United States Patent [19]

Horvath

[11] **3,783,571**

[45] **Jan. 8, 1974**

[54] **BUILDING UNIT**

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[21] Appl. No.: **156,377**

[52] **U.S. Cl.** **52/575,** 52/593

[51] **Int. Cl.** **E04c 1/04,** E04c 1/30

[58] **Field of Search** ..... 229/8, 16 R, DIG. 11; 52/575, 589–595, 608; 94/13

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Primary Examiner—Henry C. Sutherland
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Attorney—Morsbach et al.

[57] **ABSTRACT**

A building unit adapted to interfit various different relationships with like units in a building system in which the building unit is a ten faced polyhedron having two rectangular faces, two pair of outwardly converging isosceles trapezoid end faces at opposite ends of the unit, and two pairs of isosceles trapezoid side faces at opposite sides of the unit converging inwardly at an angle corresponding to the angle of the outwardly converging end faces.

1 Claim, 19 Drawing Figures

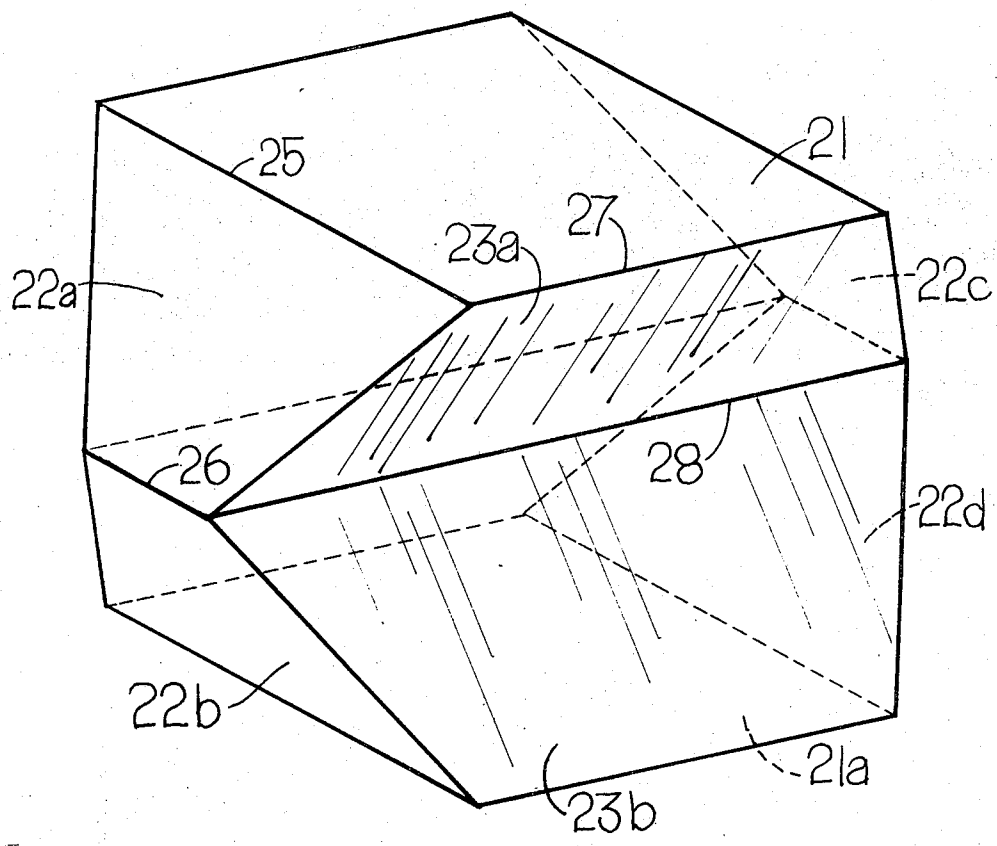


FIG. 1.

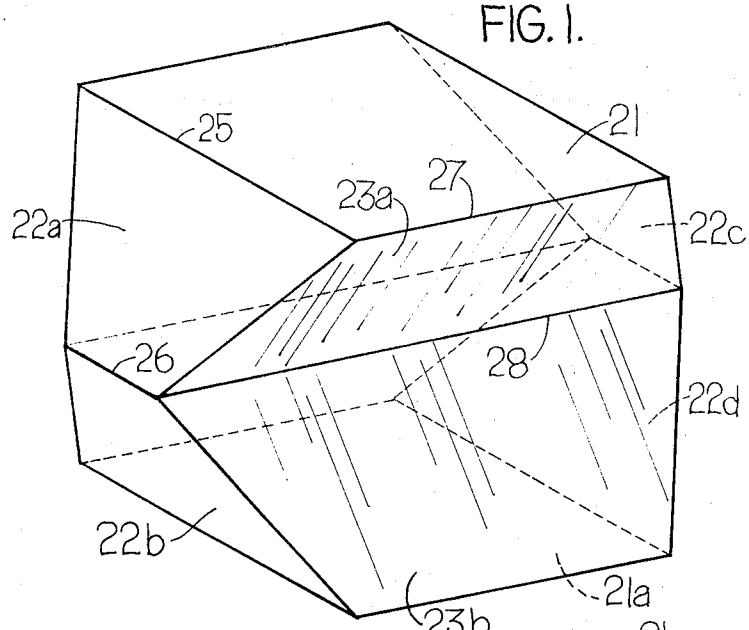


FIG. 2.

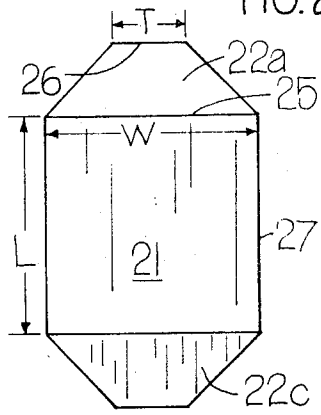


FIG. 3.

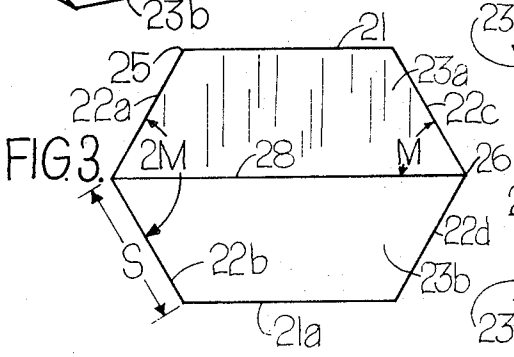


FIG. 4.

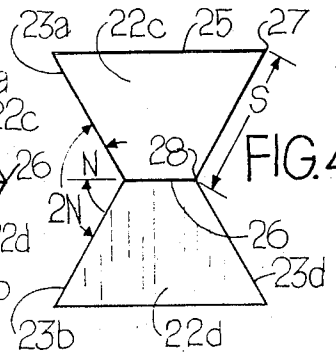
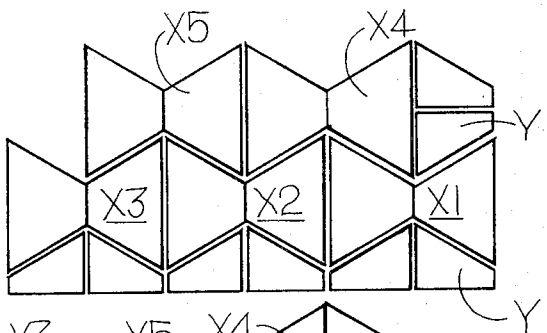


FIG. 6.



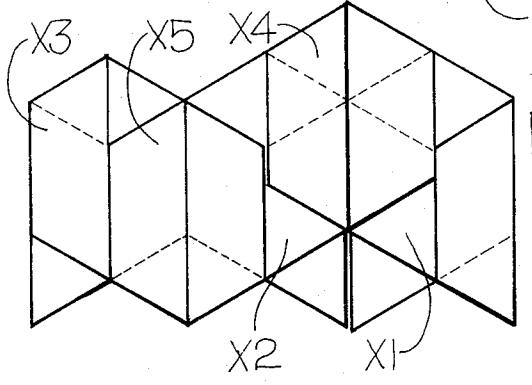
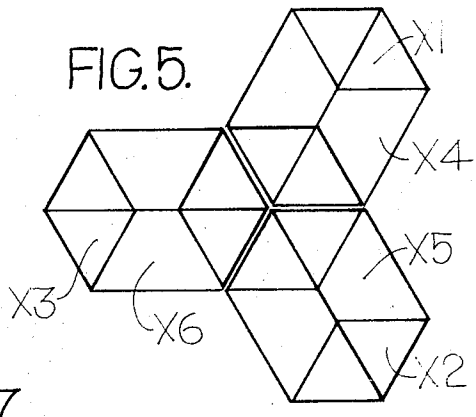


FIG. 7.

FIG. 5.



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FIG. 8.

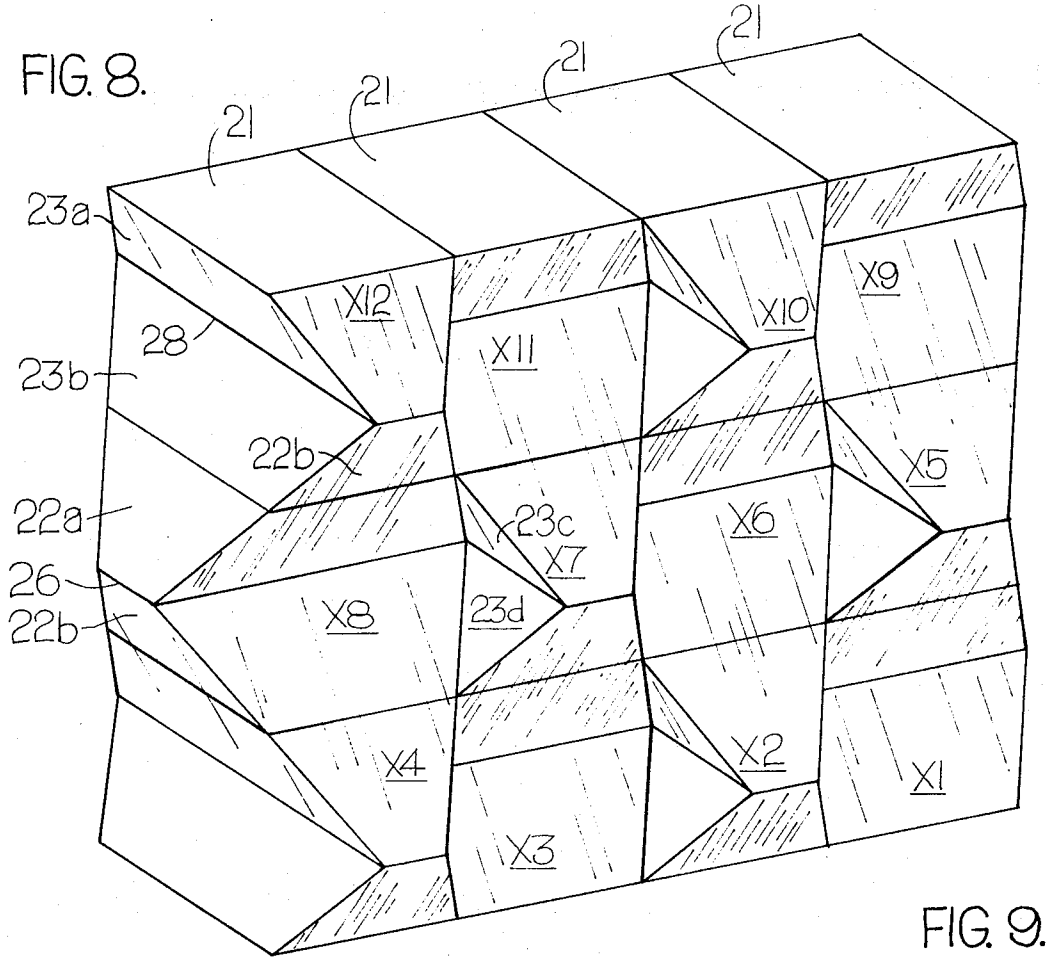


FIG. 9.

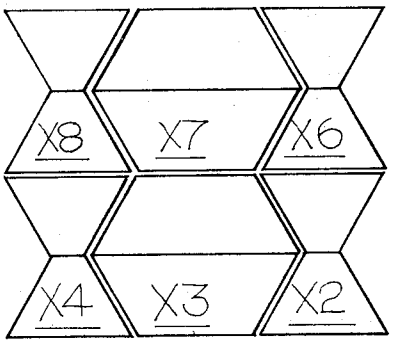


FIG. 11.

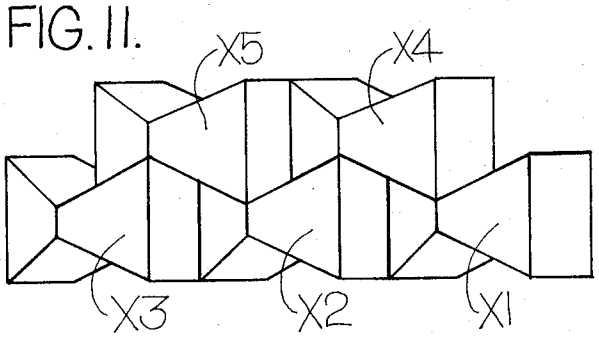
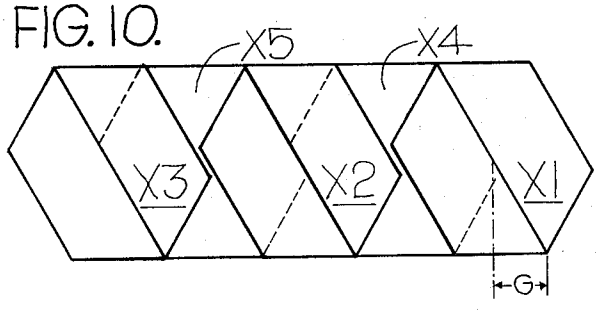


FIG. 10.



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FIG. 12.

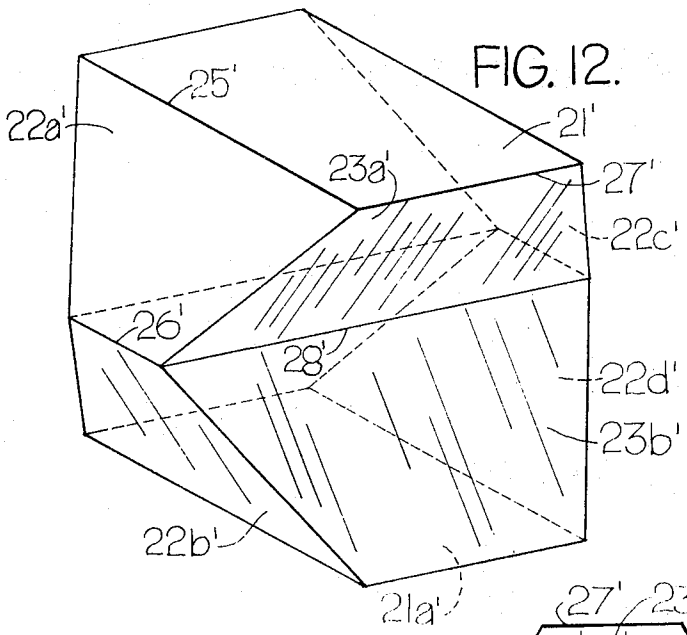


FIG. 13.

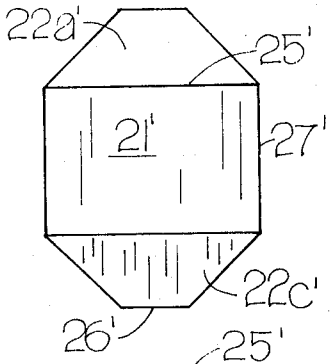


FIG. 14.

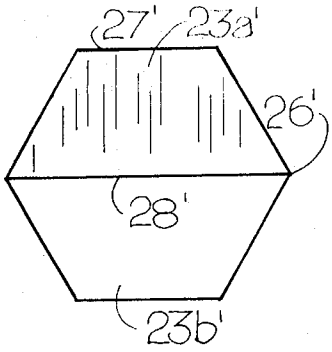


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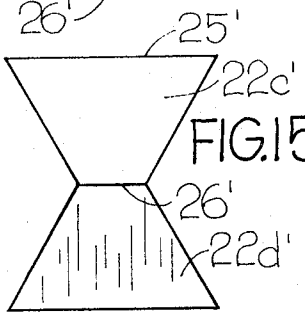


FIG. 17.

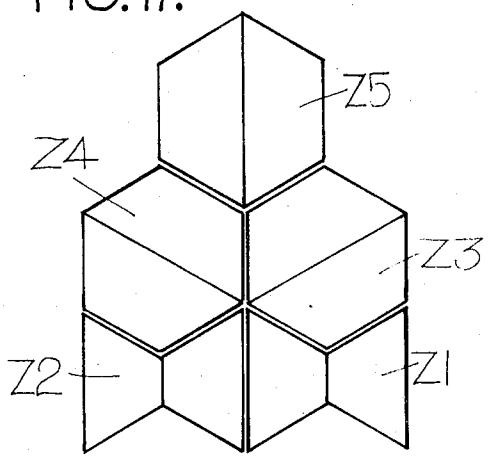
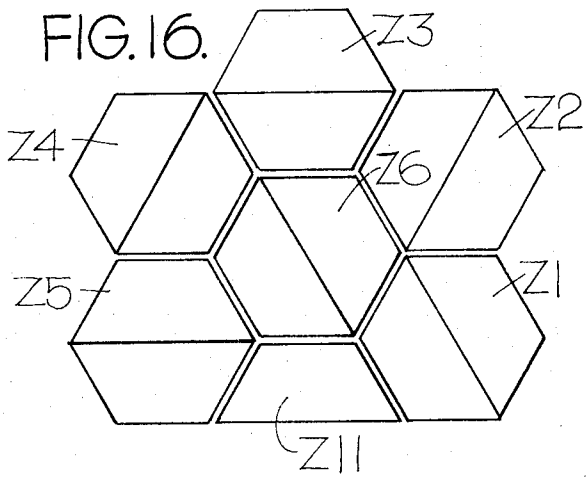


FIG. 16.



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FIG. 18.

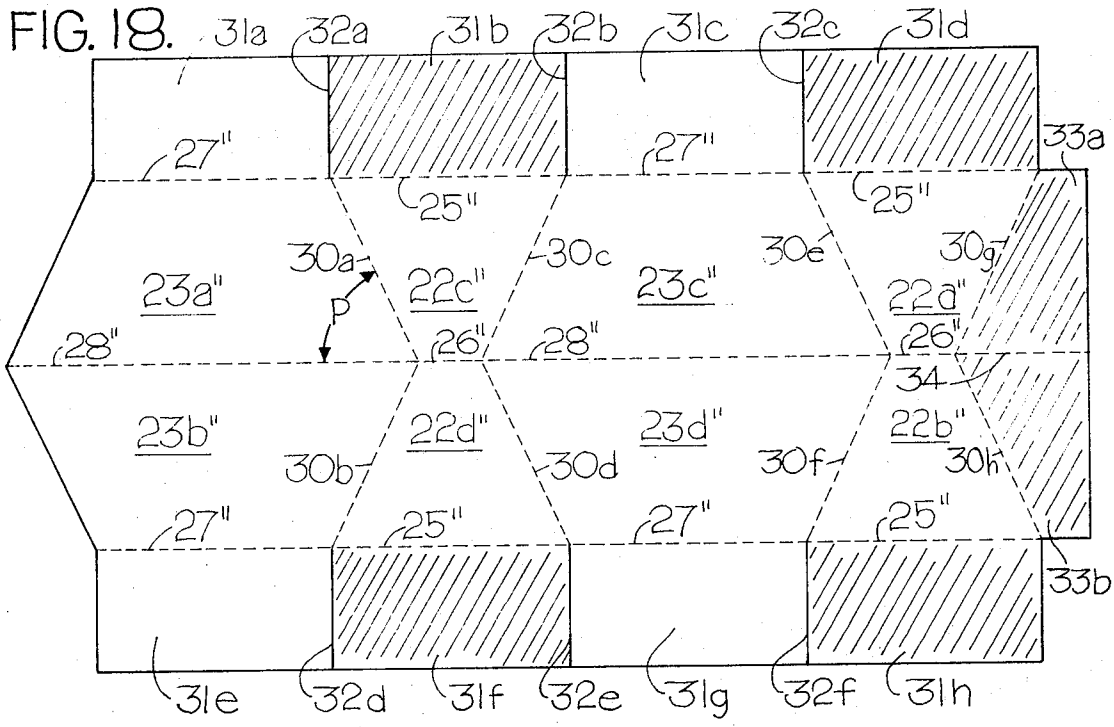
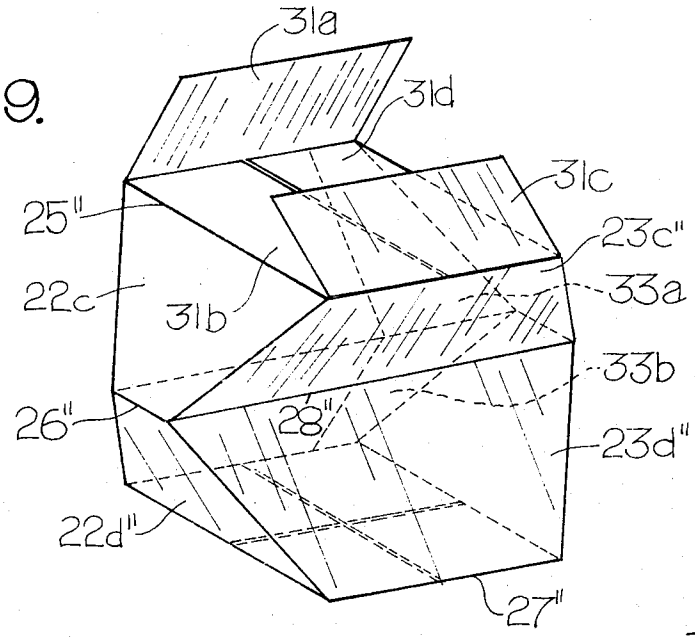


FIG. 19.



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BUILDING UNIT

SUMMARY OF INVENTION

It is the general object of this invention to provide a building unit and building systems embodying the same in which the building unit is adapted to interfit with like units in various different relationships to form a multiplicity of different structures having different structural and surface characteristics.

In accordance with the present invention, the building unit is in the form of a ten faced polyhedron having two relatively parallel rectangular faces, two pairs of outwardly converging isosceles trapezoid end faces arranged at opposite ends of the rectangular faces to form a hexagonal pattern, and two pairs of isosceles trapezoid side faces at opposite ends of the unit converging inwardly at an angle corresponding to the interior angle between the outwardly converging end faces. The units are symmetrical about their axes and are stable when supported on their rectangular faces or on the minor parallel edges of their inwardly converging side faces. These building units are adapted to interfit with like units in various different relationships. For example, like units can interfit in side-to-end abutting relation with the outwardly converging end faces of one unit extending into the inwardly converging side faces of an adjacent unit. The units are also adapted to interfit in stepped side-by-side relation with the inwardly converging side faces of one unit overlapping one of the side faces on each of two sidewise adjacent units. The rectangular faces and outwardly converging end faces of the building units form a hexagonal pattern and the building units are proportioned so as to be stable when supported on their outwardly converging end faces whereby the building units can also be arranged in various building systems with the hexagon pattern faces in abutting relation. The building units can be utilized to form solid wall type structures having different structural and surface characteristics as well as open or grid like wall structures having different patterned openings in the wall in addition to the different surface characteristics. The units are also adapted for use in forming column type structures of various different configurations and surface characteristics.

The building units can be made of a size and material suitable for use as a building block in construction, and the building units can also be made of a relatively smaller size and of a suitable material for toy building blocks. The building units can also be made hollow and can be formed from a flat blank. Relatively large building units can be utilized to provide interfitting display units which present different surfaces and areas for displaying information and/or articles. Smaller sized building units can be formed from flat blanks for use as packages and the like which can be interfitted with like units for an attractive display.

These, together with other objects, features and advantages of the present invention will be better understood by reference to the following description taken in conjunction with the accompanying drawings wherein:

FIG. **1** is a perspective view of a building unit embodying the present invention;

FIG. **2** is a plan view of the building unit of FIG. **1**;

FIG. **3** is a side view of the building unit of FIG. **1**;

FIG. **4** is an end view of the building unit of FIG. **1**;

FIG. **5** is a top plan view of a column type structure formed by building units of the type shown in FIG. **1**;

FIG. **6** is a diagrammatic side view of a portion of a wall structure illustrating the building units in stepped side-by-side interfitting relation;

FIG. **7** is a top plan view of the portion of the wall structure shown in FIG. **6**;

FIG. **8** is a fragmentary perspective view of a portion of a wall structure illustrating the building units of FIG. **1** arranged in courses with adjacent units in side-to-end interfitting relation and with the units in successive courses at right angles;

FIG. **9** is a diagrammatic side elevational view of a portion of a wall structure in which the building units are arranged in courses with adjacent units in side-to-end interfitting relation and with the units in successive courses arranged in the same relation;

FIG. **10** is a diagrammatic side elevational view illustrating an interlocking double course of building units in which the building units rest on one of the outwardly converging end faces;

FIG. **11** is a plan view of the double course of building units shown in FIG. **10**;

FIG. **12** is a perspective view of a modified form of building unit in which the rectangular faces and the outwardly converging end faces are arranged to form a regular hexagon;

FIG. **13** is a plan view of the building unit of FIG. **12**;

FIG. **14** is a side view of the building unit of FIG. **12**;

FIG. **15** is an end view of the building unit of FIG. **12**;

FIGS. **16** and **17** are diagrammatic side views illustrating the building unit of FIG. **12** arranged in different relationships;

FIG. **18** is a plan view of a blank suitable for forming a hollow building unit of the present invention; and

FIG. **19** is a perspective view of a partially erected building unit formed from the blank of FIG. **18.**

The ten faced polyhedral building units of the present invention can be formed in various different sizes and of different materials and can be made either solid or hollow for various different purposes such as structural modules, structural building blocks, toy building blocks, display modules and packages. The ten faced polyhedral building units are adapted for use in building systems in which the building units interfit in various different relationships with like building units to form a multiplicity of structures having different structural and appearance characteristics.

In general, the ten faced polyhedral building units include a pair of relatively parallel faces **21**, **21***a* of rectangular configuration and like size, four isosceles trapezoid end faces **22***a*–**22***d* of like size, and four isosceles trapezoid side faces **23***a*–**23***d* of like size. The trapezoidal end faces **22***a*–**22***d* have their major parallel edge **25** coterminous with one of the end edges of the rectangular faces **21**, **21***a* and the trapezoidal end faces **22***a* are arranged in pairs **22***a*, **22***b*, and **22***c*, **22***d* at opposite ends of the unit, with each pair of end faces converging outwardly of the unit and with the minor parallel edges **26** of each pair of end faces coterminous. The trapezoidal side faces **23***a*–**23***d* have their minor parallel edges **27** coterminous with respective side edges of the rectangular faces **21** and **21***a* and the side faces are arranged in pairs **23***a*, **23***b* and **23***c*, **23***d*, with each pair of side faces converging inwardly of the unit and with the major parallel edges **28** of each pair of side faces coterminous. The interior angle designated **2M** in FIG. **3** between the outwardly converging end faces **22***a*, **22***b* and **22***c*, **22***d* is made equal to the exterior angle desig-

nated 2N in FIG. 4 between the pairs of inwardly converging side faces 23*a*, 23*b* and 23*c*, 23*d* so that the outwardly convergent end of one building unit is adapted to interfit with the inwardly convergent side of an adjacent unit. With this arrangement, the half angles designated M and N are equal and the spacing designated S in FIG. 4 between the major and minor parallel edges 28, 27 of the side faces is equal to the spacing also designated S in FIG. 3 between the major and minor parallel edges 25, 26 of the end faces. Further, end face 22*a* is parallel to end face 22*d* and end face 22*b* is parallel to end face 22*c*. Similarly, side face 23*a* is parallel to side face 23*d* and side face 23*b* is parallel to side face 23*c*. In the preferred embodiments, the angles designated 2M and 2N are made substantially equal to 120°. In the embodiment of FIGS. 1–4, the rectangular faces 21, 21*a* have a square configuration so that the major parallel edges 25 of the end faces 22 have a length equal to the minor parallel edges 27 of the side faces 23.

The thickness designated T in FIG. 2, measured between the apexes of the pairs of inwardly converging side faces 23*a*, 23*b* and 23*c*, 23*d*, is selected to provide adequate strength in this area of the building unit, and the width of the rectangular faces 21, 21*a*, designated W in FIG. 2, can be expressed in terms of the dimension T, the angular relationship of the pairs of converging side faces, and the spacing S between the major and minor parallel edges of the side and end faces by the following equations:

$$W = T + 2S \cos N \quad 1.$$

$$W = T + S, \text{ when } N = 60° \quad 2.$$

In order to enhance the number of different positions and relationships in which the building units can be used, it is desirable to proportion the building units so that they are stable when resting on one of the outwardly converging end faces 22*a*–22*d*. Assuming that the center of gravity of the building unit is at its geometric center and the building unit is resting on one of the outwardly converging end faces as shown in FIG. 10, the horizontal distance G of the center of gravity from the minor parallel edge of that end face can be expressed as follows, when the angle N = 60°:

$$G = .25 (L + S) \quad 3.$$

Thus, the distance G will not exceed the dimension S of the end face until the dimension L equals three times S. Accordingly, the center of gravity of the building unit (with angle N equal to 60°) will not be disposed outside the end face on which the building unit rests so long as the dimension L is less than three times the dimension S of the end face. However, for good stability, it is desirable to maintain the distance G less than 0.75 S and from equation (3) it will be seen that the dimension L should accordingly be less than two times S. For maximum stability of the building unit when resting on its end face, the distance G should be equal to .5S so that the center of gravity lies medially between the minor and major parallel edges of the end face on which the building unit rests. From equation (3) it will be seen that L will equal S when G is equal to 0.5S.

The building units are adapted to interfit with like building units in various different ways to form a multiplicity of different structures, some of which are shown in FIGS. 5–11. FIGS. 8 and 9 illustrate a wall structure formed by building units arranged in courses with adjacent units in side-to-end abutting relation. More particularly, each of the units designated X1–X4 in the first course are arranged to rest on one of their rectangular faces 21a and adjacent units are disposed at right angles to each other so that the outwardly converging end faces of some units such as units X1 and X3 extend into the inwardly converging side faces of the other units designated X2 and X4. When the units are formed as described in connection with FIGS. 1–4 with square end faces 21 and 21a, the end faces of the building units in each course will be coterminous. A second course and succeeding courses can be placed upon the first course. In the wall system shown in FIG. 8, the units designated X5–X8 of the second course are disposed at right angles to the unit therebelow so that the adjacent side and end faces of vertically adjacent blocks are disposed coplanar. A third course including building units X9–X12 is shown positioned on the second course again with the units of the third course at right angles to the units of the subjacent course. Alternatively, it is apparent that the units in successive courses can be positioned in the same manner as the units therebelow as shown in FIG. 9. For example, units positioned as shown at X9–X12 could be arranged in a course directed upon the first course of units X1–X4. The building units in any course or courses can also be arranged to form a wall with patterned openings. For example, one course such as the building units X5–X8 can be positioned with their side faces 23 parallel so that adjacent building units will define a generally diamond shaped opening therebetween. It will also be seen that corners can be executed in such a block system without modification of the blocks. In this regard it is to be noted that the composite end face defined by the end column of blocks in the wall is complementary to the side face of that column of blocks. Accordingly, a wall at right angles to the wall portion shown in FIG. 8 can be formed by merely arranging the end column of building units at right angles to the building units X4, X8 and X12 so as to interfit with the side face of that column of units.

In the preferred form, the interior angle M between the outwardly converging end faces 22*a* and 22*b* is made equal to 120°. With this configuration, three building units can be arranged, as shown at X1, X2 and X3 in FIG. 5, with their end faces in abutting relationship. A succeeding tier of building units can be mounted in end-to-side relationship on the first tier, with the end faces of the building units X4–X6 extending into the inwardly converging side faces of the building units X1–X4, and with the rectangular faces 21 and 21*a* of the building units X4–X6 substantially coterminous at their inner ends. Succeeding tiers positioned alternately as described in connection with the first and second tiers, can of course be added.

The building units are also adapted to be assembled in a stepped side-by-side relation as shown in FIG. 6. In this view, one group of building units designated X1–X3 are arranged in a first course and other building units designated X4 and X5 are arranged in a second

course which is stepped longitudinally one-half of a unit relative to the units of the first course so that each unit of the second course overlies and interfits with one-half of two units of a subjacent course. While the several units X1–X5 are shown arranged horizontally in FIG. 6, it is to be understood that the units can be positioned in stepped side-by-side relation when disposed vertically. With this building system, there are some openings at the sides and ends of the courses. If desired for strength or appearance, wedge shaped fillers conveniently in the form of one quarter sections of the building units shown at Y in FIG. 6, can be provided. The building units arranged in stepped side-by-side relation as shown in FIG. 6 can be positioned with all of the building units aligned in a row or, alternatively, some of the building units can be staggered in a direction transversely of the row or course. As shown in FIG. 7, the units X1–X3 in the first course are arranged in a row lengthwise of the course and the units X4 and X5 in the second course are offset respectively rearwardly and forwardly relative to the units of the first course so as to position certain end faces of the second course in the same plane as some end faces in the first course. Other arrangements can of course be utilized for different aesthetic effects.

As previously described the building units are arranged to form a stable structure when positioned on one of the end faces. Stated otherwise, the length L of the rectangular faces is made substantialy less than three times the dimension S and preferably less than two times S so that the center of gravity of the building unit, when positioned on one of its outwardly converging end faces, is positioned above that end face at a location such as to provide a stable structure. This enables the units to be arranged in courses on their end faces as shown in FIG. 10 and subsequent courses can be laid upon the first course. The units can, moreover, be laid in a double wall course with units such as shown at X4 and X5 of the second course in stepped side-by-side relation with the units of the first course, as best shown in FIG. 11.

The building unit shown in FIGS. 12–15 is similar to that described in connection with FIGS. 1–4 and like units followed by the postscript (') are utilized to designate corresponding parts. In this embodiment, the rectangular end faces 21' and 21*a*' are proportioned in relation to the end faces 22 so as to form a regular hexagon therewith as shown in FIG. 14. More specifically, the rectangular end faces 21' and 21*a*' are proportioned so that the length of the minor parallel edge 27' of the side faces 23 is equal to the spacing between the major and minor parallel edges 25' and 26' of the end faces. In general, the building units shown in FIGS. 12–14 can be arranged in the manners previously described in connection with the building units of FIGS. 1–4. However, since the end faces 21' and 21*a*' of FIGS. 12–14 are not square, end faces of adjacent units will not be coterminous when the units of FIGS. 12–14 are positioned at right angles to each other in "end-to-end" interfitting relation. However, the regular hexagonal pattern formed by the rectangular faces 21' and 21*a*', and the isosceles trapezoid end faces 22*a*', 22*b*', 22*c*' and 22*d*', allows the units to be assembled in hexagonal patterns as shown in FIGS. 16 and 17. In FIG. 16, a plurality of units designated Z1–Z5 are arranged around a central unit Z6 in a hexagonal pattern with two of the units Z1 and Z5 resting on one of the faces of the hexagon. Half building units such as shown at Z11 can be provided to fill spaces and provide support at the base and also to fill the top course. In the building system shown in FIG. 17, a plurality of building units such as Z1 and Z2 are positioned on their sides to provide a support base for superposed building units such as Z3–Z5 arranged in a hexagonal pattern.

When the building unit is used for making structural building blocks, it can be formed of the usual material employed in making structural building blocks and bricks including concrete, clay, etc. When the building unit is utilized to form toy building blocks it can similarly be formed of the materials commonly employed for making toy building blocks such as wood, plastic or the like. Plastic building blocks can of course be molded of solid plastic or in sections and then assembled to form a hollow block or, can be blow molded to form a unitary hollow unit. The building unit is also adapted to be formed from a flat blank of paper, plastic, metal or the like and can be made in relatively large sizes to provide modular display units, or in relatively smaller sizes for packages and the like.

A blank is shown in FIG. 18 suitable for forming a ten faced polyhedron of the type described in FIGS. 1–4. The blank has a generally rectangular overall configuration and a longitudinally extending fold line which may be in the form of a crease or a score line. As illustrated, the longitudinal fold line comprises a plurality of segments designated 28'', 26'', 28'' and 26'' in end-to-end relation. The blank includes a first pair of isosceles trapezoid faces 23a'' and 23b'' of like size having their major parallel edges contiguous with the longitudinal fold line at 28''; a second pair of isosceles trapezoid faces 22*c*'' and 22*d*'' of like size having their minor parallel edges contiguous with the longitudinal fold line at 26'' and which are integrally joined along a first pair of transverse fold lines 30*a* and 30*b* to respective ones of the first pair of faces 23*a*'' and 23*b*''. The blank also includes a third pair of isosceles trapezoid faces 23*c*'' and 23*d*'' of the same size as the first mentioned pair 23*a*'' and 23*b*'', with the faces of the third pair having their major parallel edges contiguous with the longitudinal fold line at 28'', and integrally joined along a second pair of transverse fold lines 30*c* and 30*d* to the second pair of faces 22*c*'' and 22*d*''. The blank also includes a fourth pair of isosceles trapezoid faces 22*a*'' and 22*b*'' of the same size as the second mentioned pair of faces 22*c*'' and 22*d*'', and which fourth pair of faces have their minor parallel edges contiguous with the longitudinal fold line at 26'' and are integrally joined along a third pair of transverse fold lines 30*e* and 30*f* to respective ones of the third pair of faces. Flaps designated 31*a*–31*h* are joined along fold lines 27'' and 25'' to the parallel edges of the isosceles trapezoid faces remote from the longitudinal fold lines. The flaps 31*a*–31*d* are separated from each other by cut lines 32*a*–32*c* and similarly the flaps 31*e*–31*h* are separated by cut lines 32*d*–32*f*. The flaps are adapted to be folded inwardly as shown in FIG. 19 to form rectangular faces similar to those described at 21 and 21*a* in connection with FIGS. 1–4. In order to rigidify the side and end panels when they are erected to form a hollow polyhedron, the flaps are preferably provided at the outer parallel edges of each of the side and end faces. It is to be understood, however, that one or more flaps could be omitted if desired. Moreover, in order to reduce the overall size of the blank and minimize

waste, it is preferable to make the flaps **31***a*–**31***h* of equal width measured in a direction perpendicular to the respective fold lines **27''** and **25''**. However, this is not essential and it is to be understood that the flaps can be of unequal width and that one flap can, if desired, be formed so as to constitute the entire rectangular face. In the blank illustrated in FIG. **18**, the minor parallel edges **27''** of the sides faces is made equal to the major parallel edges **25''** of the end faces and the width of the flaps **31***a*–**31***h* is made equal to substantially one-half this dimension. Joining and reinforcing panels shown at **33***a* and **33***b* are advantageously provided and are integrally joined along a fourth pair of transverse fold lines **30***g* and **30***h* to one pair of isosceles trapezoid faces, preferably a pair of end faces such as **22***a''* and **22***b''*. The panels **33**a and **33**b are also preferably joined to each other along a fold line **34** aligned with the longitudinal fold line of the blank. As indicated by the adhesive stripes in FIG. **18**, adhesive can be applied to the panels **33***a* and **33***b* on the side thereof that underlies the faces **23***a''* and **23***b''* at the other end of the blank, when the side and end faces are folded as shown in FIG. **19**. Additionally, adhesive can be applied to certain of the flaps such as **31***b*, **31***d* and **31***f* and **31***h* in areas which underlie the other flaps **31***a*, **31***c* and **31***e*, **31***g* to hold the flaps in a closed condition.

In the ten faced polyhedral unit of the present invention, the end faces **22** converge outwardly and the side faces **23** converge inwardly at the same angle. Accordingly, in forming the fold lines of the blank, the angle designated P in FIG. **18** between the longitudinal fold line and the transverse fold lines which separate the side panels from the end panels is selected so that the angle between the end panels of the polyhedral building unit, shown at M in FIG. **3**, will be the desired angle. The relationship between the angle of the fold lines P and the angle of the end panels of the polyhedral unit M can be expressed by the following equation:

$$(4)\ \text{Cotangent } P = \text{Cosine } M$$

As previously described in connection with FIGS. **1–4**, it is preferred that the angle 2M between the outwardly converging end panels of the polyhedral unit be equal to 120° and the half-angle M equal to 60°. In accordance with the above-identified equation, the angle of the fold lines P in the blank should therefore be made substantially equal to 63° 26′.

From the foregoing it is thought that the improved building unit and building systems embodying the same will be readily understood. The building unit can be formed of various different materials and be made either solid or hollow and is adapted to interfit in various different relationships with like building units in various building systems to form both wall type structures as well as column type structures having different structural and appearance characteristics.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A ten faced polyhedral building unit adapted to interfit with like units in a building system characterized in that it has:

a. two rectangular faces of like size in opposed parallel relation each having relatively parallel side and end edges;

b. four isosceles trapezoid end faces of like size arranged in pairs at opposite ends of said unit with the major parallel edges of each pair of end faces coterminous with adjacent end edges of the rectangular faces, the trapezoidal end faces of each pair converging in a direction outwardly of the unit and having the minor parallel edges of each pair of end faces coterminous with each other;

c. four isosceles trapezoid side faces of like size arranged in pairs at opposite sides of the unit with the minor parallel edges of each pair coterminous with adjacent side edges of the rectangular faces, the trapezoidal side faces of each pair converging in a direction inwardly of the unit and having the major parallel edges of each pair of side faces coterminous with each other;

d. the spacing between the major and minor parallel edges of each of said isosceles trapezoid end faces being equal to the spacing between the major and minor parallel edges of each of said isosceles trapezoid side faces and the interior angle between each pair of trapezoidal end faces being 120° and equal to the angle between each pair of trapezoidal side faces measured exteriorly of the unit, said minor parallel edges of the side faces having a length less than two times the spacing between the major and minor parallel edges of the end faces, and said rectangular faces being square whereby the major parallel edges of the end faces have a length equal to the minor parallel edges of the side faces.

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