May 27, 1958 W. D. TURNER 2,836,421

MULTIPLE PUZZLE DEVICES

Filed Dec. 20, 1954 2 Sheets-Sheet 1

Fig.1.

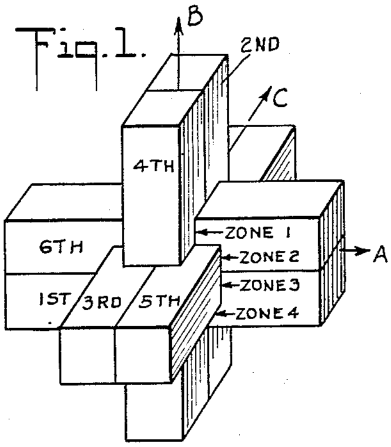


Fig.2

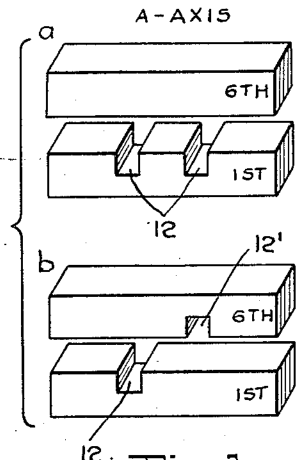


Fig.3.

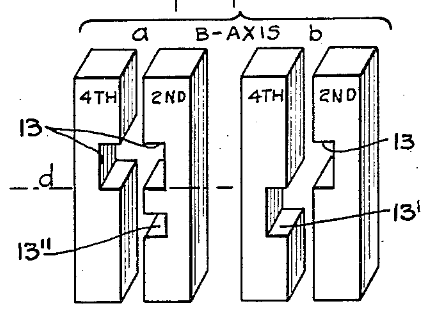


Fig.4.

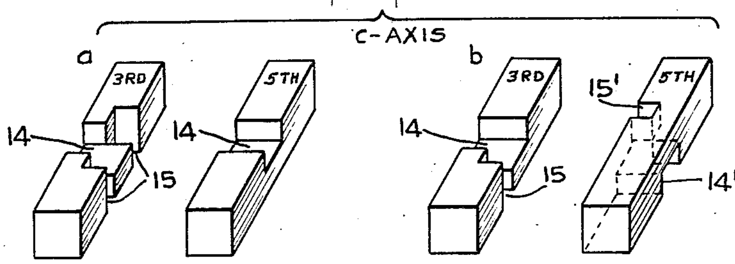
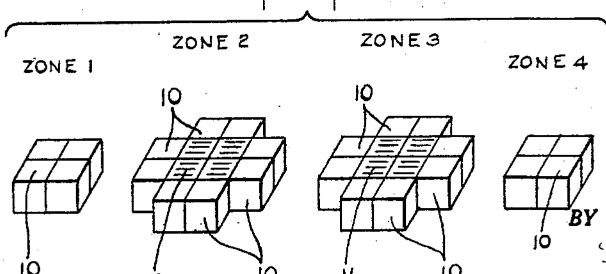


Fig.5.



INVENTOR.
WILLIAM D. TURNER
BY Howard E. Thompson Jr.
ATTORNEY

May 27, 1958 W. D. TURNER 2,836,421

MULTIPLE PUZZLE DEVICES

Filed Dec. 20, 1954 2 Sheets-Sheet 2

Fig.6.

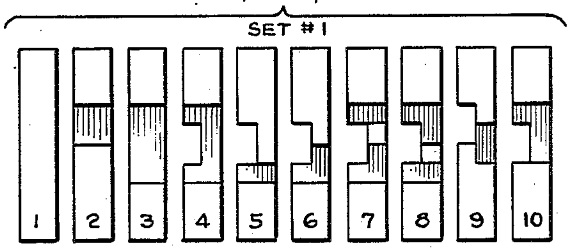


Fig.7.

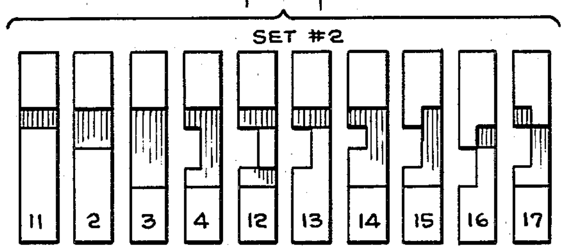


Fig.8.

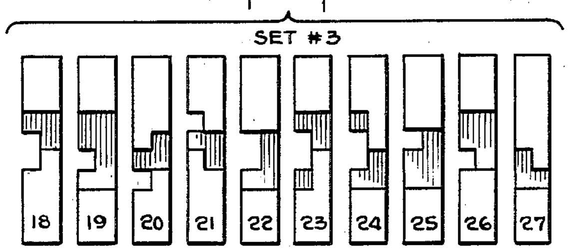


Fig.9.

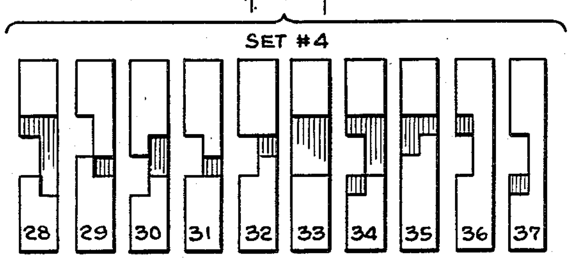


Fig.10.

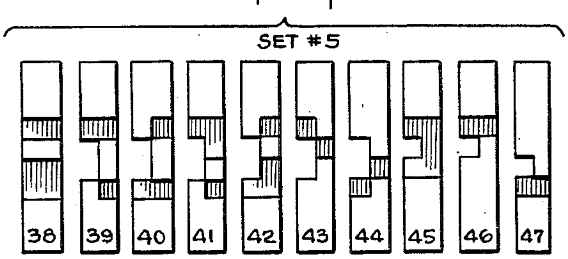
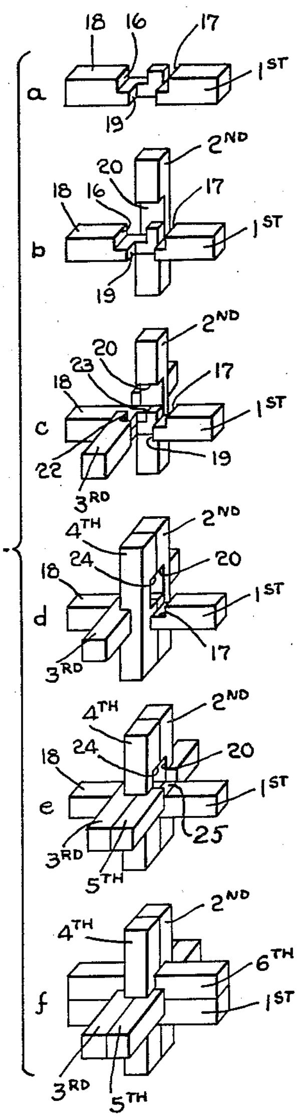


Fig.11.



INVENTOR.
WILLIAM D. TURNER

BY Howard E. Thompson Jr.

ATTORNEY

United States Patent Office

2,836,421

Patented May 27, 1958

2,836,421

MULTIPLE PUZZLE DEVICES

William D. Turner, New York, N. Y.

Application December 20, 1954, Serial No. 476,173

5 Claims. (Cl. 273—160)

This invention relates to multiple puzzle devices of the so-called Chinese cross type wherein six puzzle members in three pairs of puzzle members have interfitting parts permitting co-assembly of the three pairs with each pair perpendicular to the other two pair of puzzle members and appearing to pass through one of said other pair and to envelop the second of said other pair of puzzle members. More particularly the invention relates to multiple puzzle devices of the class described wherein a number of puzzle members substantially in excess of the six required to assemble a single puzzle are offered as a set such that from this set selection of different groups of six puzzle members provides a number of puzzles having different solutions. Still more particularly the invention relates to a method of solving puzzles of the class described which permits the codifying of solutions for large numbers of puzzles produced by interchangeable use of a relatively small set of puzzle members.

Chinese cross puzzles are exceedingly old in the art, but it has been customary in the past to provide such puzzle devices as individual puzzles having only the requisite number of pieces to provide one solution. To persons interested in puzzles of this type determining the particular interfitting arrangement of parts which permits construction of the perfect Chinese cross is a challenge and source of entertainment. After a person has worked out the solution for an individual puzzle however, the challenge and interest originally provided by the puzzle is lost or expended. Thus the Chinese cross puzzles which have been heretofore available are in the nature of novelty items having a limited one time interest for a particular person and having lasting value primarily in being passed from one person to another to be solved by each.

I have now discovered that it is possible, in accordance with the present invention, to provide Chinese cross puzzles having continuing or lasting interest for an individual by virtue of the fact that a set of puzzle members in excess of the six required for a single puzzle may be so chosen as to produce not just one, but a plurality of different puzzles; the possible number of different puzzles being multiplied many fold by employing two or more such sets of puzzle members. Moreover, I have discovered a systematic method of solving all such puzzles such that by assigning to each structurally distinct puzzle member a characteristic number or identification it is possible by simple codes of six numbers to clearly and concisely designate the proper solution of any puzzle, as well as to identify the particular pieces to be used in that puzzle.

The invention will readily be understood from the following description taken together with the accompanying drawing which shows the characteristic details and preferred adaptations of the invention with the various parts identified by suitable reference characters in each of the views, and in which:

Fig. 1 is a perspective view of an assembled Chinese cross puzzle having the characteristic appearance of

properly solved puzzles, indicating my order of assembly of the six puzzle pieces and identifying the axes and zones of intersection;

Figs. 2, 3 and 4 as hereinafter described illustrate 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 members which make up sets which I have designated as set numbers 1, 2, 3 4 and 5; and

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 order of assemblage can be described in terms of the three coordinate axes known mathematically as the Cartesian space coordinates. Pieces 1st and 6th extend from left to right along the A axis, pieces 2nd and 4th extend up and down along the B axis, and pieces 3rd and 5th extend fore and aft along the C axis. The pieces are of uniform square cross-section and of a length preferably between two and three times the length of a maximum zone of intersection. The maximum zone of intersection is in turn substantially equal to the width of two pieces with a pair of long flat surfaces superimposed. It will be apparent that each pair of puzzle members or pieces appear to envelop one of the other pair and to pass through the second of the other pair of puzzle pieces providing the zones of intersection which have been identified in Figs. 1 and 5 of the drawing from top to bottom as zones 1, 2, 3 and 4.

In Fig. 5 the zones of intersection have been broken down to the unit spaces or cubes through which the six pieces pass and each must be occupied by a solid portion of one of the pieces. It will be noted that there are a total of 32 such cubes or spaces in the four intersecting zones. The light cubes **10** representing the intersection of puzzle pieces from two axes and the shaded cubes **11** centrally of zones 2 and 3 as shown in Fig. 5 representing the intersection between pieces of all three axes. Since each of the shaded cubes **11** can only be occupied by a solid part of one puzzle piece, it will be apparent that a puzzle piece from one of the coordinate axes will have a solid portion for a particular shaded cube **11** and puzzle pieces from the other two coordinate axes passing through the space **11** must be cut out in different areas to accommodate the solid portion of the first piece. Thus it will be evident that the six puzzle pieces making up a perfect puzzle as shown in Fig. 1 must have a total of 32 solid cubes in the portions which in the assembled puzzle thereof pass through zones 1, 2, 3 and 4, but a total of 40 cut-out portions allow for the triple intersection through the shaded cubes or spaces of zones 2 and 3.

I have found that the order of assembly of pieces from 1st to 6th as shown in Fig. 1 will solve all of my puzzles and hence all solutions may be designated by reciting the characteristic piece numbers in this order. Furthermore, this order of assembly permits maximum visibility of unoccupied portions of the intersecting zones as will be apparent from a consideration of Fig. 11 of the drawing and detailed description thereof hereinafter appearing.

In puzzle pieces used along the three different coordinate axes there are certain minimum requirements as to cut-out portions. The two A axis pieces must provide at least a narrow slot at each end of the intersecting zone. These may be in the same piece as indicated by the slots **12** in Fig. 2*a*, or one may be in each piece as indicated by the slots **12**, **12'** in Fig. 2*b*.

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. 3*a*, or may be at opposed ends of the assemblage as indicated by the slots **13**, **13'** in Fig. 3*b*. If the two wide end slots are assembled in alignment as in Fig. 3*a*, to provide locking with a solid A axis piece as shown in Fig. 2*a*, 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. 4*a*, or one may face up and one down as indicated by the notches **14**, **14'** in Fig. 4*b*. In addition, they must provide at least a narrow slot at each end. These may both be in one piece as indicated by the notches **15** as shown in Fig. 4*a*, or one in each piece as indicated by the notches **15**, **15'** in Fig. 4*b*.

The minimum cut-outs in puzzle pieces used in the three axes as above described account for 24 of the unit groups or 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. 2*a*, there are 126 structurally different pieces that can be used as the 1st piece shown in Fig. 2*a*. 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. Counting all 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 or puzzle 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 my invention. It will be understood, however, that these examples are given by way of illustration and not of limitation.

Example I

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 puzzles and the selection of pieces (listed in numerical order so as not to indicate the solution) and the solution for each of the eight puzzles are tabulated below.

Puzzle No.	Selection of Puzzle Pieces						Solutions					
							1st	2nd	3rd	4th	5th	6th
1	1	2	3	4	7	8	8	3	7	2	4	1
2	1	2	4	7	8	10	8	2	10	7	4	1
3	1	3	4	5	6	8	3	8	5	4	6	1
4	1	3	5	7	8	10	7	10	5	3	8	1
5	1	3	7	8	9	10	7	9	8	3	10	1
6	1	4	5	6	8	10	8	10	6	4	5	1
7	2	3	5	6	8	9	6	9	8	3	5	2
8	2	5	6	8	9	10	5	9	10	8	6	2

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. 8 is the 1st piece in the proper solution and is oriented in a left to right position as seen in Fig. 11*a* 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. 11*b* 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. 11*c* 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. 11*d*. In this solution this placement is accomplished by sliding 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. 11*e*.

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. 11*f*.

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.

The 4th, 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 poistion.

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 assemblage.

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 the other and from the puzzles provided by set No. 1. The puzzles and solutions for set No. 2 are as follows:

Puzzle No.	Selection of Puzzle Pieces						Solutions					
							1st	2nd	3rd	4th	5th	6th
1	2	3	11	12	14	15	2	14	12	3	15	11
2	2	3	12	13	16	17	16	3	13	17	12	2
3	2	4	11	13	14	15	13	14	4	2	15	11
4	3	4	11	13	16	17	16	3	13	17	4	11
5	11	13	14	15	16	17	16	14	13	17	15	11

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 notch identified 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.

Puzzle No.	Selection of Puzzle Pieces						Solutions					
							1st	2nd	3rd	4th	5th	6th
1	18	19	20	22	24	27	27	19	24	22	18	20
2	18	20	21	22	24	26	20	26	18	22	24	21
3	19	20	23	24	25	27	27	19	24	25	23	20
4	20	21	23	24	25	26	21	26	24	25	23	20

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 for each, it will be evident that a total of 10,050 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 99½% 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 puzzles 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 structuarlly 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 five 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.

References Cited in the file of this patent

UNITED STATES PATENTS

943,496	Weigt	Dec. 14, 1909
1,221,149	D'Autremont	Apr. 3, 1917
1,225,760	Brown	May 15, 1917
1,350,039	Senyk	Aug. 17, 1920
1,455,009	Schenk	May 15, 1923
2,037,966	Dailey	Apr. 21, 1936