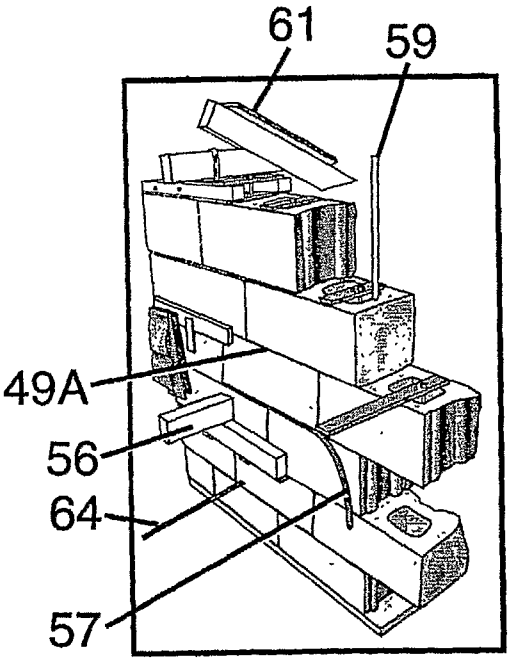


Fig. 7B

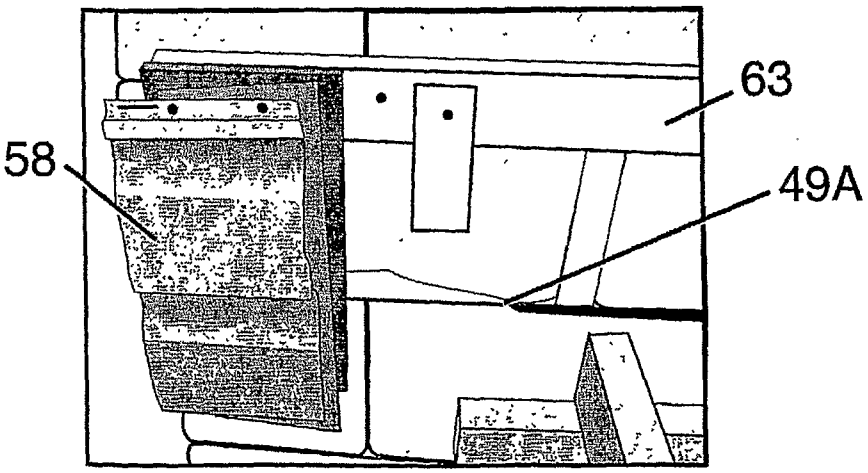


Fig. 8

Fig. 8A

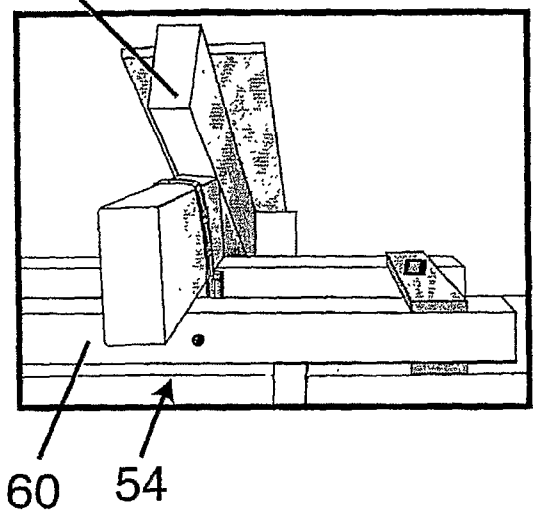
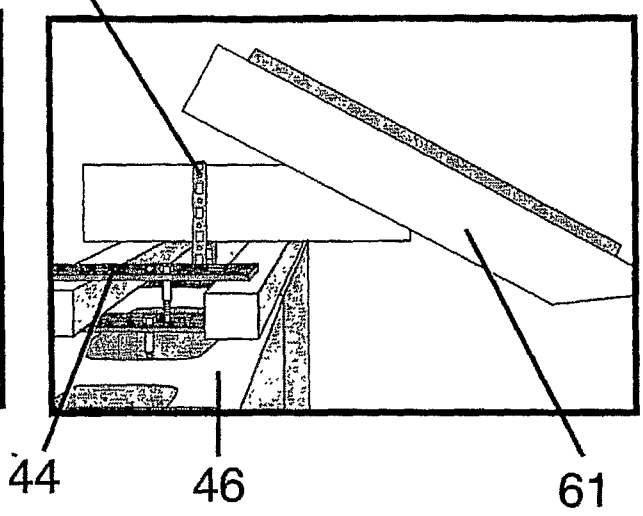


Fig. 8B



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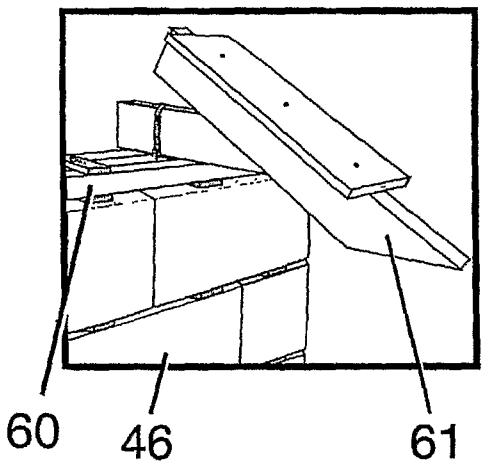

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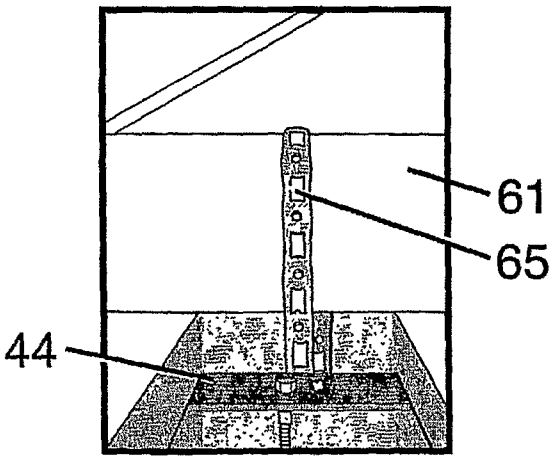

Fig. 9

Fig. 9A

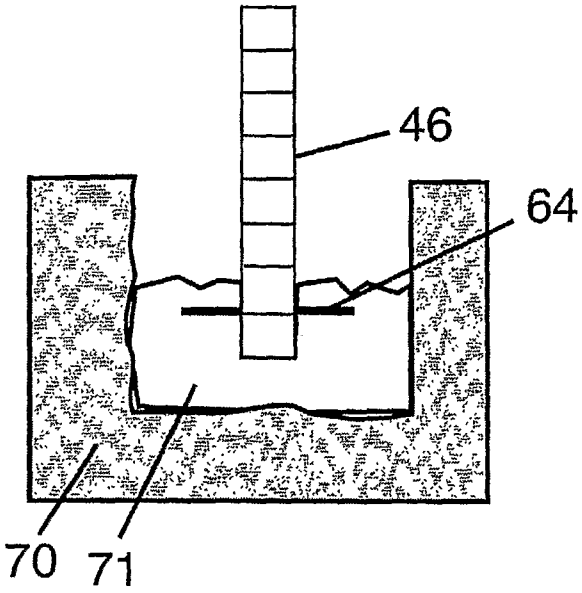

Fig. 9B

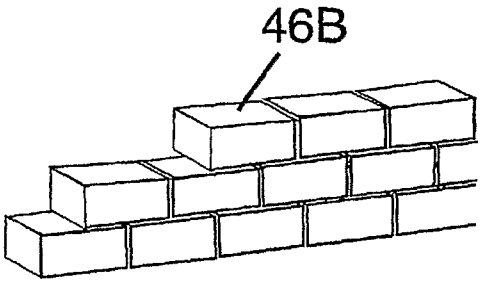

Fig. 9C

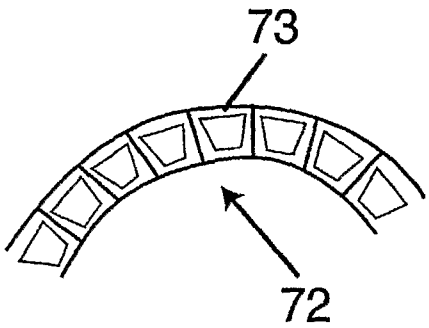

Fig. 9D

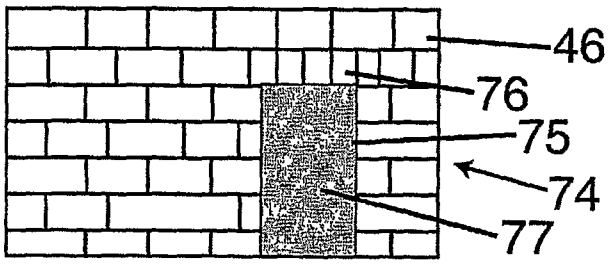

Fig. 9E

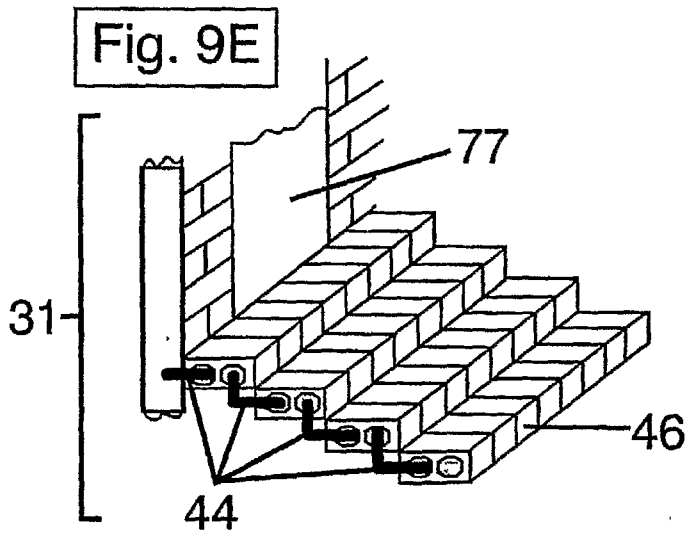

Fig. 10

Fig. 10A

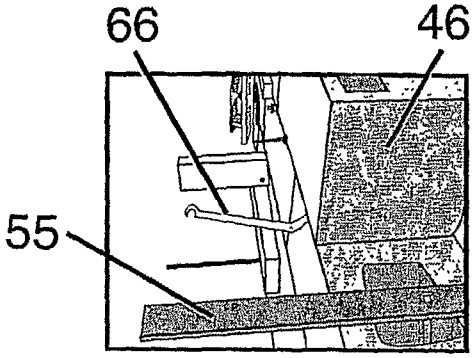

Fig. 10B

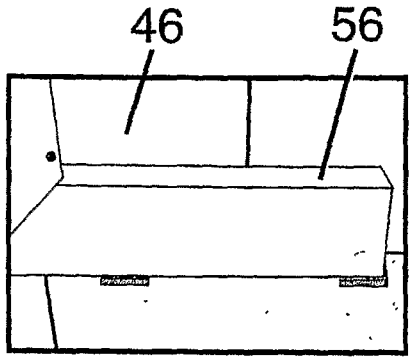

Fig. 10C

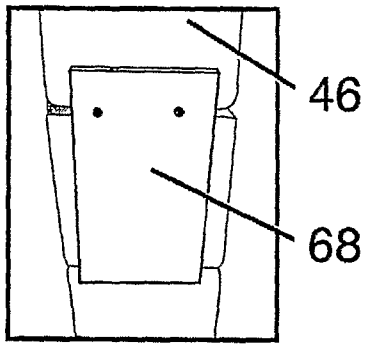

Fig. 10D

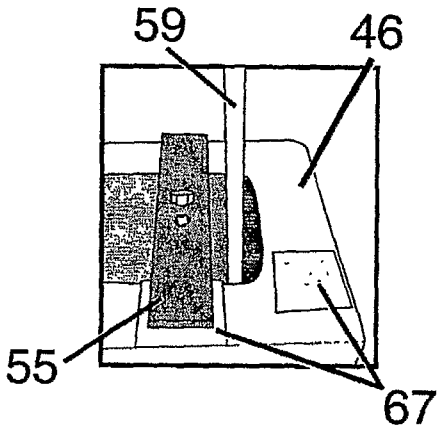

Fig. 10E

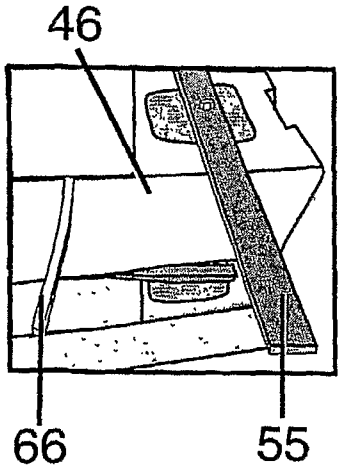

Fig. 10F

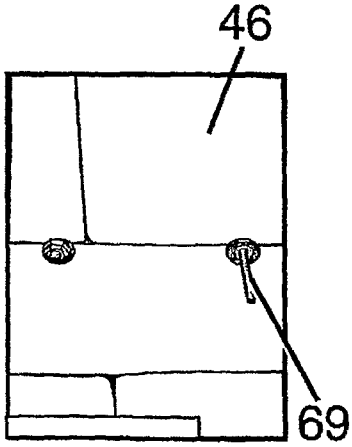

Fig. 10G

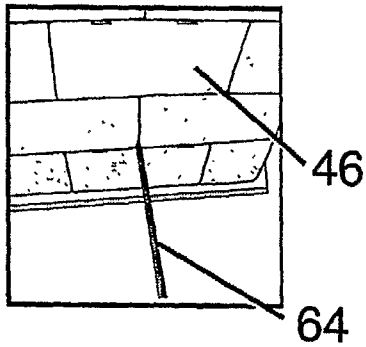

Fig. 11

Fig. 11A

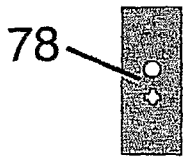

Fig. 11B

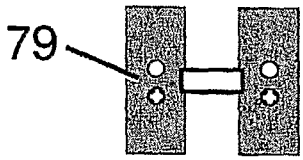

Fig. 11C

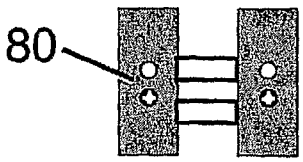

Fig. 11D

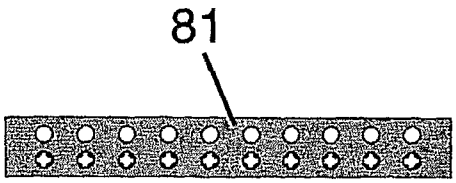

Fig. 11E

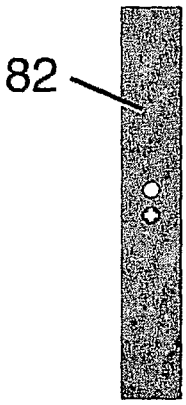

Fig. 11F

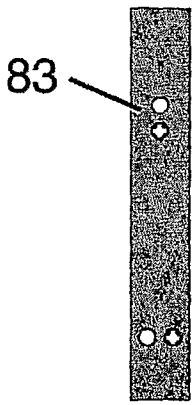

Fig. 11G

Fig. 11H

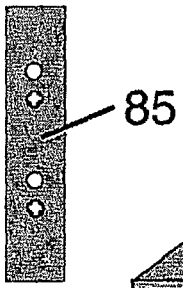

Fig. 11I

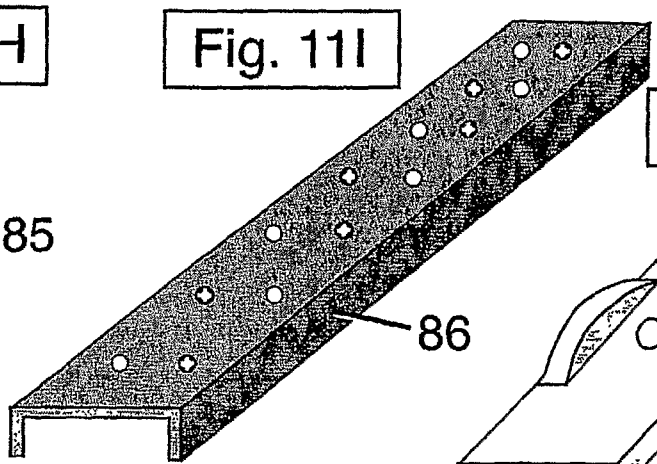

Fig. 11J

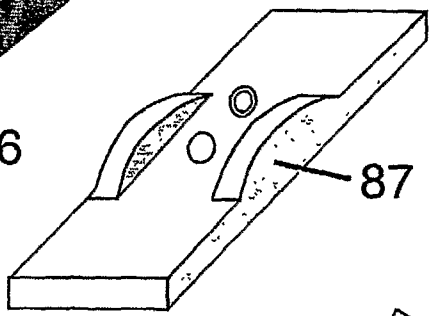

Fig. 11K

Fig. 11L

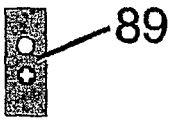

Fig. 11M

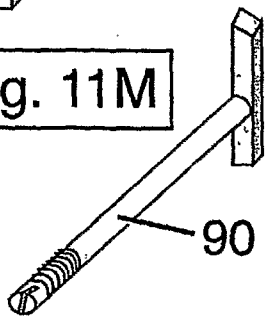

Fig. 12

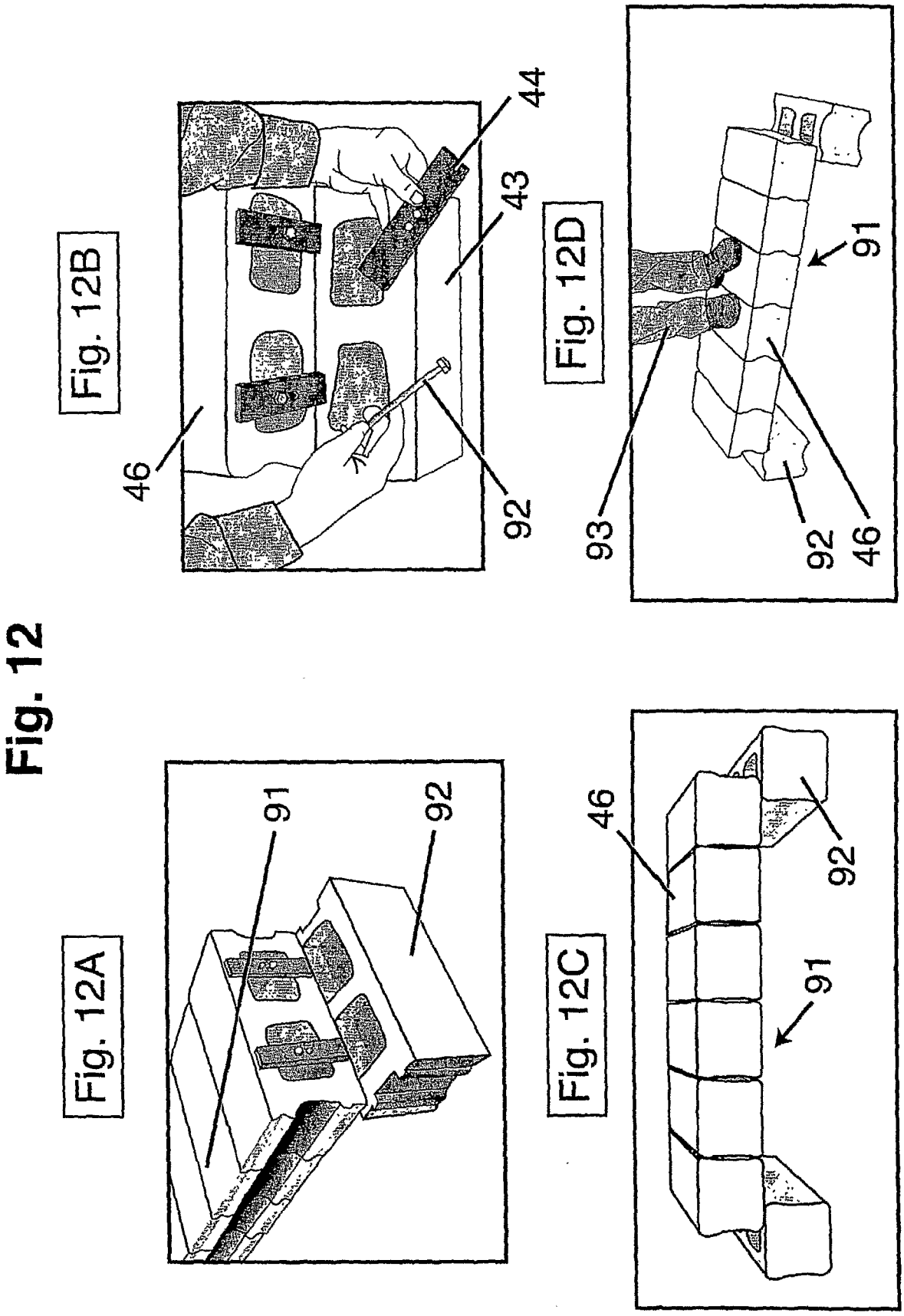
Fig. 12A
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Fig. 12B
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Fig. 12C
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Fig. 12D
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Fig. 13

Fig. 13A

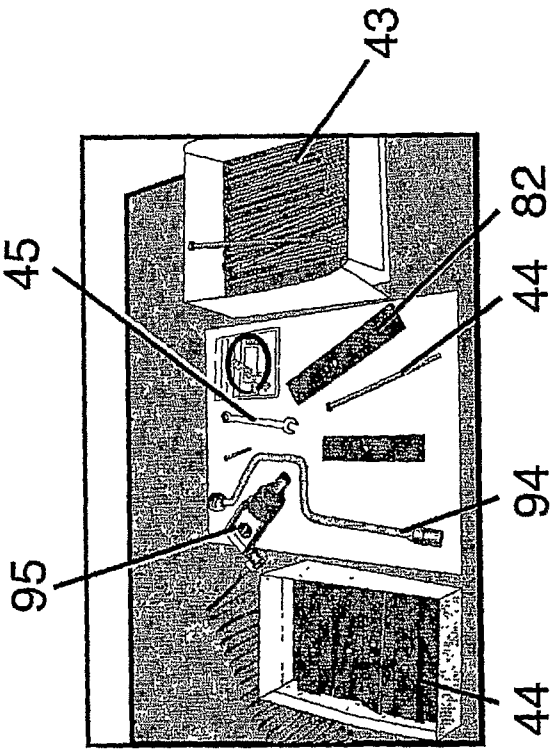

Fig. 13B

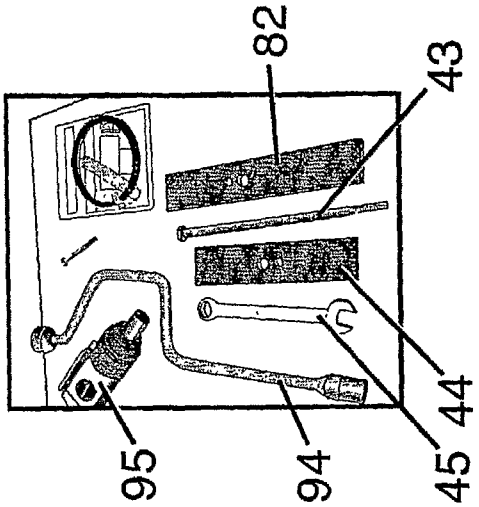

Fig. 13C

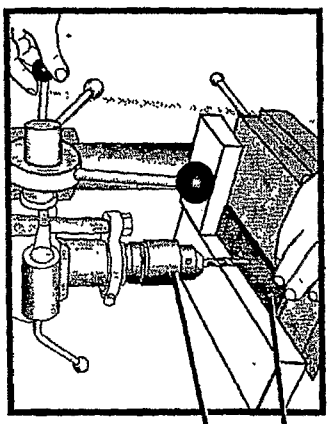

Fig. 13D

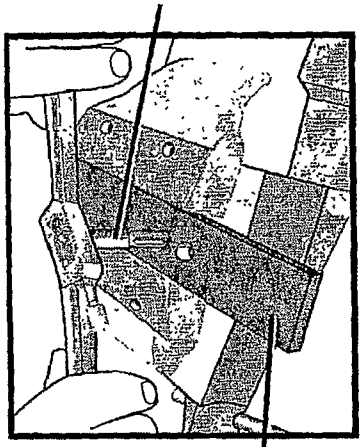

Fig. 14

Fig. 14A

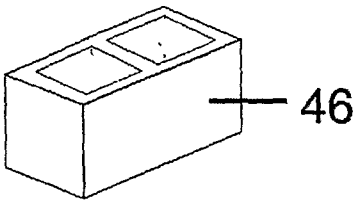

Fig. 14B

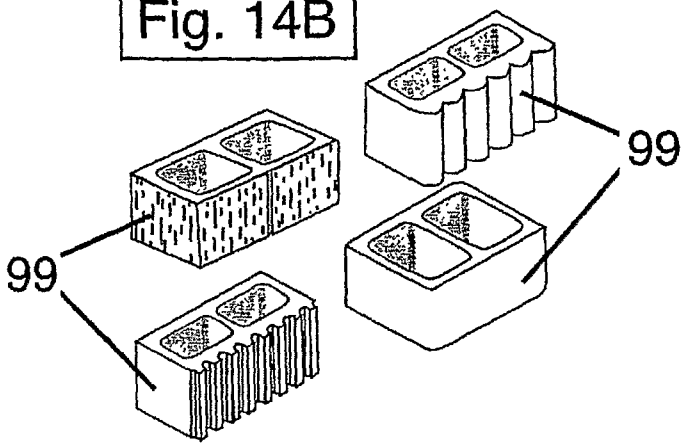

Fig. 14C

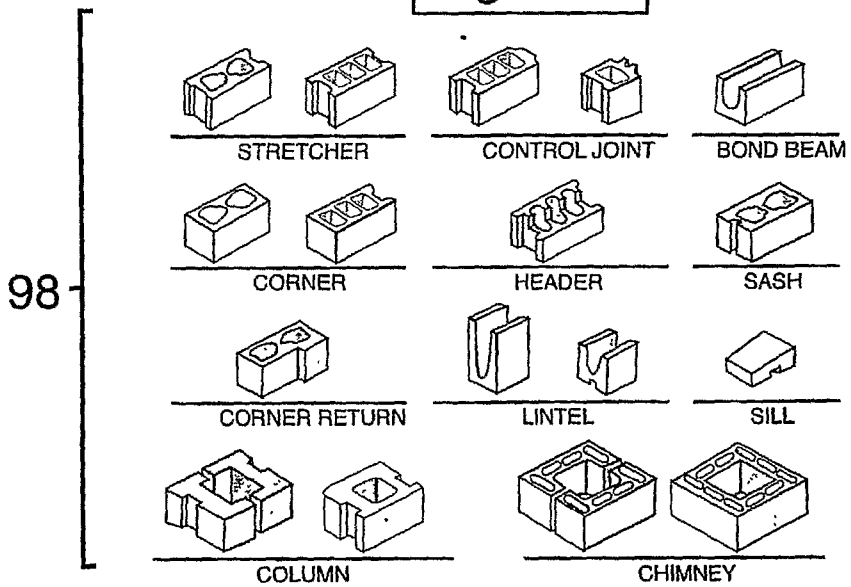

Fig. 14D

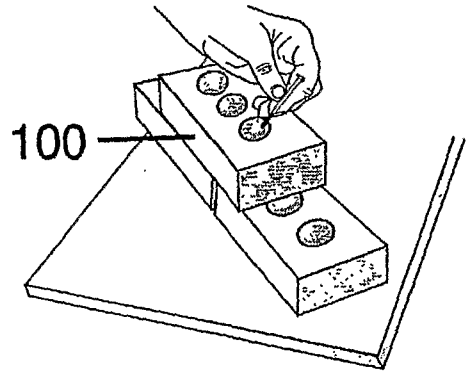

Fig. 14E

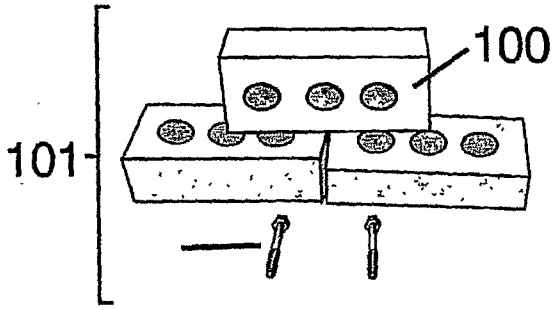

Fig. 15

Fig. 15A

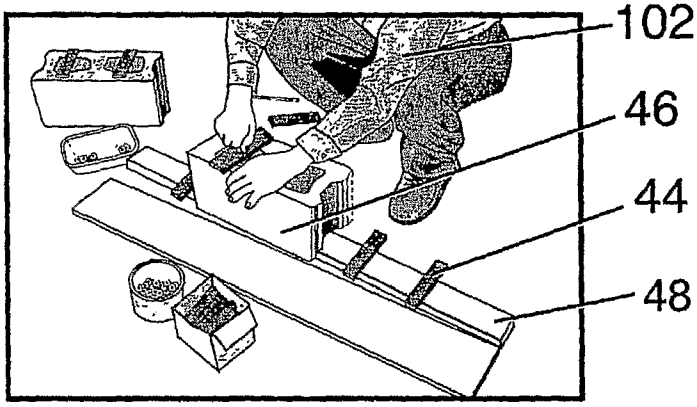

Fig. 15B

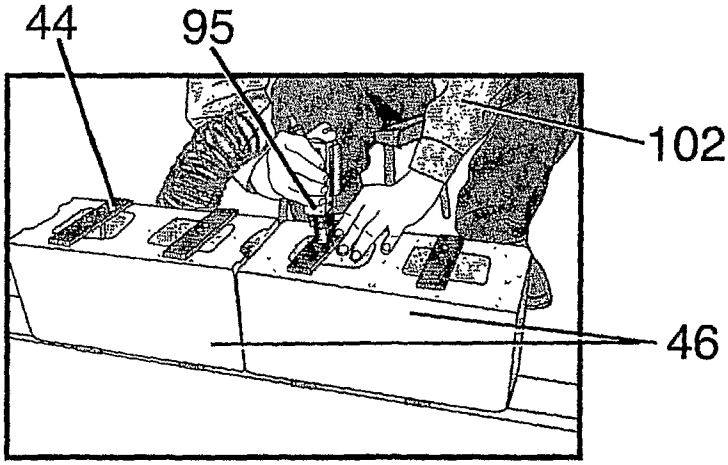

Fig. 15C