United States Patent

Keister

[15] **3,637,215**

[45] **Jan. 25, 1972**

[54] LOCKING DISC PUZZLE

[72] Inventor: **William Keister,** 66 Baltusrol Way, Short Hills, N.J. 07078

[22] Filed: **Dec. 22, 1970**

[21] Appl. No.: **100,559**

[52] **U.S. Cl.** **273/155,** 273/156
[51] **Int. Cl.** **A63f 9/08**
[58] **Field of Search** .....273/153 R, 153 S, 156, 155

[56] **References Cited**

UNITED STATES PATENTS

636,109 10/1899 Bowers 273/155

FOREIGN PATENTS OR APPLICATIONS

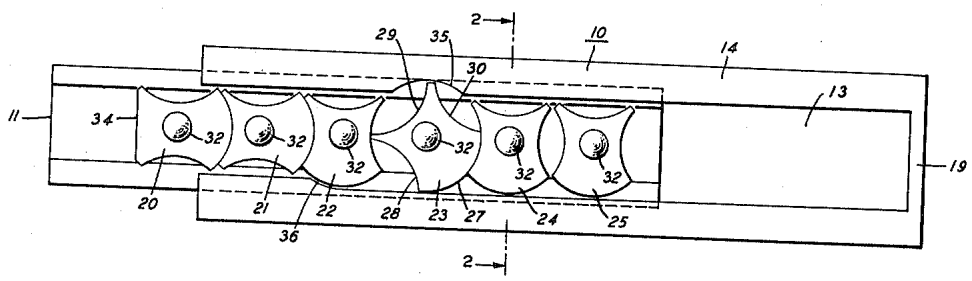
758,402 11/1933 France.....273/155

Primary Examiner—Anton O. Oechsle
Attorney—James Warren Falk

[57] **ABSTRACT**

A locking disc puzzle is disclosed in which a slide is to be removed from a frame member, the slide carrying a plurality of discs thereon and the frame being restricted at its one end so that the slide cannot be removed unless all the discs are in the horizontal position. Each disc is so shaped, however, that an adjacent disc can prevent it from moving unless the adjacent discs have the cutout portions facing the disc it is desired to pivot. Further, the frame is so formed that a disc can only pivot, provided its adjacent discs permit, if that disc is positioned at a cutout portion in the frame upper side rail. The slide is removed by following an iterative pattern of disc rotations or moves which allows all the discs to be placed in the horizontal position.

9 Claims, 5 Drawing Figures



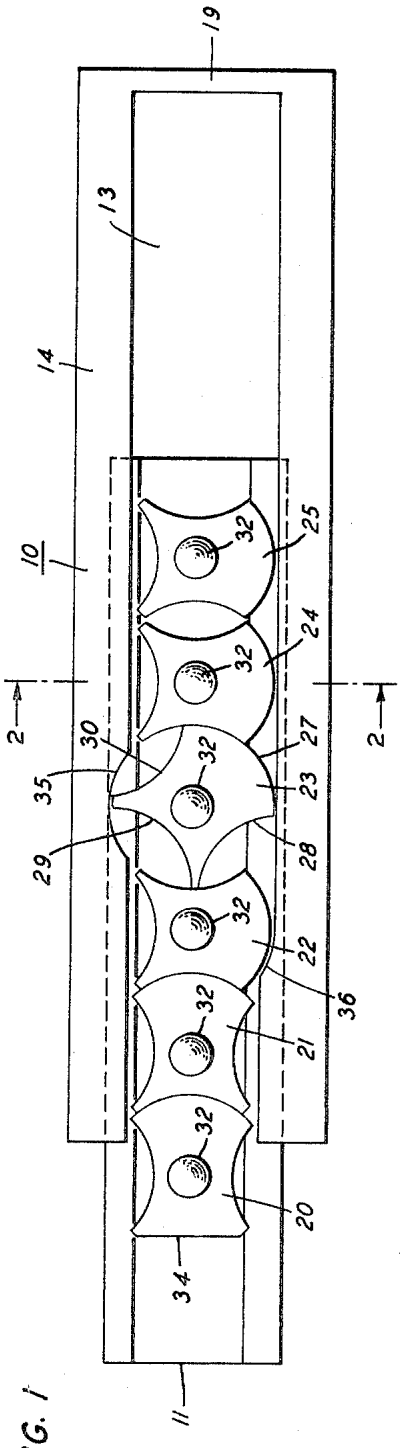


FIG. 1

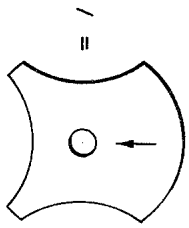


FIG. 4B

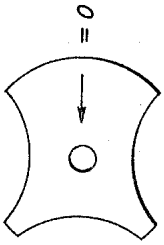


FIG. 4A

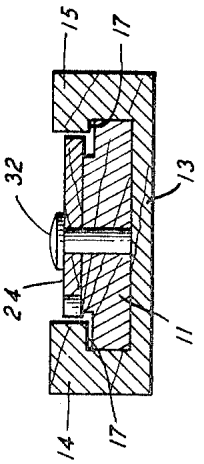


FIG. 2

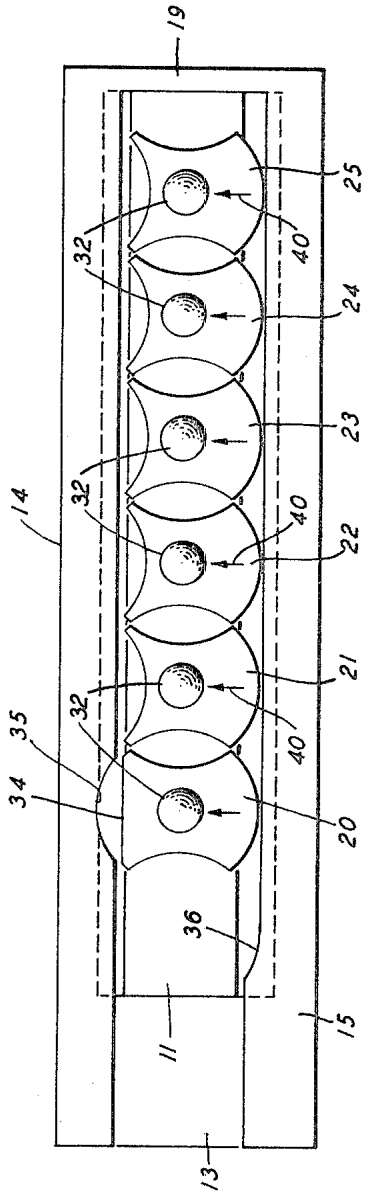


FIG. 3

INVENTOR
WILLIAM KEISTER

BY

ATTORNEY

LOCKING DISC PUZZLE

BACKGROUND OF THE INVENTION

This invention relates to a puzzle and more particularly to such a puzzle wherein various elements are normally locked into a confined location and must be manipulated in a particular order in order to unlock the puzzle or release the elements.

Mathematically various problems can be solved by iterative processes. The well known "do-loop" in the writing of a computer program is an instruction for such an iterative process. A great many individuals can be challenged by a puzzle that requires them to establish the iterative process required for its solution.

When such a puzzle is presented in a physical form, rather than purely as a mathematical speculation, it is more difficult to appreciate the basically mathematical nature of the puzzle. On the other hand, and perhaps for the same reason, the puzzle becomes that much more enjoyable. The ingenuity of past mathematicians and inventors have devised a great many such puzzles, from the Benares rings that must be transferred between three posts to the Chinese rings that must be removed from a support despite the interlocked strings.

It is an object of my invention to provide such a puzzle which is both entertaining and instructive.

It is a further object of my invention to provide a puzzle of the locking element type wherein successive manipulations are required, the manipulations presenting a challenge to the player.

It is a still further object of my invention that the puzzle be of simple but sturdy construction and easily held and manipulated.

SUMMARY OF THE INVENTION

These and other objects of my invention are attained in one specific illustrative embodiment wherein a plurality of discs are mounted on a slide, the discs being so shaped in relation to a frame member in which the slide is positioned as individually to be locked against the frame member unless they are oriented properly. At the same time the discs are so shaped and mounted adjacent each other that a change in orientation can only occur at specific places along the frame and when the adjacent discs are in specific positions. Such a puzzle may be referred to as a locking disc puzzle.

Specifically in this illustrative embodiment the puzzle comprises a base or a frame member having two side members extending up and over the base of the frame so as to define tracks which can receive a slide, much in the manner of a slide rule. The frame member is closed at one end so that the slide can only be slid in, or out, of the frame from the other or open end.

Positioned on the slide are a plurality of discs, all identical except the first one closest the open end of the frame. Each disc has four sides, three of which have a concave or circular segment cut out. The fourth side has a convex segment, the arc of which has the same radius as the concave segments. The discs are positioned adjacent each other so that when a disc can be rotated, the convex segment passes through a concave segment of an adjacent disc.

The discs may also be considered as originally having been circles, with three of the 90° sectors of the circle having a circular segment cut out therefrom of the same radius as the circular disc itself.

Accordingly, the distance between disc centers on the slide is such that a disc is free to rotate or turn if cutout segments face it on adjacent discs. Thus one disc improperly positioned can lock an adjacent disc and prevent it from turning.

The first disc has one straight sector to block rotation of the second disc if this straight sector faces the second disc.

When the slide is placed in the frame, the rotation of the discs is further restricted by the top and bottom rails or side portions of the frame member. A sector is cut from the top rail at a position along the rail so that a disc can only be turned when it is positioned at that top rail sector, and providing the adjacent discs do not lock the disc and also prevent it from turning. The sector in the top rail is also of a radius to match that of the convex or circular sector of the disc.

The bottom rail, however, is also restricted adjacent the open end of the frame member. Advantageously the restriction in the bottom rail is positioned relative to the sector in the top rail such that when a disc is held by the restriction in the bottom rail, the adjacent disc is at the sector in the top rail. The bottom rail is restricted so that a disc can pass by this restriction, and thus allow the slide to be further removed from the frame member, only when the disc is in a horizontal position, i.e., with the curved or convex sector facing along the slide.

The operation of the puzzle and further objects and features of my invention can be better understood from the following detailed description of one specific illustrative embodiment.

DESCRIPTION OF THE DRAWING

FIG. 1 is a top view of one specific illustrative embodiment of a locking disc puzzle in accordance with my invention, the slide being shown with the discs in an intermediate state;

FIG. 2 is a sectional view of the specific embodiment of FIG. 1 along the line 2—2;

FIG. 3 is a diagram indicating the starting position for removing the slide and with hypothetical arrows indicated on each disc to provide a basis for identification of the orientation of the discs in the subsequent description and

FIGS. 4A and 4B show the orientation of the discs as equated to a binary notation.

DETAILED DESCRIPTION

Turning now to FIG. 1, as therein depicted the specific embodiment of my invention illustrated comprises a frame member **10** into which a slide member **11** fits. The frame member **10**, as best seen in FIG. 2, includes a base portion **13**, a top side rail **14**, and a bottom side rail **15**. The two rails extend slightly over the base **13** so as to define tracks **17** into which the slide **11** extends.

The frame member **10** has a closure **19** at one end; the other end is open and slide **11** can be removed from the frame member **10** and the tracks **17** through that open end. Positioned on the slide **11**, however, are a plurality of locking discs **20** through **25**. Except for the first discs **20**, each of the discs is the same. Each disc **21** through **25** may be considered as formed from a circular disc, having, as depicted for disc **23**, one 90° arc **27** of the circumference of the circle of the disc and concave segments **28**, **29**, and **30** cut from the other 90° sectors of the circle of the disc.

Each disc is mounted by a pivot pin **32**, best seen in FIG. 2, on the slide **11**. The distance between the disc centers, i.e., between successive pivot pins **32**, is such that the circular segment **27** directly mates with an adjacent concave segment, **28–30**, the radii being approximately the same. Further the distance between successive pivot pins is such that a disc is free to turn only if cutout segments **28**, **29**, **30** on the adjacent discs are facing that particular disc. Thus a disc whose convex circular segment **27** faces an adjacent disc, locks that adjacent disc and prevents it from turning.

The first disc **20** has one straight sector **34** to block rotation of the second disc **21** if this sector **34** faces the second disc **20**.

As seen in FIG. 1 when the slide **11** is placed in the frame **10**, rotation of any of the discs is further restricted by the top and bottom rails **14** and **15**. However a circular sector **35** is cut from the top rail **14** so that a disc can turn only when it is positioned opposite that sector **35**. The sector **35** again directly matches with the circle of the disc, both in position and radius. The bottom rail **15** is also restricted by a partial sector **36** so that a disc can pass to the left of this point of restriction, that is towards the open end of the frame **10**, only when it is positioned so that the circular convex sector **27** is horizontal.

In this specific illustrative embodiment, when the slide **11** is positioned all the way in the frame **10** so as to be against the closure piece **19**, the first disc **20** is positioned at the cutout sector **35**. More importantly, however, the restriction **36** at the bottom rail **15** is placed so that subsequently when a disc is held against that restriction, the next succeeding disc is opposite the segment or sector **35** in the top rail **14**.

Turning now to FIG. **3**, each of the discs has been assumed to have an arrow **40** thereon. While any of a large number of positions of the discs may be used as a starting point, I have assumed the starting position to be as shown in FIG. **3**. In fact, however, by using different disc orientations as the starting orientation, a degree of confusion can be created in the mind of one who does not appreciate how the puzzle is solved. With the starting position as shown in FIG. **3**, all of the discs are oriented the same way, with the arrows **40** pointing upward. In this state the slide **11** may be positioned so that either the first disc **20** or the second disc **21** may be rotated. By an iterative process of rotating the proper discs in the proper sequence, as described further below, the discs may be aligned so that all of the arrows **40** point to the left and the slide completely removed from the base.

It may be pointed out that if the first disc **20** did not have a straight sector **34** which prevents any rotation when it is towards the next adjacent disc **21**, then it would be possible simply to align the disc **20** so that its arrow could be considered as pointed down along the slide **11** and then rotate each disc successively.

The number of rotations or moves required to go from the starting position assumed in FIG **3** to the proper positions of the discs to allow removal of the slide **11** depends on the number of the discs on the slide. If we define the rotation of a disc through a quarter turn, either clockwise or counterclockwise, as one "move" and if we assume that there are n discs on the slide **11**, then it can be shown that the minimum number of moves for a solution is as follows: for n, even, then minimum moves $=(2^{n+1}-2)/3$

for n, odd, then minimum moves $=(2^{n+1}-2)/3$.

For the specific illustrative embodiment shown in the drawing wherein six discs are mounted on the slide **11**, the minimum number of moves is **42**. Seven discs require 85 moves and eight discs require 170 moves.

The possible moves are set forth below. Turning to FIG. **4**, I there define the binary bit "0" to represent a horizontal disc, as shown in FIG. **4A**, and the binary bit "1" to represent a vertical disc, as shown in FIG. **4B**. To insert a slide **11** into the frame **10**, one starts with all of the discs in the horizontal position, represented by the binary notation 000000. All possible moves, in succession, are therefore given by the following table I; it is to be noted that the assumed starting position, FIG. **3**, is indicated in table I by the underlined notation.

TABLE I

000000
100000
110000
010000
011000
111000
101000
001000
001100
101100
111100
011100
010100
110100
100100
000100
000110
100110
110110
010110
011110
111110
101110
001110
001010
101010
111010
011010
010010
110010
100010
000010
000011
100011
110011
010011
011011
111011
101011
001011
001111
101111
111111
011111
010111
110111
100111
000111
000101
100101
110101
010101
011101
111101
101101
001101
001001
101001
111001
011001
010001
110001
100001
000001

If we assume the puzzle to have been placed in the starting position by FIG. **3**, then the **42** moves required to remove the slide are those given in the following table II:

TABLE II

111111
101111
001111
001011
101011
111011
011011
010011
110011
100011
000011
000010
100010
110010
010010
011010
111010
101010
001010
001110
101110
111110
011110
010110
110110
100110
000110

000100
100100
110100
010100
011100
111100
101100
001100
001000
101000
111000
011000
010000
110000
100000
000000

The various parts of this puzzle may be made of any of many materials. In this specific embodiment depicted I have formed the puzzle of wood, which gives the puzzle a particularly pleasant appearance. However various hard plastics, as known in the art, could be employed to lower the cost of manufacture of the puzzle.

It is to be understood that the above-described arrangements are merely illustrative of the application of the principles of my invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of my invention. Thus in the embodiment depicted it can be noted, by reference to table I, that one must go through a substantial number of manipulations of the discs to insert the slide **11** into the frame **10** and have it assume the starting position depicted in FIG. **3**. Accordingly, if desired, an alternative construction in another embodiment may provide a means for quickly inserting the slide and restoring the puzzle to the initial state. In this embodiment the end closure **19** is removed and the frame **10** is thus open at both ends. However a longitudinal slot with both ends closed is cut in the bottom of the slide **11**. A spring-loaded pawl is inset in the base **13** adjacent the sector **35** and midway between the top and bottom rails **14** and **15**; the pawl is positioned accordingly to be in line with the slot in the bottom of the slide **11**. The direction of the pawl is such that the closure at the ends of the slot will pass over it from right to left, i.e., from the priorly closed end **19** of the frame to the open end, but not in the opposite direction. With the slide **11** removed from the frame **10**, the discs are easily positioned to the starting position, FIG. **3**; the slide may then be inserted from the closed end until the pawl clicks into the slot. The pawl rides freely in the slot for the slide motions necessary to solve the puzzle but prevents removal of the slide from the right.

In a further embodiment of my invention, some or all of the discs may be removable from the slide **11**. Thus one may start learning how to solve the puzzle with a simple slide having only four discs on it directly adjacent each other and then may progress to harder puzzles, such as those with **7**, **8** or more discs. For such an embodiment the frame member should be long enough to accommodate the increased length of the slide that may be required for the larger number of discs. Obviously, the first disc **20** should not be removed and may, in fact be permanently on the slide. The variation in the number of discs should be attained by removing or adding discs at the other end of the line of discs.

What is claimed is:

1. A locking disc puzzle comprising a frame member having an upper and a lower side rail,

a slide slidable in said frame,

a plurality of discs pivotally mounted in a row on said slide member, each of said discs having a convex segment and a plurality of matching concave segments, said discs being positioned adjacent each other so that the convex segment of one disc can fit into the concave segment of an adjacent disc to allow rotation of said one disc, and

said slide being positioned in said frame such that at least one of said rails prevents rotation of said discs, said one rail having a concave segment at one point mating with a convex segment on said discs so that a disc can pivot adjacent said one rail concave segment if the two adjacent discs have concave segments towards said pivoting disc.

2. A locking disc puzzle in accordance with claim **1** wherein each of said discs, except said first, has a 90° convex circular sector and three 90° concave circular sectors.

3. A locking disc puzzle in accordance with claim **2** wherein said frame member further includes means for preventing passage of said slide out one end thereof.

4. A locking disc puzzle in accordance with claim **3** wherein the other of said side rails has a restricted portion adjacent the end of said frame member opposite said one end, said restricted portion preventing motion of said slide member when a disc has its convex segment directed toward said other side rail.

5. A locking disc puzzle in accordance with claim **4** wherein said side rails extend partially over said slide.

6. A locking disc puzzle in accordance with claim **4** wherein said concave segment in said one said rail is positioned relative to said restricted portion of said other side rail such that when a disc is against said restricted portion of said other side rail the adjacent disc on said slide is adjacent said one side rail concave portion.

7. A locking disc puzzle in accordance with claim **6** wherein said first disc has a convex circular segment, two concave circular segments, and a flat segment opposite said convex circular segment.

8. A locking disc puzzle comprising a frame having an upper and lower side rail extending over a base,

a slide positionable on said base and under said side rails,

means for preventing passage of said slide out one end of said frame, and

means including a plurality of discs pivotally mounted on said slide for preventing passage of said slide out the other end of said frame unless said discs are oriented in a particular way, each of said discs comprising a circle having four 90° sectors, three of said 90° sectors being concavely cut out in each of said discs except the first said discs being positioned adjacent each other and said sectors having radii such that a disc can only pivot when the two adjacent discs have their cutout sectors facing said pivoting disc,

said upper side rail including a similar cutout sector, a disc being able to pivot only when adjacent said upper side rail cutout sector, and

said lower side rail having a restricted portion adjacent the other end of said frame, said lower side rail restriction and said upper side rail cutout sector being relative to each other such that when a disc is held against said lower side rail restricted position the adjacent disc is in position to pivot in said upper side rail cutout sector.

9. A locking disc puzzle in accordance with claim **8** wherein the first of said discs adjacent said other end has two concave cutouts and a flat segment opposite its uncut 90° circular sector.

* * * * *