This invention relates to multiple puzzle devices of the so-called Chinese cross type wherein six puzzle members in the form of puzzle pieces are mounted on an assembly comprising a puzzle member, and to an assembly permitting co-assembly of the three pieces with each pair of two other pieces, thereby forming a single puzzle figure as illustrated. The invention further relates to a method for solving the puzzle figure, which comprises providing a puzzle figure having a number of puzzle members substantially in excess of the six required to assemble a single puzzle figure as illustrated. The invention further relates to the method for solving the puzzle figure, which comprises providing a puzzle figure having a number of puzzle members substantially in excess of the six required to assemble a single puzzle figure as illustrated. The invention further relates to the method for solving the puzzle figure, which comprises providing a puzzle figure having a number of puzzle members substantially in excess of the six required to assemble a single puzzle figure as illustrated.

In the Chinese cross as shown in Fig. 1, the six component pieces or members which are identified as 1st to 6th to designate the numbers of pieces and the order of assembling the puzzle may be designated in the order of assembling the puzzle figure.

Figs. 2, 3 and 4 as hereinbefore illustrated describe certain characteristic features which must be present in all pieces used respectively in the A, B and C axes as shown in Fig. 1;

Fig. 5 is a break-down of the four zones of intersection as shown in Fig. 1;

Figs. 6, 7, 8, 9 and 10 show respectively the structure of the ten puzzle pieces which make up sets which have designated as set numbers 1, 2, 3 and 4 and 5;

Fig. 11 is a view showing in perspective the successive steps in assembling a typical puzzle solution.

In the Chinese cross as shown in Fig. 1, the six component pieces or members which are identified as 1st to 6th to designate the numbers of pieces and the order of assembling the puzzle figure may be designated in the order of assembling the puzzle figure. The invention further relates to the method for solving the puzzle figure, which comprises providing a puzzle figure having a number of puzzle members substantially in excess of the six required to assemble a single puzzle figure as illustrated. The invention further relates to the method for solving the puzzle figure, which comprises providing a puzzle figure having a number of puzzle members substantially in excess of the six required to assemble a single puzzle figure as illustrated. The invention further relates to the method for solving the puzzle figure, which comprises providing a puzzle figure having a number of puzzle members substantially in excess of the six required to assemble a single puzzle figure as illustrated.
The two B axis pieces must each have at least one wide end slot. In an assembled puzzle these may be in alignment as indicated by the slots 13 shown in Fig. 3a, or may be at opposites ends of the assemble as indicated by the slots 13, 13' in Fig. 3b. If the two wide end slots are assembled in alignment as in Fig. 3a, to provide locking with a solid A axis piece as shown in Fig. 2a, then at least one of the B axis pieces must have a minimum of one narrow end slot at the other end portion thereof.

The two C axis pieces must each provide a center notch in the assembled puzzle both may face up as indicated by the notches 14 as shown in Fig. 4a, or one may face up and one down as indicated by the notches 14, 14' in Fig. 4b. In addition, they must provide at least a narrow slot at each end. These may both be in one piece as indicated by the notch 15 as shown in Fig. 4a, or one in each piece as indicated by the notches 15, 15' in Fig. 4b.

The minimum cut-outs in puzzle pieces used in the three other axes as above described account for 24 of the unit groups of spaces as shown in Fig. 5, four in the A axis pieces, eight in the B axis pieces and twelve in the C axis pieces. Since a total of 40 spaces must be cut-out of the six pieces employed in a puzzle, it follows that sixteen additional cubes or spaces must be cut from the pieces which make up the puzzle. This allows for a considerable variation in the structure of individual puzzle pieces. I have found for example, that when locking with a 6th puzzle piece, which is a solid unnotched prism, as shown in Fig. 2e, there are 126 structurally different pieces that can be used as the 1st piece shown in Fig. 2a. These I refer to as double A pieces. There are 101 B type and 83 C type pieces, but among these three groups are many identities so that the net total of different pieces which can be locked by a solid prism is 236 pieces. In addition to those structures which can be locked by use of a solid prism, there are additional A type pieces with a slot only at one end which I refer to as single A pieces which can be locked by another single A type piece. Combination of these (many of which are mirror images in pairs), there are 133 single A pieces, bringing to 369 the total number of structurally different pieces which can be employed.

I have found that of the 369 structurally different pieces that can be used as members, some are quite versatile and can be used in many puzzles, whereas others can be employed in only a relatively few puzzles. I have further discovered that the more versatile pieces may be assembled in sets of ten, such that several selections of six pieces may be made from a single set of ten to provide several different and distinct puzzles.

I have further found that it is possible to provide two, three or more sets of puzzle members each comprising ten pieces which can be used as individual sets to provide a number of different puzzles, but which can also be used collectively taking one or more pieces from each of several sets so that the number of possible puzzles is multiplied many times.

The following examples will serve to illustrate certain adaptations of this puzzle. It will be understood, however, that these examples are given by way of illustration and not of limitation.

Example 1

I have shown in Fig. 6 of the drawing a set of ten puzzle pieces which I have identified as set No. 1. In this figure, as in Figs. 7 to 10, the showing of the individual pieces fully indicates the structure thereof when it is realized that these are plan views of square rectangular prisms. Slots cut through from the face to the back are self-evident, and shaded areas indicate that the face is cut away half way through to the back of the piece. The numbers appearing at the bottom of the individual pieces are the numbers above referred to which have been arbitrarily assigned to these pieces and are utilized for designating pieces to be used in an individual puzzle, and when listed in the order of assembly 1st piece to 6th piece to designate the proper puzzle solutions.

Set No. 1, as shown in Fig. 6, provides eight different puzzle pieces (listed in numerical order so as not to indicate the solution) and the solution for each of the eight puzzles are tabulated below.

<table>
<thead>
<tr>
<th>Puzzle No.</th>
<th>Selection of Puzzle Pieces</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>2</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>3</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>4</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>5</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>6</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>7</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>8</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td>1 1 1 1 1 1 1 1 1 1</td>
</tr>
</tbody>
</table>

To illustrate a typical puzzle solution, the following solution is given for puzzle No. 1 of set No. 1 and illustrated in Fig. 11 of the drawing:

Step 1.—Piece No. 6 is the 1st piece in the proper solution and is oriented in a left to right position as seen in Fig. 11a with the end slots 16 and 17 opening upwardly through the face 18. In this solution the center slot 19 faces to the front, but in other solutions the 1st piece may have no center notch or may have a center notch at the back side of the piece.

Step 2.—Piece No. 3 is then placed in the 2nd or back position as shown in Fig. 11b with the middle of the 2nd piece level with the face 18 of the 1st piece so that a wide slot 20 is provided to receive the locking or 6th puzzle piece.

Step 3.—Piece No. 7 is then placed in the 3rd or left position as shown in Fig. 11c occupying the end slot 16 and having the floor of its center notch 21 in alignment with the face 18 of the 1st piece and its end slot 22 facing toward the right. Point 23 now indicates the point through which abutting faces of the three pairs of puzzle pieces in the fully assembled puzzle will pass.

Step 4.—Piece No. 2 is placed in the 4th or front position face to face with the 2nd piece as shown in Fig. 11d. In this solution this placement is accomplished by guiding the 4th piece downwardly into the space provided by the center slot 19 in the 1st piece and the end slot 22 provided in the 3rd piece, and the 4th piece is oriented so that its end slot 24 is in alignment with the end slot 20 of the 2nd piece completing the passage which is to receive the 6th or locking piece.

Step 5.—Piece No. 4 is arranged in the 5th or right position face to face with the 3rd piece occupying the end slot 17 of the 1st piece and having its center notch 25 in alignment with the face 18 of the 1st piece as shown in Fig. 11e.

Step 6.—Piece No. 1 is then inserted in the 6th position by passing the piece from right to left through the tunnel provided by the center notches in the 3rd and 5th pieces and the wide end slots provided in the 2nd and 4th piece, thus completing the assembled puzzle solution as shown in Fig. 11f.

In the working out of all puzzle solutions the following simple rules should be followed:

(1) Each end slot must face the center of the assembled puzzle.

(2) The middle of the 2nd piece and the floor of the center notch of the 3rd piece must be level with the face of the first piece.

(3) The 5th and 6th pieces must be fitted directly opposite the 2nd, 3rd and 1st pieces respectively, i. e. with no lateral displacement of the abutting faces.

(4) The centers of all faces coincide at the center of the assembled Chinese cross.
In the more advanced puzzles the starting piece has only one end slot and in such event, the 1st piece should be oriented with the end slot to the left facing up. In all such cases the 6th piece will have an end slot which will be oriented in the assembled puzzle with the end slot at the right end facing downwardly. Interlock between the 5th and 6th pieces is then made by momentarily sliding the 5th piece to the extreme right. The interlocked 5th and 6th pieces will then slide collectively into assembled position.

In working out puzzle solutions it must be borne in mind that it is frequently necessary to temporarily move one or two previously added pieces to permit insertion of the next piece. A number of puzzles for example are solved by means of a locking or 6th member which interlocks with both the 4th and 5th member so that the three must be slid collectively into engagement with the assembled 1st, 2nd and 3rd pieces in making the final assembly.

**Example II**

In Fig. 7 of the drawing I have shown a set of ten puzzle pieces which I have designated as set No. 2. This set provides in and of itself five puzzles each different from each other and from the puzzles provided by set No. 1. The puzzles and solutions for set No. 2 are as follows:

<table>
<thead>
<tr>
<th>Puzzle No.</th>
<th>Selection of Puzzle Pieces</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 3 11 12 14 15</td>
<td>2 14 12 2 15 16 11 10 9 8 7 6</td>
</tr>
<tr>
<td>2</td>
<td>4 10 13 15</td>
<td>1 15 14 2 13 12 11 10 9 8 7 6</td>
</tr>
<tr>
<td>3</td>
<td>2 4 11 13 15</td>
<td>2 14 12 2 15 16 11 10 9 8 7 6</td>
</tr>
<tr>
<td>4</td>
<td>2 4 11 13 15</td>
<td>1 15 14 2 13 12 11 10 9 8 7 6</td>
</tr>
<tr>
<td>5</td>
<td>11 13 14 15 16</td>
<td>18 14 13 17 15 16 11 10 9 8 7 6</td>
</tr>
</tbody>
</table>

When one uses set No. 1 and set No. 2 together selecting pieces from either or both sets, the combination provides 82 different puzzle solutions. 63 of these provide a completely symmetrical Chinese cross as shown in Fig. 1 of the drawing, whereas 19 are what I refer to as eccentric puzzles. In an eccentric puzzle one or more pieces will lock in a longitudinally off-set position resulting from interchangeable use of a piece as providing a wide end slot or a center for identification respectively in Figs. 3 and 4 of the drawing.

**Example III**

I have shown in Fig. 8 a set of ten puzzle pieces which I have designated as set No. 3, and which is capable of producing four different puzzles. The selection of pieces for the four puzzles and the corresponding solutions therefore are tabulated below:

<table>
<thead>
<tr>
<th>Puzzle No.</th>
<th>Selection of Puzzle Pieces</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15 19 20 22 24 27 29 20 18 16</td>
<td>19 24 22 15 20 18 16 15 24 22 15 20 18 16</td>
</tr>
<tr>
<td>2</td>
<td>19 20 22 24 27 29 20 18 16</td>
<td>19 24 22 15 20 18 16 15 24 22 15 20 18 16</td>
</tr>
<tr>
<td>3</td>
<td>19 20 22 24 27 29 20 18 16</td>
<td>19 24 22 15 20 18 16 15 24 22 15 20 18 16</td>
</tr>
<tr>
<td>4</td>
<td>19 20 22 24 27 29 20 18 16</td>
<td>19 24 22 15 20 18 16 15 24 22 15 20 18 16</td>
</tr>
</tbody>
</table>

When set No. 3 is employed in conjunction with sets Nos. 1 and 2, the total number of puzzles possible by the selection of groups of six pieces from any and all of the three sets is 402.

**Example IV**

I have shown in Fig. 9 of the drawing a set of ten puzzle pieces which I have designated as set No. 4. While the pieces provided in set No. 4 do not by themselves permit any new puzzles, these pieces are selected as a set for use in conjunction with sets 1, 2 and 3 to vastly increase the total number of puzzles.

A master puzzle set comprising a combination of sets Nos. 1, 2, 3 and 4, providing a total of 40 puzzle pieces from which to make selections, makes possible 1675 different puzzles. If this number of puzzles were to be made up with separate sets of six puzzle pieces each, it will be evident that a total of 10,030 puzzle pieces would be required.

The standard procedure which I have disclosed for solving these puzzles coupled with the distinctive characterization of structurally different puzzle pieces permitting both the easy selection of pieces for a particular puzzle and clear designation of the proper solution therefor thus provides an approximately 99 1/2% reduction in the bulk and cost of puzzle pieces, while retaining all the benefits of 1675 individual puzzles.

**Example V**

I have shown in Fig. 10 of the drawing a set of ten puzzle pieces which I have designated as set No. 5. While the pieces provided in set No. 5 do not themselves permit any new puzzles, these pieces are selected for use in conjunction with sets 1, 2 and 3, or sets 1, 2, 3 and 4 to further increase the total number of puzzles.

A master puzzle set comprising a combination of sets 1, 2, 3, 4 and 5, a total of 50 pieces provides a total of 3349 different puzzles. If this number of puzzle pieces were to be made up with separate sets of six puzzle pieces each, the total number of such pieces would be 20,094, over four hundred times the number employed in my sets 1 to 5.

It will be apparent that the puzzle pieces employed in practicing my invention can be fashioned from various materials such as wood, metal, plastics and the like and are particularly adapted for mass production by molding or casting from plastic material.

The particular selection of pieces employed in the individual puzzle sets 1, 2 and 3 and the supplementary sets 4 and 5 (forming master sets when one or both are combined with sets 1, 2 and 3) represents the selection of pieces, in groups of ten, which I have found to give the greatest possible number of puzzles as successive sets are added to the first set. If more than three sets individually capable of producing a plurality of puzzles are desired such additional sets can readily be made up. For example, by replacing two or three pieces in set No. 4 and/or set No. 5 with more versatile pieces such as 4, 6, 7, 8, 12 or 18 these sets can be modified to produce a plurality of different puzzles by appropriate selection of groups of six pieces from the individual ten piece sets.

Such modification of sets 4 and/or 5 would somewhat reduce the total number of puzzles that could be produced by combining the modified sets with sets 1, 2 and 3, but the fact that somewhat fewer puzzles can be produced when combining the several sets may, from a practical standpoint, be offset by the advantage of having more sets of ten puzzle pieces which will individually produce a plurality of different puzzles.

It is to be understood that such further extension of my puzzle devices by adding ten piece sets beyond sets 1, 2 and 3 which are themselves capable of producing a plurality of puzzles, or by adding other sets like 4 and 5 which do not themselves produce puzzles, but which, in combination with other sets greatly increase the total number of puzzles, is within the scope of my invention.

By way of illustration of the possibilities in such further extension of the invention, I have to date set up eight sets of ten pieces and have worked out and catalogued over 8000 different puzzle solutions; and in so doing have by no means exhausted the possibilities provided by all the possible structurally different puzzle pieces which can be employed.

While I have described my invention in terms of sets of ten puzzle pieces and multiples of ten puzzle pieces, it is to be understood that it is within the scope of my invention to provide unit sets made up of other numbers.
of puzzle pieces. Thus for example, the individual sets may comprise 12 or 15 structurally different pieces. Decreasing the number of pieces in a set below ten, however, will result in a substantial reduction in the number of puzzles which the set can produce.

Various changes and modifications in the puzzle devices herein disclosed and in the disclosed puzzle selection and solution methods may occur to those skilled in the art and to the extent that such changes and modifications are embraced by the appended claims, it is to be understood that they constitute part of my invention.

I claim:

1. A multiple solution Chinese cross puzzle consisting of the ten structurally different puzzle pieces as illustrated in Fig. 6 of the drawing, and characterized as providing eight different solution groups.

2. A multiple solution Chinese cross puzzle consisting of the ten structurally different puzzle pieces as illustrated in Fig. 7 of the drawing, and characterized as providing fifty different solution groups, and in conjunction with the set as illustrated in Fig. 6 as providing eighty-two different solution groups.

3. A multiple solution Chinese cross puzzle consisting of the ten structurally different puzzle pieces as illustrated in Fig. 8 of the drawing, and characterized as providing four different solution groups, and in conjunction with the sets as illustrated in Figs. 6 and 7 as providing four hundred and two different solution groups.

4. A multiple solution Chinese cross puzzle consisting of the combined set of forty puzzle pieces, including thirty-seven structurally different pieces, as illustrated in Figs. 6, 7, 8 and 9 of the drawing, and characterized as providing 1675 different solution groups.

5. A multiple solution Chinese cross puzzle consisting of the combined set of fifty puzzle pieces, including forty-seven structurally different pieces, as illustrated in Figs. 6, 7, 8, 9 and 10 of the drawing, and characterized as providing 3349 different solution groups.

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