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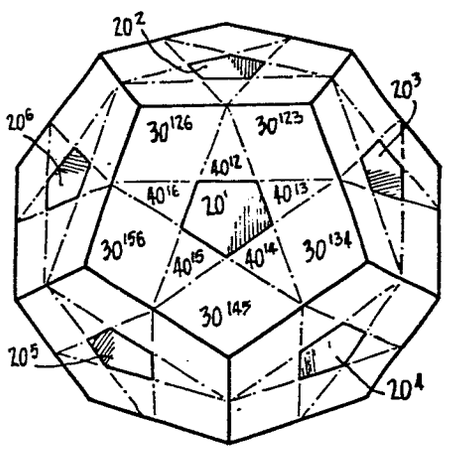
(54) Improved puzzle.

(57) A puzzle of the solid type in which each face of the puzzle can be rotated relative to the remainder of the puzzle, the puzzle comprising a dodecahedron in which each face includes eleven components, a central pentagon (20), five edge pieces (40), the bases of each of which abut one side of the central component and five corner pieces (30) each being four sided with two of the sides abutting adjacent edge pieces of the other two sides defining portions of the adjacent edges of the face.



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"IMPROVED PUZZLE"

This invention relates to a puzzle and in particular to puzzles of the type in which surfaces of the puzzle can be rotated relative to the remainder of the puzzle.

The best known puzzle of this general type is that sold as the Rubik's cube which comprises a cube, each face of which has nine components and each face of which can be rotated relative to the remainder of the cube so that, on successive random rotation, the order of the components on the faces can be mixed.

Whilst the Rubik's cube has been extremely successful world wide, it is basically not sufficiently complicated for persons who have a serious interest in puzzles.

For that reason, it is the object of the present invention to provide a puzzle of this general type which is substantially more complicated than known puzzles and yet which can, if treated properly, be solved.

The invention in its broadest sense comprises a puzzle comprising a regular dodecahedron in which the components defining each face can be rotated about an axis normal to the face, each face including eleven components, a central pentagon, five edge pieces, the base of each abutting one side of the central component and extending outwardly therefrom to the adjacent edge of the face and five corner pieces, each being four sided, two of the sides abutting adjacent edge pieces and the other two sides defining portions of the adjacent edges of the face.

Preferably the surface of the edge piece which can be seen on each face is triangular in form and its base corresponds to the side of the central pentagon so that the pentagon and the five edge pieces form a five pointed star within the larger pentagon which defines the shape of the face.

Particular features of the invention and constructional features thereof will be

understood better later on consideration of the particular embodiment described.

However, generally, it will be preferred that the components be made of a relatively rigid thermoplastics material which can be accurately moulded and, if required, the various surfaces can be provided to be different colours or can otherwise be arranged with patterns or the like.

In order that the invention can be more readily understood I shall describe one form of the invention in relation to the accompanying drawings, in which;

Fig 1 is a first perspective of the puzzle;

Fig 2 is an opposite perspective view of the puzzle of Fig 1 and shows that the opposite face is "inverted" in comparison with the front face;

Figs 3, 4 and 5 are three views showing three planes of rotation in each of which one corner piece is involved;

Fig 6 is a view similar to that of Fig 2 but showing the front face partially rotated and in a position where it is approximately half way between two stable positions;

Fig 7 is a view similar to that of Fig 6 in which the partially rotated face is removed and looking into the puzzle;

Fig 8 is a view looking outwards towards the partially rotated face after it has been removed;

Fig 9 is a view of the central spindle piece showing planes on which truncated conical members can be located, conical members in position and one conical member complete with a centre piece in the form of a truncated pentagonal cone;

Fig 10 is a view of a corner piece showing, downwardly extended, the portion of the piece which inter-reacts with other components to maintain the piece in position;

Fig 11 is a rear perspective view of the corner piece of Fig 10;

Fig 12 is a perspective view of an edge piece showing the two outwardly extending planes which are seen when the piece is in the puzzle and showing one of the planes which are not seen when the member is located;

Fig 13 is a rear perspecive of the edge piece of Fig 12;

Fig 14 shows the relationship between two corner members and an edge member and how they inter-engage; and

Fig 15 shows the relationship between an edge member and two adjacent centre members and how they abut and inter-engage.

Referring first to Figs 1,2 and 6, the puzzle is a regular dodecahedron, that is it has twelve faces each of which is identical, except for spatial orientation.

Each face can rotate about a central axis and in a plane spaced towards the centre of the puzzle by an amount which is equal to the apparent thickness of each of the components which form the face. The form of rotation can best be seen from examination of Fig 6 and will be explained more fully in relation to Figs 3 to 5.

Each face has a centre piece 20 and, where a specific centre piece is referred to herein, it will be given a superscript depending upon which face it is on, for example 20^{1}, and so on. There are five corner pieces 30, and each of these, where it is necessary to differentiate these, will have a superscript indicating the three faces with which they are common, for example 30^{123}. There are five centre pieces 40 and, where it is necessary to differentiate these, they will have a superscript indicating the faces with which they are common, for example 40^{12}.

It will be appreciated that the particular definition of any piece is only an immediate thing as any piece, except the centre pieces 20, can assume any position relative to any other piece, the central pieces 20 being fixed in relation to each other.

On examination of Figs 3, 4 and 5 the drawings stress three different faces 1, 2 and 3 each of which can rotate independently of the other. From appreciation of these, the concept of any one of the twelve faces rotating can readily be visualised. It will be seen that these three faces have only one common piece, corner piece 30^{123}.

Each pair of faces has a further common corner piece, 30^{126}, in the case of faces 1 and 2, 30^{134} in the case of faces 1 and 3 and 30^{237} in the case of faces 2 and 3.

Each pair of faces has one common centre piece, piece 40^{12} in the case of faces 1 and 2, 40^{23} in the case of faces 2 and 3 and 40^{13} in the case of faces 1 and 3.

It will be appreciated that the centre pieces 20 are each fixed, one relative to the other, and that each can rotate about a central axis and it is this axis about which the face of the centre piece rotates.

The construction and arrangements of the centre pieces 20 can best be seen from Fig 9.

The centre of the puzzle can be considered to be a regular icosidodecahedron 50 having 12 faces 51, each of which is a pentagon, and the normal axes of each of which is the axis of the centre of one of the faces of the puzzle. Extending outwardly from each face 51 there is a truncated conical member 52 to the outer face 53 of which there is rotatably connected a centre piece 20 which, as previously stated, is a truncated pentagonal cone.

Whilst in Fig 9 I have shown the outer face 53 of the cone 52 as having an aperture or the like 54 to permit rotational movement of the centre piece 20 it is to be appreciated that the component 50 is illustrated in a somewhat stylized manner for ease of understanding. In practice this would not necessarily be seen to be an icosidodecahedron as, although this shape is desirable to obtain the correct angles for the axes, it is not necessarily the best shape for moulding purposes. Neither would the centre piece 20 necessarily be rotatably mounted at the end 53 of the truncated conical member 52. Portion, or indeed all, of the conical member could be integral with the centre piece.

It may be preferred that the interconnection between the centre piece 20 and the conical member 52 is sprung in some way to provide a certain amound of resilience in the puzzle when it is being used. This is not strictly necessary as the construction described permits full movement but when manufacturing tolerences are taken in consideration certain movement may be desirable.

The formation of a corner piece 30 is illustrated in Figs 10 and 11. In Fig 10 the faces 60 and 60' are two of the three faces of the corner piece which are seen when the puzzle is assembled and face 60", which cannot be seen is the third face.

The corner piece has three further faces 61, 61' and 62" which lie in planes spaced from but parallel to the planes of the corresponding faces 60 bearing the same superscript.

Spaced inwardly from the faces 61 there are three further faces 62, 62' and 62" which, in turn, are in parallel planes to the two earlier faces having the same superscript.

Each of the faces 60, 61 and 62 are of diamond shape and have the same included angles, the faces 60 and 61 being congruent and the faces 62 being smaller.

The faces 62 are also truncated along one edge where two faces are not in contact, edges 66, and are spaced from the adjacent faces 61 by a number of surfaces 63, 64 and 65 which extend completely around the extension having surfaces 62.

In practice these surfaces could be made continuous but are shown in the drawing as planar to illustrate the method of development.

The formation of an edge piece is illustrated in Figs 12 and 13. The two faces which are exposed when the edge piece is located in a puzzle are faces 70, 70'. These are interconnected by two further pairs of faces 71, 71' and 72 and 72'. The inner edges of faces 71, 71' are formed as arcs 79 which are defined by faces 75, 75'.

Two further faces 73, 73', parallel to faces 72, 72' are spaced therefrom by faces 74, 74'.

A series of faces, shown generally as 77 are located between the faces 73, 74 and 74' and 73', 74 and 74'.

The location of the various components in the puzzle can commence to be understood by examination of Figs 7 and 8. Fig 7 is a view into the puzzle when one face has been removed and Fig 8 is a view from the puzzle of the removed face.

The truncated cone of the removed face has also been shown removed so the centre of Fig 7 shows the pentagon 51 relating to this cone and the five surrounding cones 52.

Referring most particularly to the left side of the drawing it can be seen that centre piece 20^6 has one face 25 directed inwardly which face would have been in contact

with a removed edge piece and each other face 25 is in abutment with a face 72 of a centre piece. The surface 77 of the edge piece passes beneath the face and the surface 73 lies along the surface of the cone 52.

Each corner piece 30 has its surfaces 61 in abutment with surfaces 71 of three edge pieces 40 each of which is in abutment with a side 25 of a centre piece 20.

Referring to Fig 8 the internal orientation of the components may be better understood.

Looking at the upper left edge it can be seen how two corner members 30 and one edge piece join, as along line 80 in Fig 3. The outwardly directed surface 61 and surface 72 are coplanar as are the surfaces 62 and 73, the two planes being parallel and spaced. The surfaces 62 and 74 also engage. Shown in broken line in this figure is the incursion of the surfaces 62 beneath the planes 73 which incursion is possible because of the inclination of the surfaces 74.

The lines 78, formed at the junction of the surfaces 73 form a pentagon the sides of which are tangential to the diameter of the cone at that position.

Fig 14 is a partial, broken, view showing the inter-relationship between corner pieces 30 and edge pieces 40 looking into an edge of the portion illustrated in Fig 8 and is shown by arrows 14-14 and, in particular, shows the inter-engagement of the faces 61 and 71 and the incursion behind the face 71 into the area defined by the surfaces 74 and 75 of the surfaces 63, 64 and 65.

Fig 15 illustrates the inter-relationship between an edge piece 40 and two adjacent centre pieces 20 and particularly the abutment of surfaces 25 and 72 and the abutment of surfaces 73 of a single edge piece with the surfaces of two cones 52. This view is substantially as would be seen along line 15-15 of Fig 8.

The puzzle can be assembled by locating the various components around a fully or partially formed centre component 50. Each corner and edge piece can be located in relationship with the adjacent centre and corner pieces and the centre pieces with which they co-operate. As the last face is being completed either the centre piece 20 must be left for final connection or one of the last corner pieces 30 must be sprung into place. Particularly where the centre pieces are resiliently connected to the cones 52 this may be the preferred method.

It can be seen from examination of the figures that each face of the puzzle can be seen to comprise a five pointed star formed from the central pentagon and the five edge members and the star itself located in the centre of a regular pentagon.

I have found this to be the most satisfactory form of puzzle but it is to be appreciated that the shape of the edge pieces can be such that they do not move to a point at the edge of the face but rather have a finite width at that point. Also the shape of the corner pieces can be varied so that the final shape of each face is not pentagonal. These variations can be considered partially cosmetic. For example, if the edge pieces were thickened so as not to give the appearance of a sharp point, a consequential alteration may be made to the thickness of the rear part of these edge pieces and a further consequential alteration to each conical member is necessary.

To use the puzzle normally it is provided with each face being a different colour but each face could equally well be patterned. Also, if required, each centre piece could be marked to permit an indication of its initial condition to be achieved. It is normally required to commence with a puzzle in a mixed condition and to return the puzzle to its original condition, that is with each of the pieces in its starting position and in the same rotational orientation.

Whilst it is not intended in this specification to give instructions or illustrations as to the operation of the puzzle a very simple indication will be given.

The corner piece 30^{123} can be brought into the 30^{2611} position in two very simple ways which can be described in relation to Figs 3 to 5. In the first of these the face 3, shown in Fig 4 can be rotated through 72, in the clockwise direction and then face 2, shown in Fig 5 can be rotated through 144, in an anticlockwise direction and the piece has reached the 30^{2611} position with the surface 60 which was originally in face 1 now being in face 2.

In the alternative method, face 1 is first moved 72, anticlockwise and face 2 72, clockwise bringing the piece into the required condition but in this case the surface 60 which was originally in face 1 is now in face 6.

It can be seen that in order to return the puzzle to its original condition once it has been moved from this condition can be extremely difficult, if not impossible for many people, and time consuming, which are desiderata for puzzles.

It will be appreciated that whilst I have selected and described certain particular

formations of the interior parts of the corner and edge pieces these may be varied within the limitation that they must be basically complementary and they must not obtruct movement of the pieces themselves or adjacent pieces when rotation is required.

CLAIMS:

1. A puzzle comprising a regular dodecahedron in which the components defining each face can be rotated about an axis normal to the face, each face including eleven components, a central pentagon (20), five edge pieces(40), the base of each abutting one side of the central component (20) and extending outwardly therefrom to the adjacent edge of the face and five corner pieces (30) each being four sided, two of the sides (61) abutting adjacent edge pieces and the other two sides (60) defining portions of the adjacent edges of the face.

2. A puzzle as claimed in claim 1 wherein each edge of each face is a line (80) defined by two corner pieces (30) and one edge piece (40).

3. A puzzle as claimed in claim 2 wherein the surface of each edge piece (40) that can be seen on each face is of iscosles triangular form with the apex of the triangle being located at the mid point of the line (80) defining the edge of the face.

4. A puzzle as claimed in claim 1 wherein each central pentagon (20) is located as the outer portion of an extension (52) from a central component (50), there being twelve such extension equally spaced about the component.

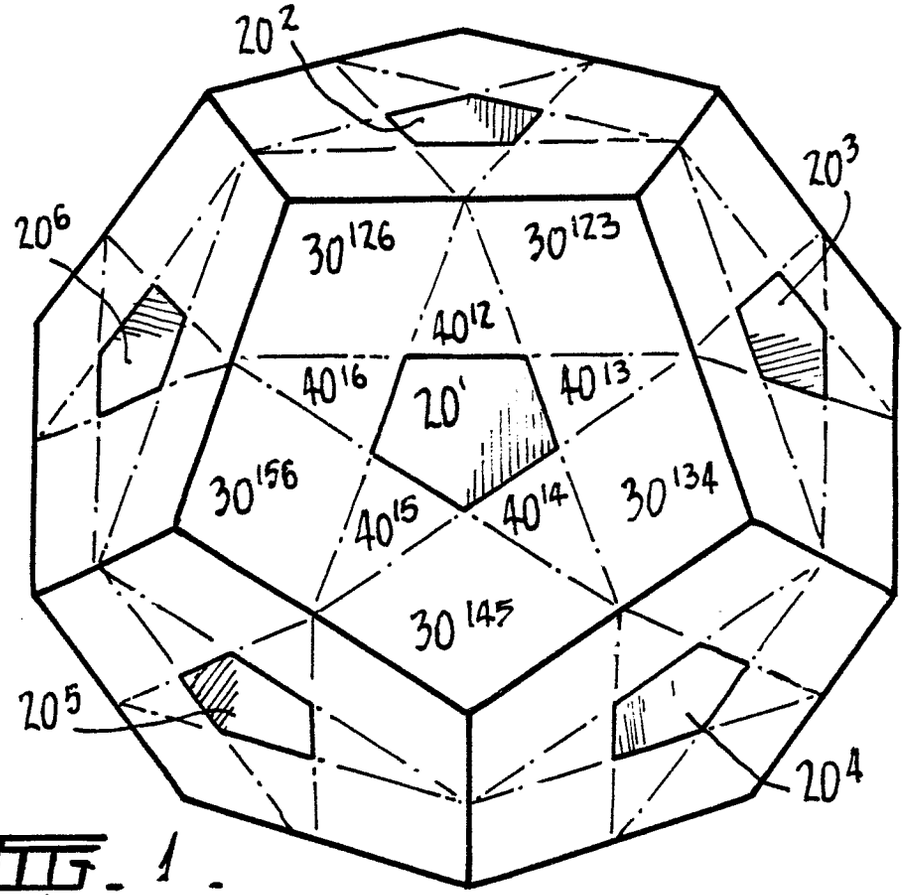
5. A puzzle as claimed in claim 1 wherein the central component (50) is a uniform icosidodecahedron or is developed therefrom.

6. A puzzle as claimed in Claim 5 wherein each extension (52) is in the form of a truncated cone to which the associated central pentagon (25) is rotatably connected at some position along its length.

7. A puzzle as claimed in claim 1 in which each edge piece (40) has a first two surfaces (70), each of which forms part of one face, a second two surfaces (71) interconnecting the first two surfaces and each adapted to be located in contact with a surface (61) of an adjacent corner piece and an inwardly directed extension (62-64) which can be located beneath one side of the central pentagon (20) and receive an extension (72-74) from a corner piece whereby relative outward movement of the pieces is restrained without relative rotational movement being restrained.

8. A puzzle as claimed in claim 7 wherein the centre piece (20) is located on a truncated conical extension (52) and wherein one surface of the inwardly directed extension of the edge member is adapted to abut and to rotate relative to the conical extension.

9. A puzzle as claimed in claim 1 wherein each corner piece (30) has a first three surfaces (60) each of which forms part of one face, a second three surfaces (61) interconnecting the first three surfaces and being in planes parallel to the first three surfaces and each of the second three surfaces being adapted to be in contact with a surface (71) of an adjacent edge piece and an inwardly directed extension (62-64) which can be located beneath portion of each adjacent edge member (40) whereby relative outward movement of the pieces is restrained without relative rotational movement being restrained.


20²
20³
20⁶
30¹²⁶
30¹²³
40¹²
40¹⁶
20¹
40¹³
30¹⁵⁶
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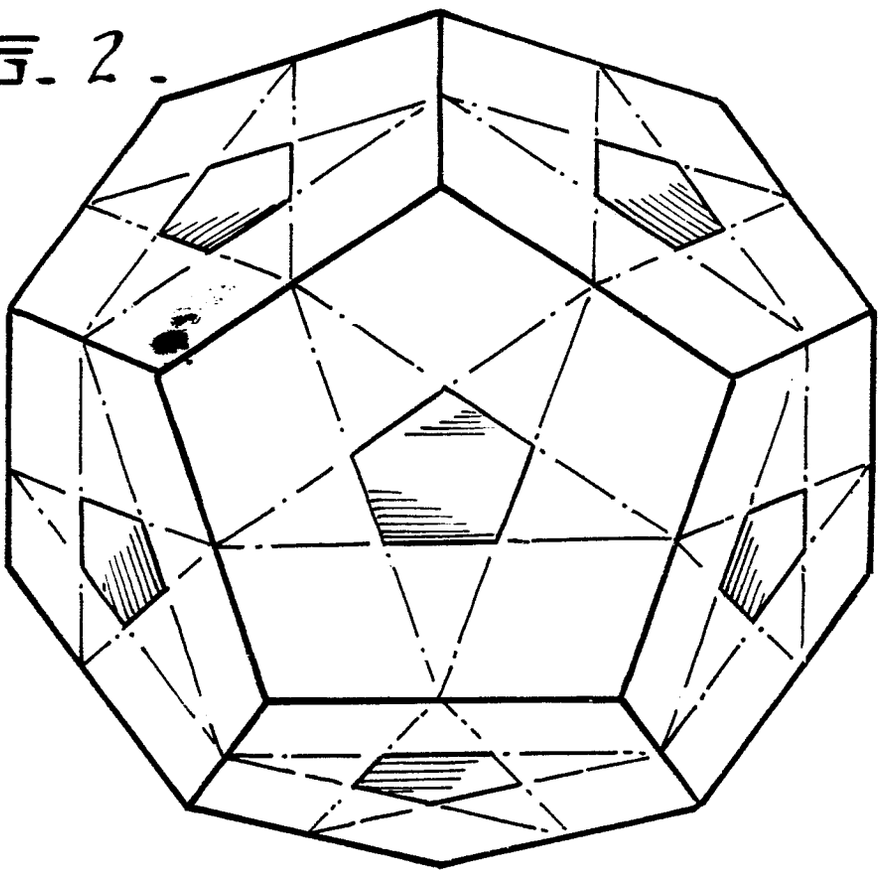
40¹⁴
30¹³⁴
30¹⁴⁵
20⁵
20⁴

FIG. 1.

FIG. 2.



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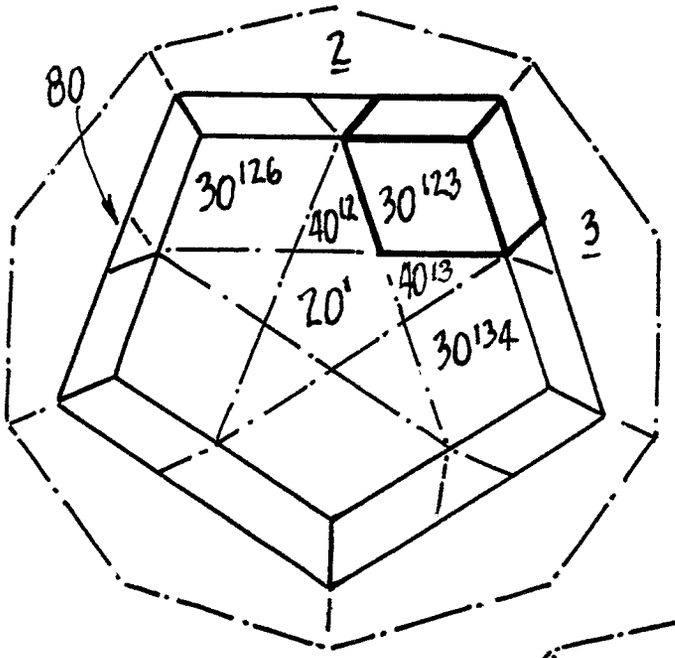

FIG. 3.

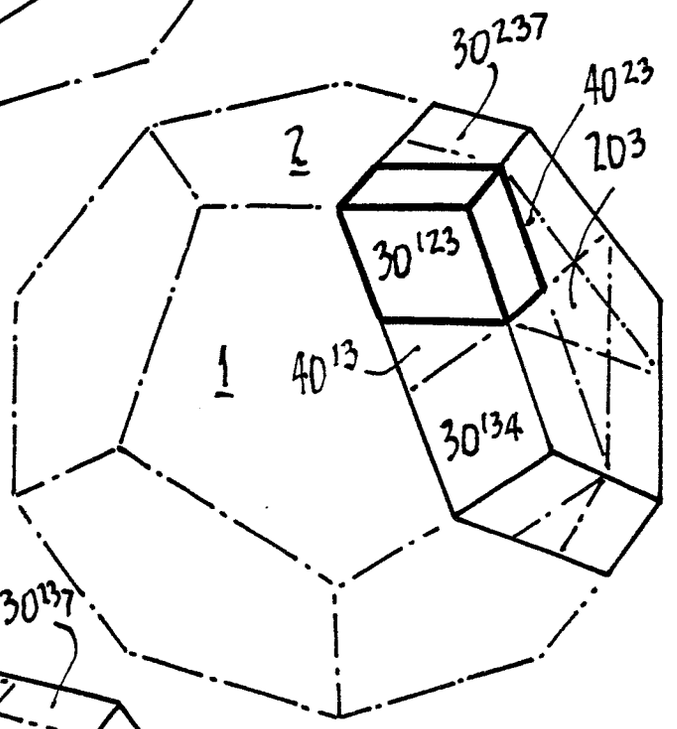

FIG. 4.

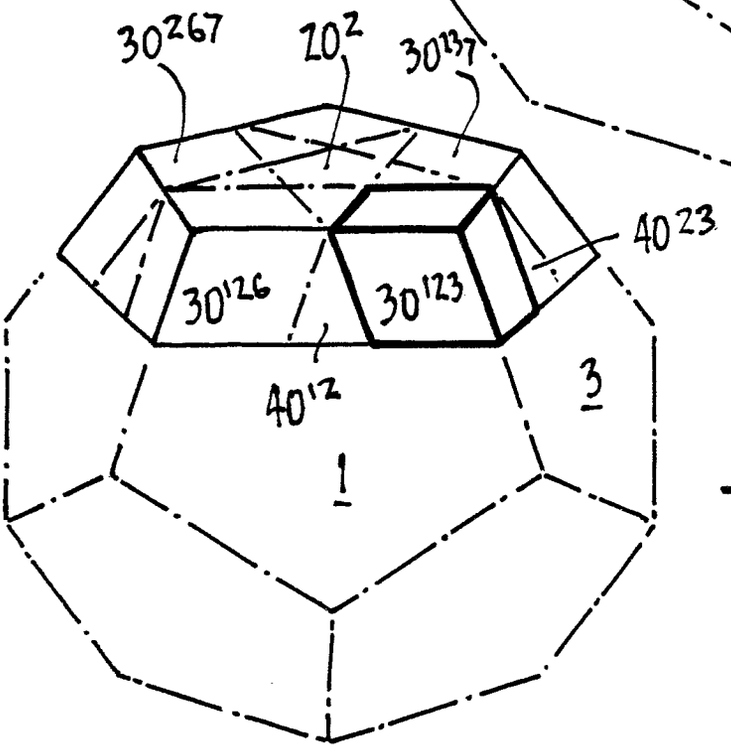

FIG. 5.

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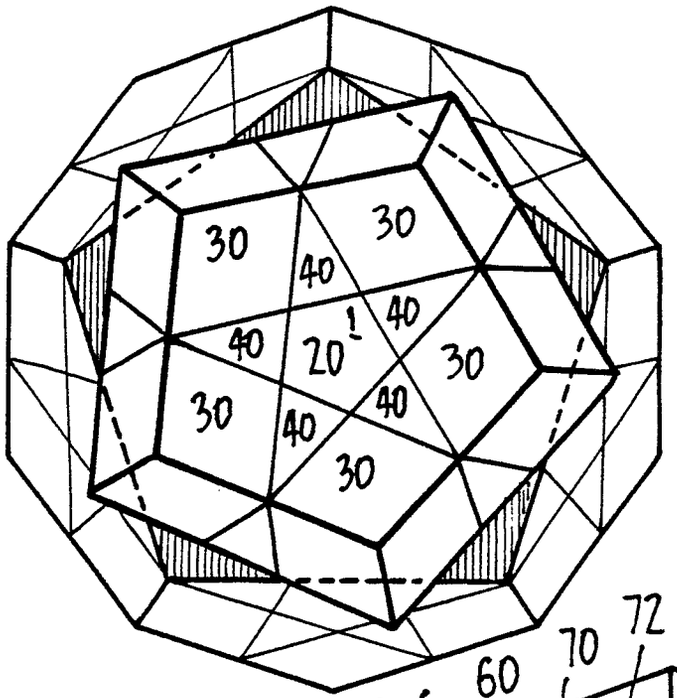

FIG. 6.

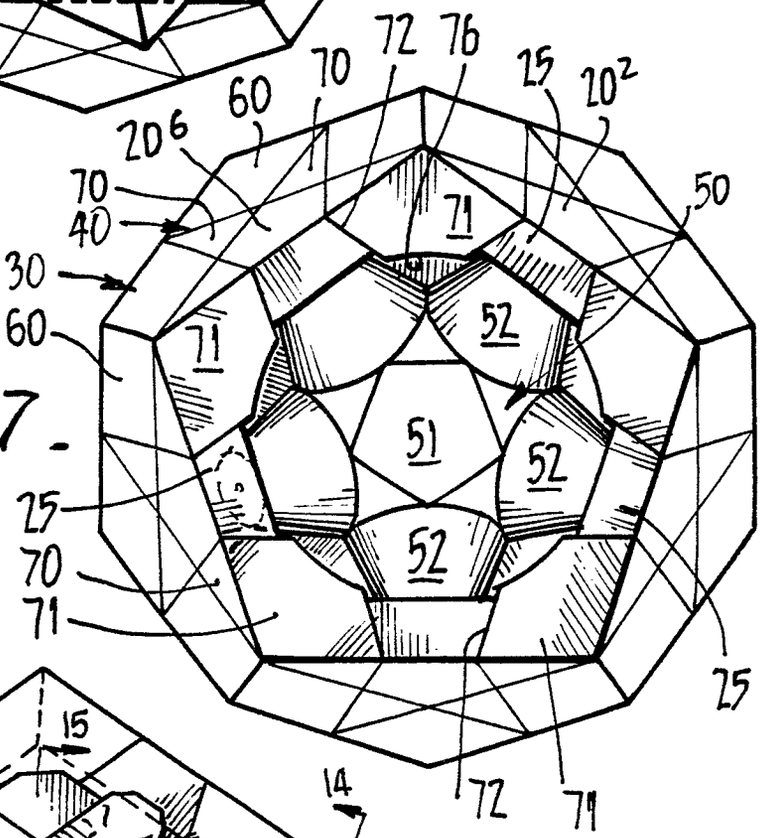

FIG. 7.

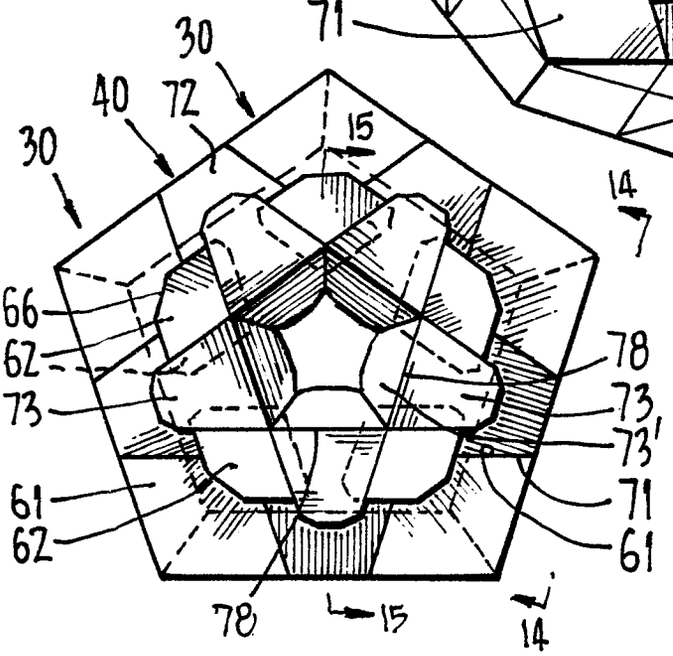

FIG. 8.

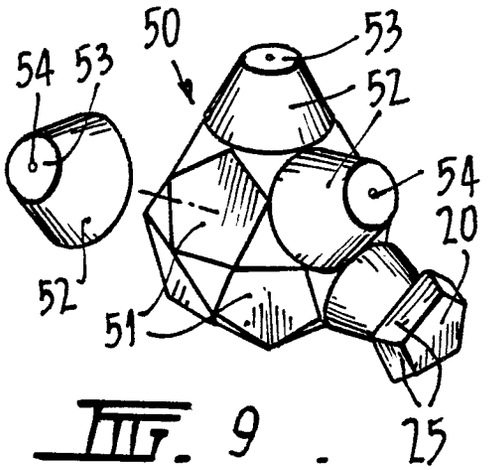

FIG. 9.

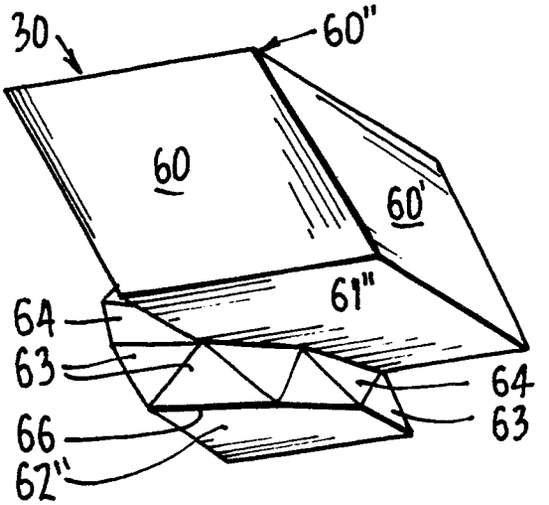

FIG. 10.

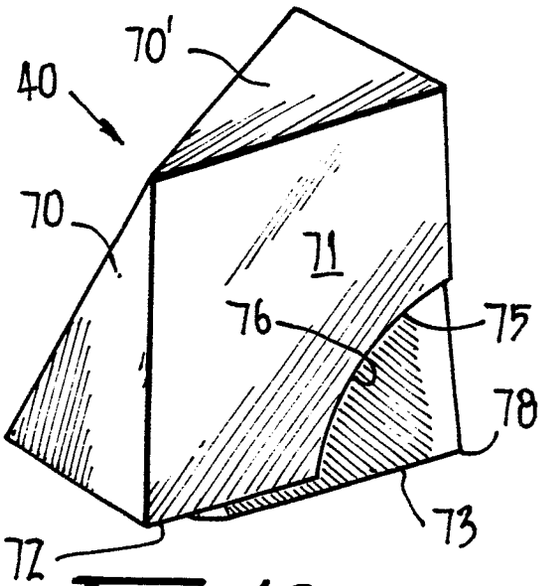

FIG. 12.

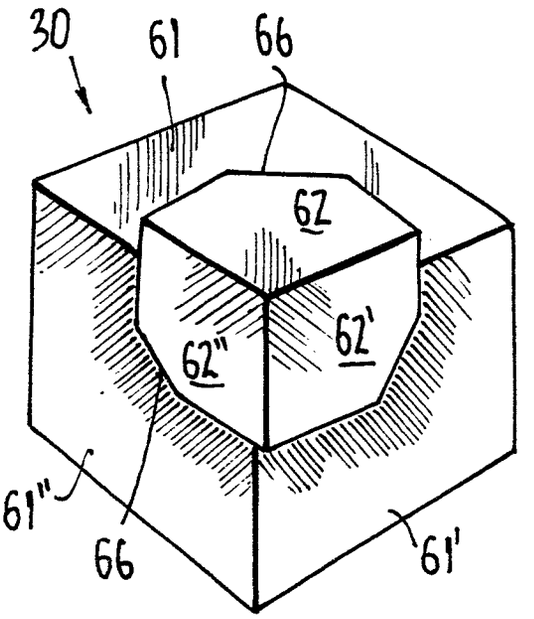

FIG. 11.

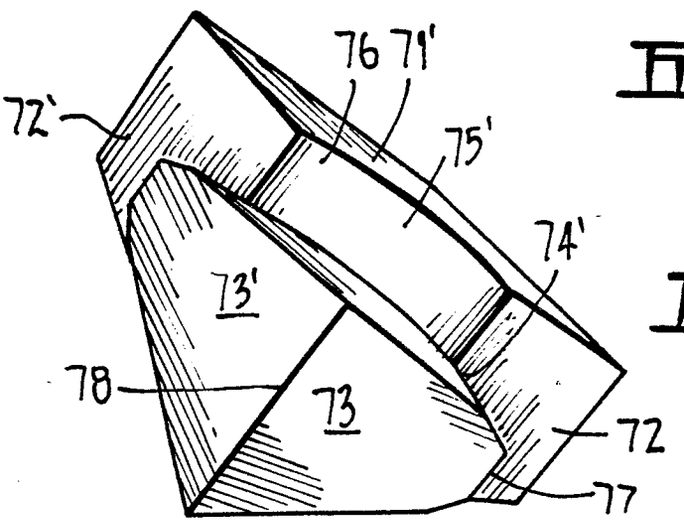

FIG. 13.

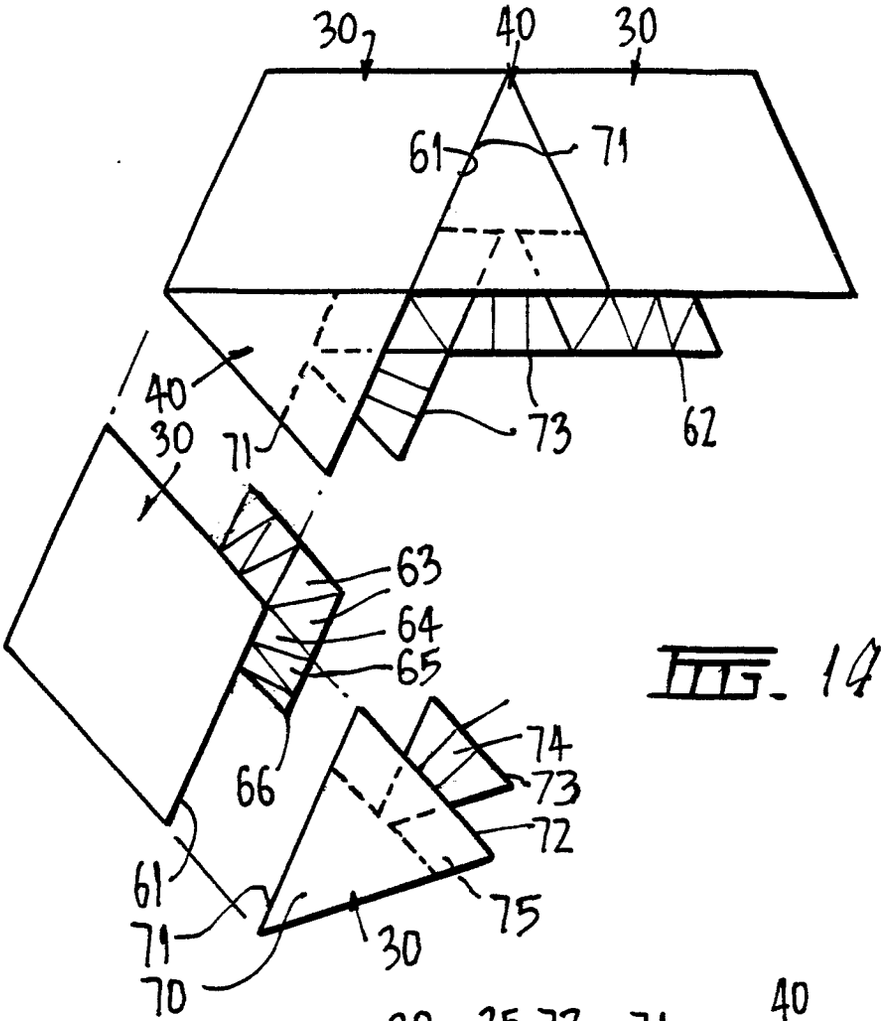
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FIG. 14.

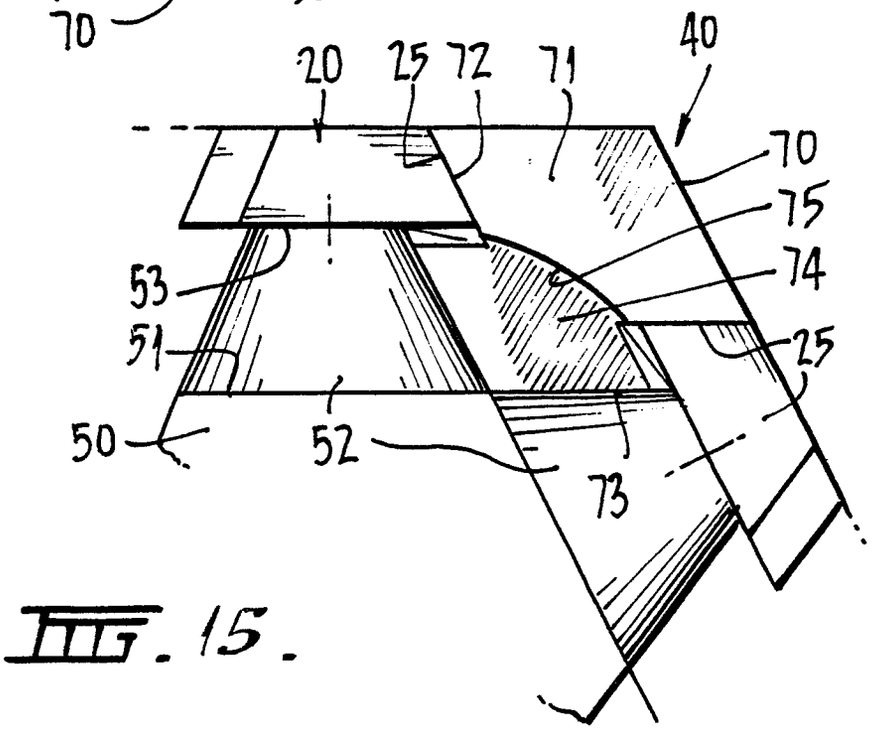
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FIG. 15.