

Aug. 19, 1969

A. BRUGNOLA

3,461,631

COMPLEMENTARY MODULES AND STRUCTURES THEREFROM

Filed Jan. 16, 1967

3 Sheets-Sheet 1

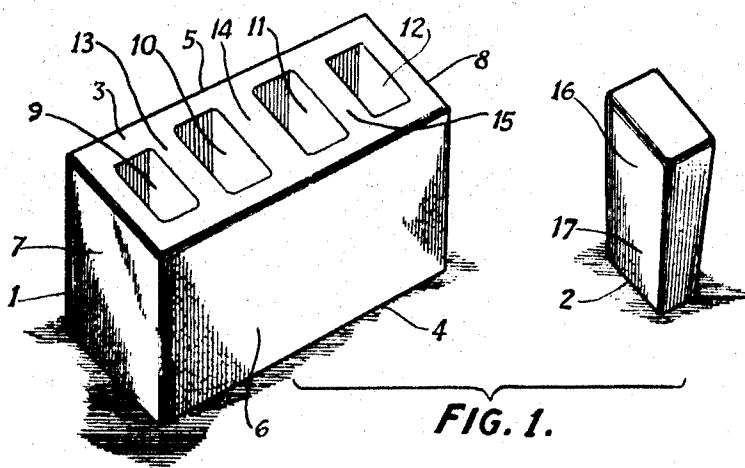


FIG. 2

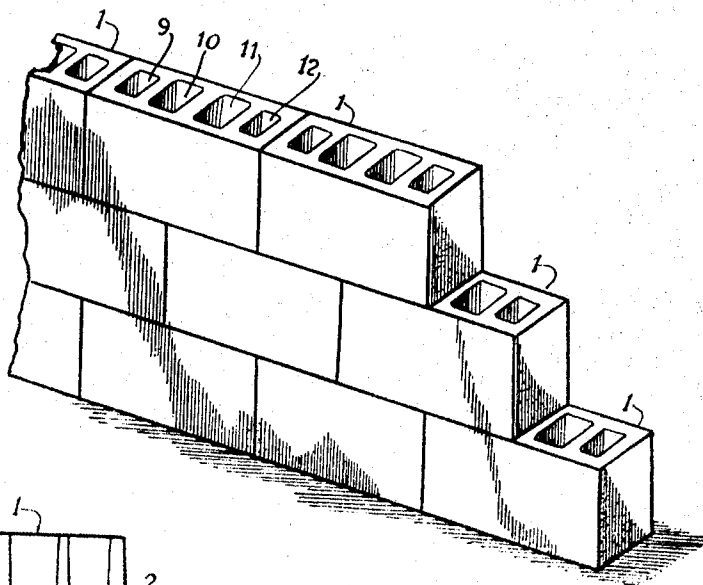
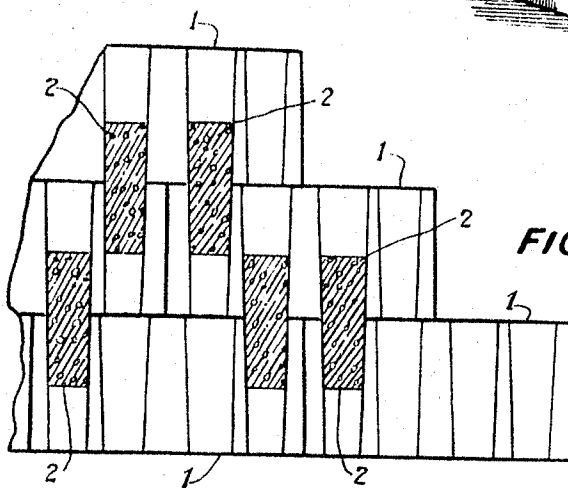


FIG. 3



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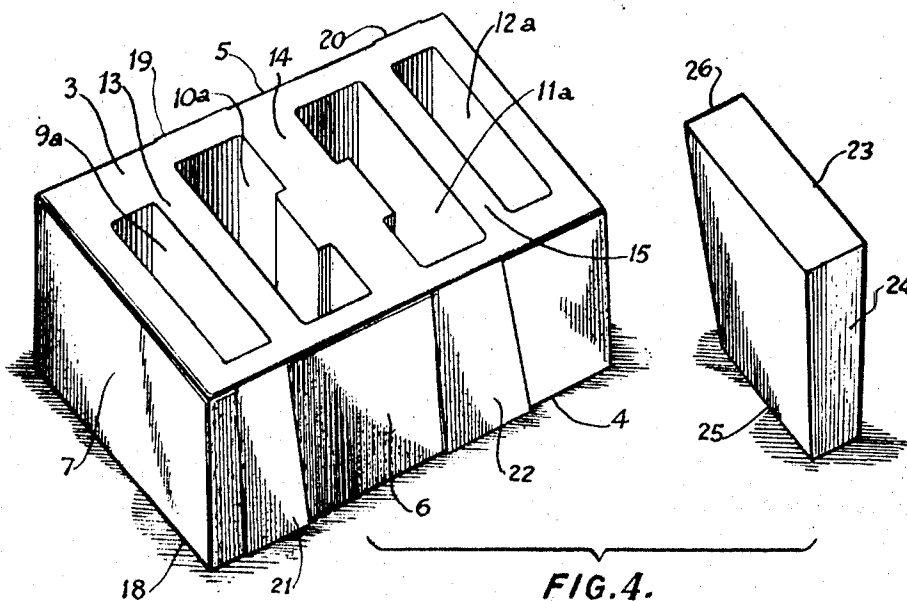
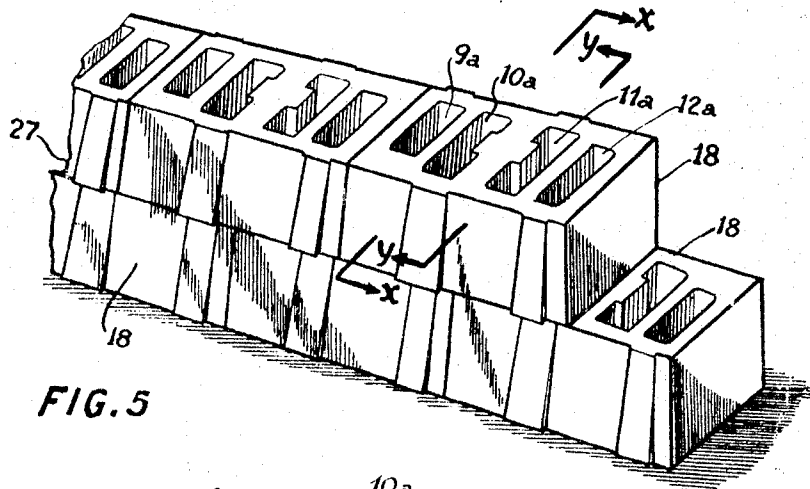
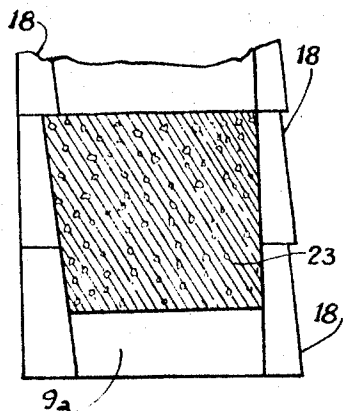
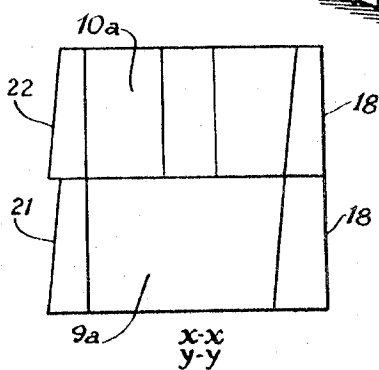
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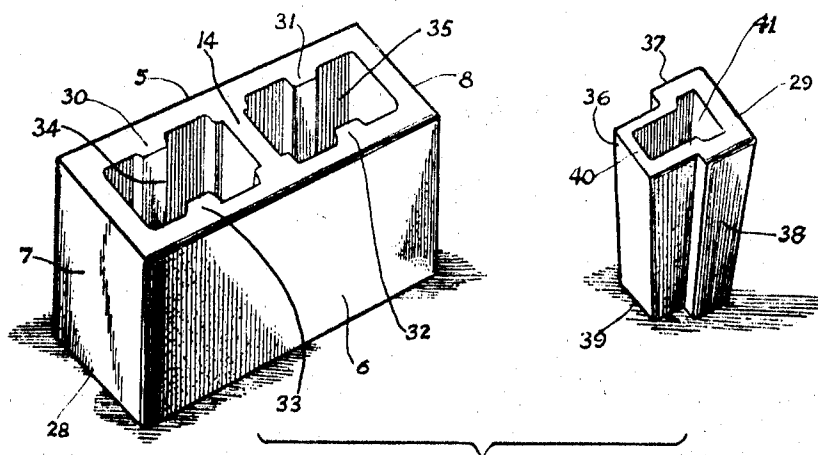


FIG. 8

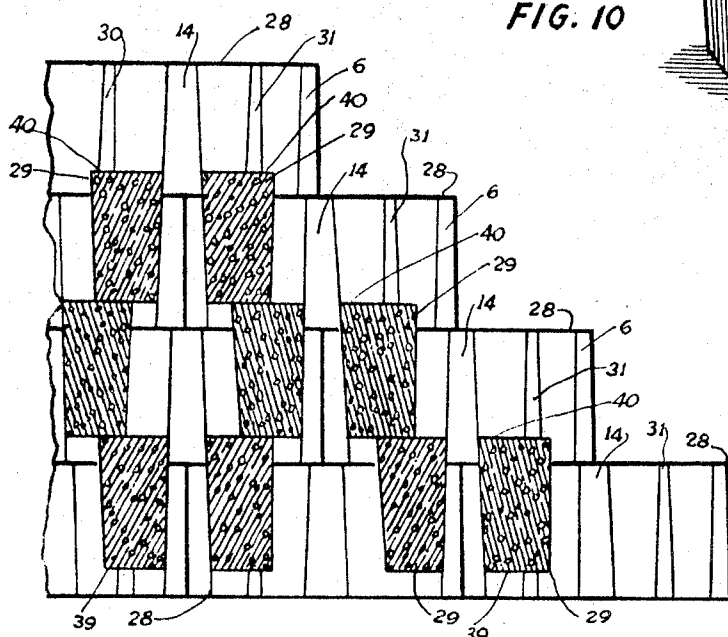


FIG. 9

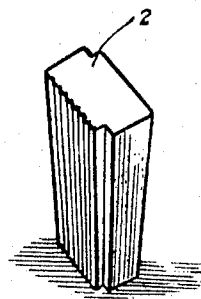


FIG. 10

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COMPLEMENTARY MODULES AND STRUCTURES THEREFROM

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7 Claims

ABSTRACT OF THE DISCLOSURE

The invention relates to blocks, adapted to being assembled, without mortar or other cementitious material into a homogeneous and self-aligned structure, by using complementary modules, which are partially inserted into cavities of said block, whereby any two contiguous blocks within the course of a structure thus assembled, are inter-linked one to the other by means of said modules, thus effectively constructing a structural unit to resist disruptive forces.

The present invention relates to modules and, more particularly, to complementary modules capable of forming self-aligned and inter-engaged structures.

Modules of many types have been devised over the years with the aim of producing self-aligning structures by the use of interlocking component elements. None of these, however, have achieved such acceptance as to bring them into common use. The reason for this is that most of the modules described in the art suffer from distinct disadvantages. Foremost among these is the fact that such modules cannot be easily produced by quantity methods. In the construction field, existing lock-making machines require a draft-angle of 1° 30' to 2° in order to withdraw the die that forms the cavities within the module. None of the wall faces within the block can be vertical. Hence, concrete blocks must be designed to satisfy these requirements. Still another serious drawback of such modules is that they propose the forming of very thin protrusions and walls and tongue-and-groove arrangements, which are manifestly unfeasible, and even if they were possible, would be attended by much breakage and increased costs. Yet another disadvantage of such modules is in their unusual configuration which would require a measure of practiced skill for their assembly without mortar and increase the cost of erecting a wall with them.

These and other drawbacks well known to those versed in the art have prompted the achievement of the present invention.

It is, then, a primary object of the present invention to provide complementary modules which are capable of forming structures without the use of mortar or other cementitious materials, by inter-engaging when erected in alternate course.

It is another primary object of the present invention to provide complementary modules, which are self-aligning when assembled into a structure.

It is yet another object of the present invention to provide complementary modules that can be produced readily by existing machines by conforming with all standards set for mass production.

It is still another object of the present invention to provide complementary modules that are capable of forming sea-walls, earth-retaining walls and other walls of greater mechanical strength by developing to the fullest degree the structural characteristics of their basic material.

It is a general object of the present invention to provide complementary modules that are economical to produce,

require little skill in assembling and greatly reduce the cost of finished structures.

These and other objects of the present invention are achieved by three modules complementing each other, one of which is a right-angle parallelopiped, or block, with four cavities, and the other, two modules adapted to enter and fill portions of the first module's cavities. If a series of such blocks is laid over another series of alike blocks in alternate course, that is, the end of each overlying block falling over the center line of the block of the underlying course, as is customary in the building industry, the bottom open ends of two cavities of the overlying block will register with the top open ends of two cavities of the underlying blocks, thus forming two continuous tapering hollow shafts, in which two wedge-like key modules can be fitted. It will be seen that these key-modules will resist any disrupting force acting against the wall thus formed and that the greater of their two section moduli will apply.

A simple embodiment of the present invention is a building block with its two complementary wedge-tapered keys or pegs. This example, however, will only be described as a simple illustration of the invention and is not intended to limit the invention in any way, nor to preclude other embodiments within the scope of the invention.

In the drawings:

FIG. 1 is a perspective showing of a building block and one of its complementary key-modules.

FIG. 2 is a perspective showing of a building wall erected by using blocks and key-modules as shown in FIG. 1.

FIG. 3 is a cross sectional view of structure shown in FIG. 2.

FIG. 4 is a perspective showing of modules for sea-walls and the like.

FIG. 5 is a perspective showing of a sea-wall of modules as in FIG. 4.

FIG. 6 and FIG. 7 are cross sectional views of a sea-wall structure as shown in FIG. 5.

FIG. 8 is a perspective showing of complementary modules of lighter weight.

FIG. 9 is a cross-sectional view of a structure of modules as in FIG. 8.

FIG. 1 shows a building block, whose configuration is similar to that of concrete blocks widely used throughout the world. Its parameters and physical dimensions conform with those established for routine machine production and satisfy requirements and specifications of architects and builders. FIG. 1 also shows a complementary key module 2, which is adapted to routine manufacture by existing block-making machines, such as the Besser, Bergen, Columbia, Pratt-Whitney, Lithibar, Kent and others well known to the concrete industry. Length and height of block 1 are greater than usual blocks' by half the thickness of a mortar joint, no mortar being used in the erection of a wall. Also, to allow for expansion, .794 millimeter is deducted from the module length of 16 inches.

Block 1, being a parallelopiped, comprises a top face 3, a base surface 4, side walls 5 and 6, and end walls 7 and 8. Block 1 is traversed by four cavities 9, 10, 11 and 12 which have parallel axes and decrease uniformly in their sectional area from top face 3 to base 4. Inner walls 13, 14 and 15 separate cavities 9, 10, 11 and 12 one from the other respectively. Block 1 must meet two critical conditions to make assembly possible on alternate courses: cavities 10 and 11 must comprise an area within base surface 4 which is substantially the same as the area comprised by cavities 9 and 12 on top face 3; and secondly, inner wall 14 must be twice as thick as end wall 7 and 8, so that when block 1 is set with the outer face

of its end wall 7 or 8 falling substantially over the middlelength line of the underlying block, base area of cavity 10 or 11 registers with top face area of cavity 9 or 12 of the underlying block. As the hollow shaft so formed has walls tapering equally by the same draft angle, normally $1^{\circ} 30'$ or more, it presents four surfaces which are unbroken and inclined from the vertical, and extend for the height of two blocks.

Module 2 is dimensioned and contoured so that its upper portion 16, which may or may not be half of module 2, will abut on the inner faces of the lower portion of cavity 10 or 11, and its lower end 17 will abut on the inner faces of the higher portion of cavity 9 or 12. While this design manifestly attains a greater section modulus for module 2 and so it is preferable, the larger cavities may be disposed in the outer portions of block 1, and the lesser cavities in portions closer to the center. Module 2 may fill the entire hollow shaft formed by the aligning of cavities 10 or 11 over cavities 9 or 12 or it may fill only a portion of it, if proper consideration is given to the fact that portion 16 of module 2 is brought to an abutting relationship with the surfaces of cavity 10 or 11, and so it cannot be stressed beyond a certain measure without rupturing block 1, while portions 17 of module 2 is in a frictional relationship with the surfaces of cavity 9 or 12, and so large areas of contact must be provided. It will be seen that the two modules 2 using their wedge-like configuration during assembly of block 1, act as alignment guides; as well as connectors between two contiguous blocks within the course by means of the underlying block. A wall made up of blocks 1 and comprising key modules 2 when subjected to stress will resist by taking up this stress in shear within modules 2. To indicate the area available for this purpose, an example will be given: for a standard concrete block 16 inches long, which is customary in the construction field, each one of the two modules 2 will have a width of $4\frac{3}{4}"$ and a thickness of $2\frac{3}{32}"$. Tests have confirmed that when modules 2 are made of the same compacted materials as block 1, their structural strength is much greater than the strength of block 1.

FIG. 2 shows how a wall structure can be erected by using blocks 1 in alternate courses by means of complementary modules 2. The configuration of block 1 is very similar to existing concrete blocks and the use of modules 2 is simple to visualize. Hence, erection is straightforward and requires no particular skill. A first course of such blocks 1 is laid in a straight line and on an even and substantially level surface, taking care that blocks 1 are not abutting but are adjacent and separated by a minute allowance for expansion. As a practical matter, when the blocks of the second course are laid over the blocks of the first course, if the first course is not positioned by anchor bolts in the foundation, but mortar or other cementitious materials are used, the key modules 2 act as spacing guides, as well as alignment and connecting components in erecting a wall. The procedure of assembly requires no skill. Each block 1 is laid with the faces of its end walls 7 and 8 aligned on wall 14 approximately at midpoint of the two underlying blocks 1. Two modules 2 are then placed into cavities 10 and 11 respectively. If the registration of cavity 10 over cavity 12 of the underlying block is accurate, the module 2 will drop into place and with very little force applied to it will come into frictional relationship with the faces of cavities 10 and 12. If registration is not accurate, the wedge-like configuration of key module 2 will induce the overlying block 1 to shift laterally until the faces of cavities 10 and 12 are aligned. This procedure is repeated with successive blocks and a tightly connected structure results. It has also been observed, that after a time, key modules 2 become firmly wedged in place and any minute and even imperceptible joggling of the structure tends to increase the rigidity of the wall. Where walls meet to form a 90° corner, alternate blocks from each wall

project into the corner and are interconnected by a special module which fills the sections of cavities in each block that register one over the other. This anchors both walls at the corner.

FIG. 3 shows a cross-sectional view of a wall as shown in FIG. 2. It will be apparent that a true concatenation results from the interconnecting of complementary modules 1 and 2. Each module 1 is secured in place within its course by four modules 2, and vertically by two of the four modules 2 held by friction in the underlying course. This interconnecting is achieved by components made of the same materials and with the same coefficient of expansion. Hence, time and weather have little effect on the concatenation, whereas mortar joints have a tendency to become brittle and calcify. This is of considerable importance where earthquakes, tremors, landslides and hurricanes are likely to occur. While the construction described is preferable, where maximum strength of the complementary modules is desired, many other configurations of block and wedge are possible within the scope of the present invention.

FIG. 4 shows complementary modules of greater size and strength for erecting sea-walls, earth-retaining walls and the like, while remaining within the standards set for machine production. It should be understood, however, that while mass production by machine offers advantages in cost and uniformity, production by casting offers greater latitude in designing the complementary modules and it is intended to come within the scope of the present invention. Module 18 of FIG. 4 is, in a general way, similar to module 1 of FIG. 1. Block-making machines are usually designed to make three concrete blocks at once, hence module 18 can be made by utilizing the total width of three standard blocks for its length, and the length of a standard block for its width. For similar parts, the same numbers are given to parts of module 18 as are given to parts of module 1. However, module 18 differs substantially from configuration of module 1. Module 18 is traversed by four cavities 9a, 10a, 11a and 12a, aligned along axes, which are alternately inclined from the vertical on opposite sides and by such an angle that one face of each cavity, in alternate sequence, is perpendicular to base 4 of module 18. In order to provide the draft angle necessary to allow for withdrawal of the molding die after molding the block, a sloping buttress is provided on the outer face of the side wall 5 or 6 wherever the inner configuration of either side wall is vertical, or normal to base 4. Thus, side wall 5 comprises buttresses 19 and 20, and side wall 6 comprises buttresses 21 and 22. A complementary module 23 takes the form of a wedge with one of its minor faces inclined from the vertical double the draft angle used for module 18.

FIG. 5 shows a structure 27 comprising a plurality of modules 18 and 23, assembled in alternate courses. The greater width of the component modules 18 and 23 gives structure 27 a wider base and far greater strength to resist any disrupting force. Modules 23 act within each block 18 along lines of force which are set, alternately, at an angle to each other.

FIG. 6 shows successive cross-sectional views through structure 27, illustrating the oblique line of abutment for module 23.

FIG. 7 shows how module 23 is adapted to abut the hollow shaft formed by cavities 10a or 11a when aligned over cavities 9a or 12a. If modules 23 are long enough to fill cavities 10a and 11a of the upper block 18 completely as shown in FIGS. 6 and 7, the base 4 of block 18 of the course above rests over base 25 of modules 23 and effectively increases resistance to dislodgement of modules 23.

FIG. 8 shows yet another embodiment of the present invention. Module 28 and complementary key module 29 are generally similar to modules 1 and 2 of FIG. 1, but differ greatly from them in particulars. Module 28 has the outer configuration of module 1, but inner web walls 13

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and 15 are truncated short to form jutting spurs 30 and 31 in side wall 5 and spurs 32 and 33 in side wall 6. Thus module 28 is traversed by only two cavities 34 and 35 with web wall 14 separating one from the other. Module 29 differs from module 2 in that it has a rectangular section 36, adapted to fit between spurs 30 and 32 or 31 and 33 and protrude beyond them into smaller section of the cavity formed by side walls 5, 6 and end wall 7, or 8. Module 29 may also be traversed by an inner cavity 41 to lighten its weight. Erection and assembly of modules 28 and 29 are entirely similar to those of modules 1 and 2.

FIG. 9 shows a cross section of a wall constructed of modules 28 and 29. It will be apparent from this that a shorter portion of module 29 fits within cavity 34 or 35 of the overlying block 28 and a longer portion of module 29 extends in the same cavity 34 or 35 of the underlying blocks 28. This is to provide a greater area of frictional relationship between the faces of cavity 34 or 35 and surfaces 36, 37 and 38 of module 29. It will also be noted that when module 29 is positioned within cavities 34 or 35, the lower surface 39 of the rectangular extension 30 rests on top surface 40 of module 29 of the underlying course. This in effect strengthens the concatenation of modules 28 and 29 within the structure, by resisting any stress acting to dislodge modules 29. A continuous pilaster of modules 29 is thus formed from top of bottom of the wall.

The examples given within this specification illustrate embodiments of the present invention related to manufacturing of concrete blocks. However, many other materials and uses are possible, such as resin-and-sawdust blocks, glass bricks, stone and plastic monoliths, etc., for the building, packaging and the toy industries, all within the scope of the present invention.

I claim:

1. A building block, comprising upper, lower, opposed side and opposed end surfaces, said block containing four intermediate cavities opening at said upper and lower surfaces, said cavities lying on axes of symmetry parallel to said side and end surfaces, openings of two of said cavities in upper surface defining an area and configuration substantially the same as area and configuration of the openings of the remaining two of said cavities at lower surface, said openings being spaced to register, said cavities being adapted to receive complementary modules

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through said openings to establish a frictional relationship within said cavities.

2. A building block as set forth in claim 1, whereby upon setting said block to lie contiguous to an alike block within a course, said complementary modules held in portions of the cavities of an alike block within the overlying course, establish a linking relationship between said contiguous blocks.

3. A wall structure comprising a plurality of blocks as set forth in claim 2, said blocks being laid in courses to form a self-aligned structure.

4. A building block as set forth in claim 1, wherein said axes of symmetry are inclined from the normal to said bottom surface alternately and in opposed direction.

5. A wall structure comprising a plurality of blocks as set forth in claim 4, said blocks being laid in courses to form a self-aligned structure.

6. A building block as set forth in claim 1, wherein said cavities are paired to form double-chambered cavities, the web partition between said paired cavities being truncated to form narrow buttresses, said complementary modules being adapted to be received in said double-chambered cavities.

7. A wall structure comprising a plurality of blocks as set forth in claim 6, said blocks being laid in courses to form a self-aligned structure.

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U.S. Cl. X.R.

46—26; 52—606, 609