United States Patent

Marotte

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[54] COMBINATION LOCK

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[21] Appl. No.: **58,966**

[30] **Foreign Application Priority Data**

July 28, 1969 Australia 58694/69

[52] **U.S. Cl.** **70/299,** 70/DIG. 49

[51] **Int. Cl.**.....**E05b 37/00**

[58] **Field of Search**.....70/299, 297, 287, 288, 300, 70/133

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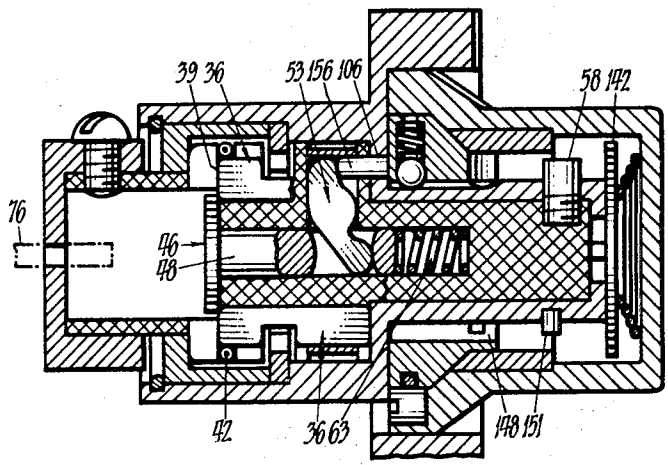
Primary Examiner—Albert G. Craig, Jr.

Attorney—Waters, Roditi, Schwartz & Nissen

[57] **ABSTRACT**

A combination lock having a rotor, mounted in a casing, and which carries locking elements arranged in lengthwise extending slots on the outer surface thereof, the locking elements each being manipulatable, by suitable mechanism, to cause movement between first and second longitudinally spaced dispositions, each element in one disposition precluding rotation of the rotor by engagement with an abutment on the internal surface of the casing and in the other disposition clearing the abutment so as not to preclude rotation, the rotation precluding condition for some elements normally corresponding to one disposition, and for others normally corresponding to the second disposition.

16 Claims, 20 Drawing Figures



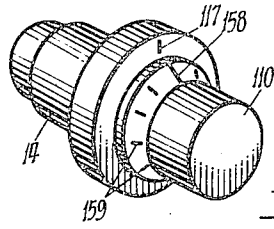


FIG. 1

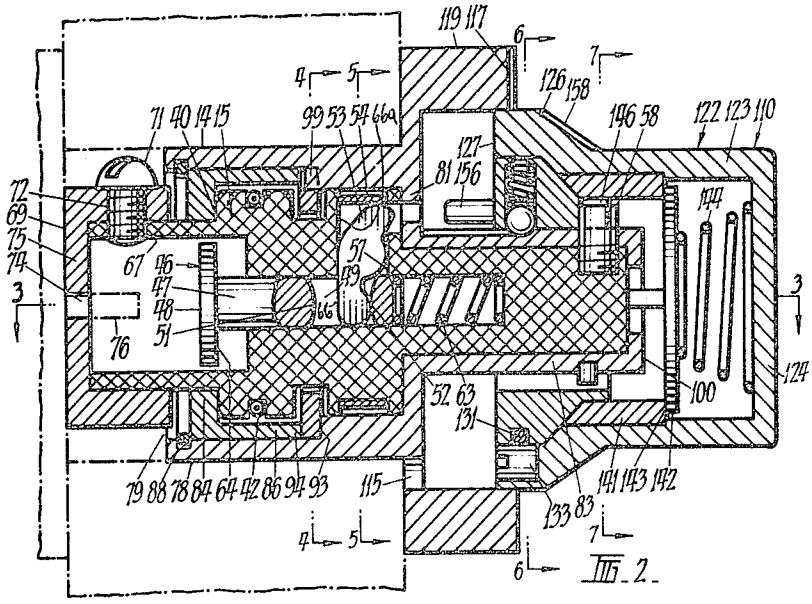


FIG. 2

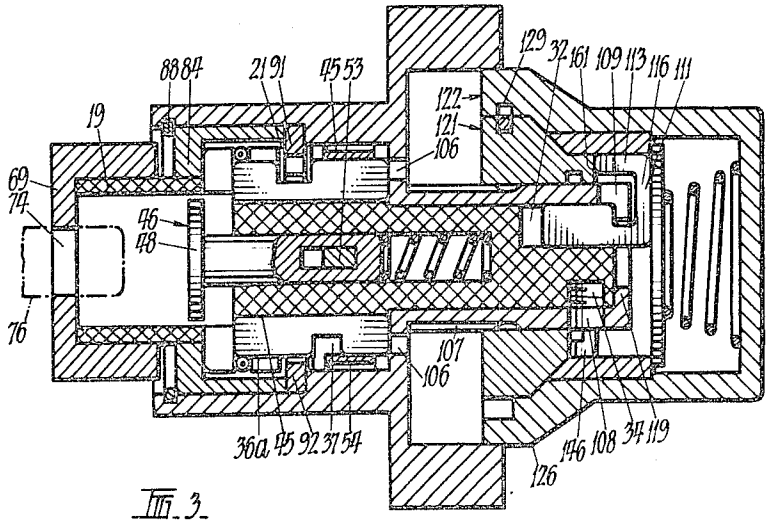


FIG. 3

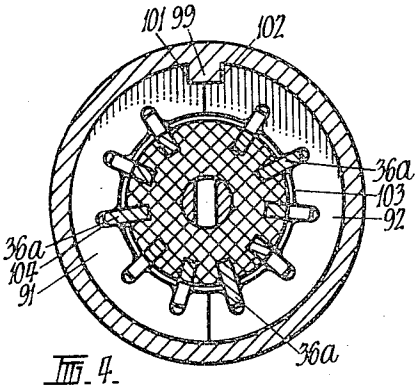


Fig. 4.

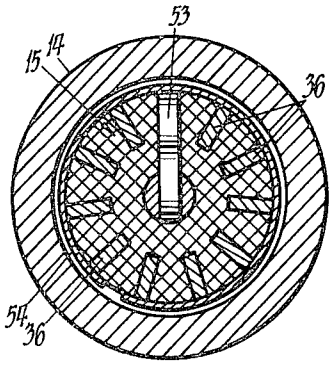


Fig. 5.

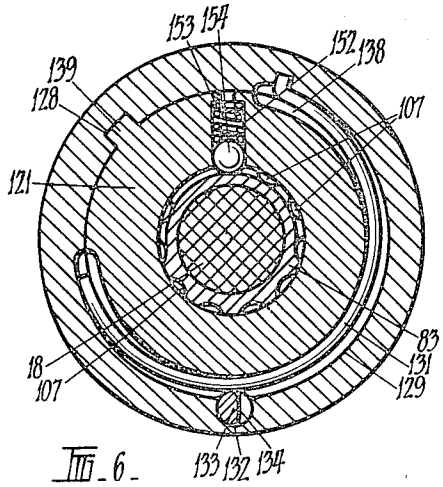


Fig. 6.

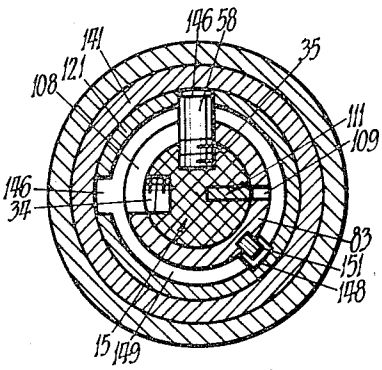


Fig. 7.

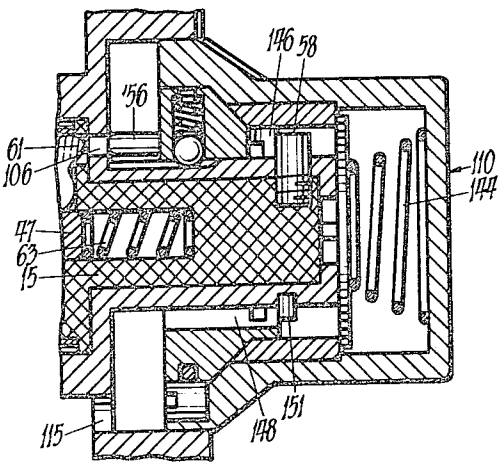


Fig. 8.

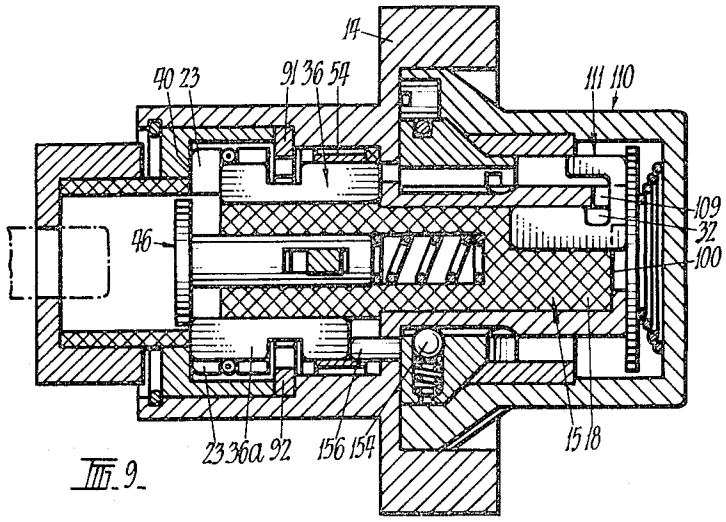


FIG. 9

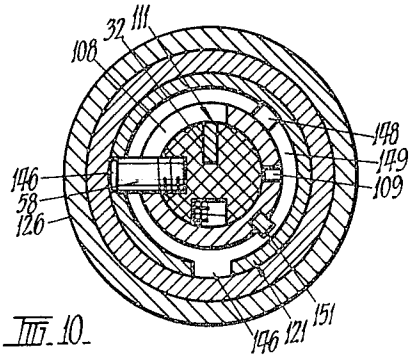


FIG. 10

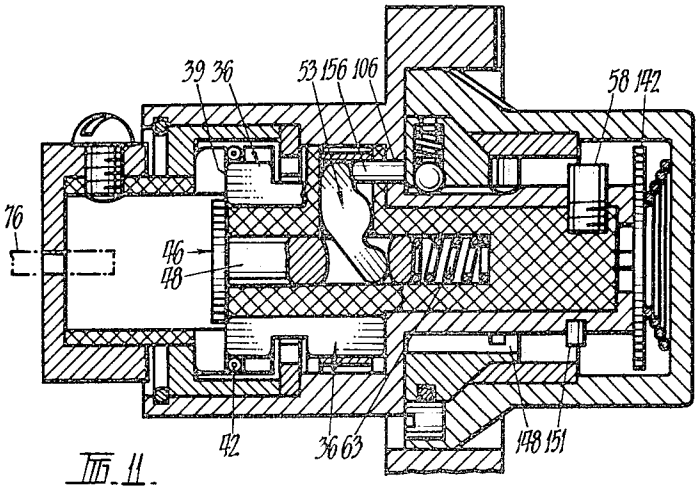


FIG. 11

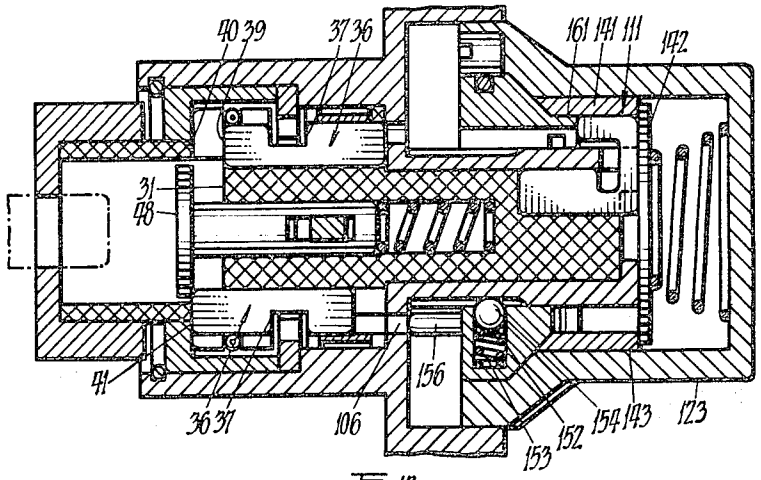


FIG. 12

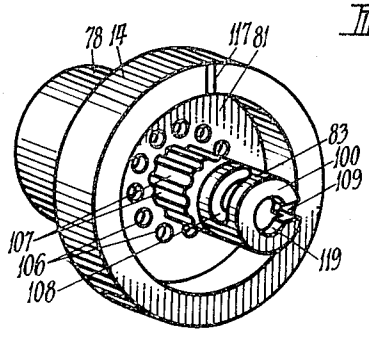


FIG. 13

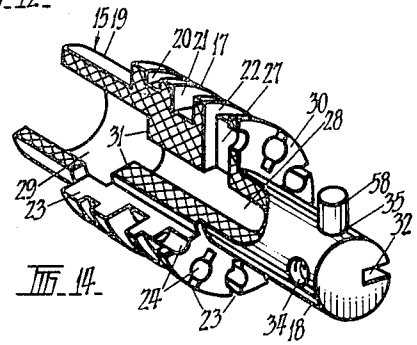


FIG. 14

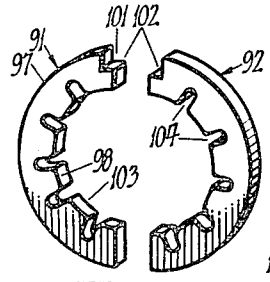


FIG. 15

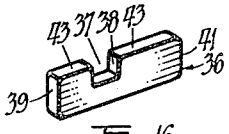


FIG. 16

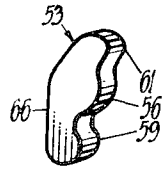


FIG. 19

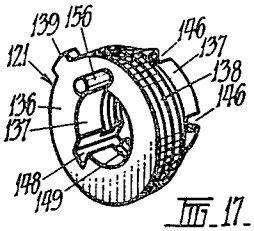


FIG. 17

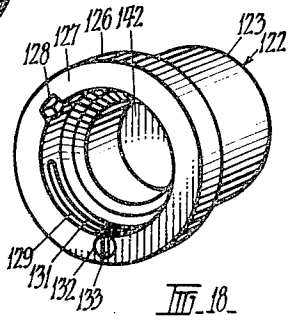


FIG. 18

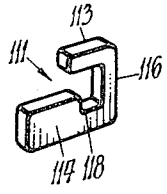


FIG. 20

COMBINATION LOCK

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to combination locks.

2. Description of the Prior Art

It is well known that combination locks possess a number of advantages over the more commonly used domestic types of lock, not the least of which is that no difficulties can arise through lost keys. However, since efficient combination locks have hitherto been relatively complicated and expensive it has not been customary to use combination locks for ordinary domestic purposes.

It is an object of the invention to provide an improved combination lock which is of comparatively simple construction and which may be manufactured relatively cheaply so as to render practicable its use in domestic applications.

Aside from the above-mentioned cost and complexity of the common combination locks, many of these offer the further disadvantage that it is possible to detect when the individual locking elements are released because of noises made during release. It is possible for a skilled person to open these locks by manipulating the locking mechanism and listening for the operation of the locking elements. Another object of the invention is therefore to provide a lock which may be easily arranged to at least substantially eliminate this drawback.

BRIEF SUMMARY OF THE INVENTION

In accordance with this invention the above objects are attained by a lock construction in which the locking elements are slidable between locked and unlocked positions. Specifically the invention provides a combination lock having a casing structure, a rotor mounted for rotation within said structure, a plurality of locking elements carried by one of said rotor and casing structure and actuating means, said locking elements each being slidable between first and second locations and each, in one of these locations, preventing substantial rotation of said rotor within said casing structure and in the other location not precluding such rotation, said actuating means being operable to move said elements or any selected one or more thereof one by one from the first location to the second location.

Normally the locking elements are carried by the rotor. The locking elements preferably cooperate, in the rotation precluding condition, with abutments on that one of the rotor and casing structure which does not carry the locking elements.

The above described lock construction is relatively simple and the movement of each locking element, effected by the said actuating means, may be arranged to be the same regardless of whether the elements are being moved into or out of a locking position, so that it is not possible to detect audibly the result of any such movement of the element.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

FIG. 1 is a perspective view of a lock constructed in accordance with the invention;

FIG. 2 is a longitudinal cross-section of the lock shown in FIG. 1, the lock being shown in the condition in which the rotor is free;

FIG. 3 is a longitudinal cross-section of the line 3—3 of FIG. 2;

FIG. 4 is a transverse cross-section on the line 4—4 of FIG. 2;

FIG. 5 is a transverse cross-section on the line 5—5 of FIG. 2;

FIG. 6 is a transverse cross-section on the line 6—6 of FIG. 2;

FIG. 7 is a transverse cross-section on the line 7—7 of FIG. 2;

FIG. 8 is a fragmentary cross-section corresponding to FIG. 2 but illustrating the position of the knob immediately before the dialing operation;

FIG. 9 is a cross-section corresponding to FIG. 2 but showing the manner in which shifting of the locking elements is accomplished;

FIG. 10 is a cross-section corresponding to FIG. 7 but illustrating the position of the knob when it is turned to operate the latch;

FIG. 11 is a transverse cross-section corresponding to FIG. 2 but illustrating the manner in which resetting of the lock is accomplished;

FIG. 12 is a longitudinal cross-section corresponding to FIG. 3 but illustrating the lock in a condition in which the rotor is freed but has not been actuated;

FIG. 13 is a perspective view of the casing of the lock shown in FIG. 1;

FIG. 14 is a perspective view of a rotor incorporated in the lock shown in FIG. 1 partly broken away to illustrate the interior;

FIG. 15 is a perspective view of a pair of abutment members incorporated in the lock shown in FIG. 1;

FIG. 16 is a perspective view of a locking element incorporated in the lock shown in FIG. 1;

FIG. 17 is a perspective view of portion of the knob assembly of the lock shown in FIG. 1;

FIG. 18 is a perspective view of another part of the knob assembly incorporated in the lock shown in FIG. 1;

FIG. 19 is a perspective view of a lever element incorporated in the rotor of the lock of FIG. 1;

FIG. 20 is a perspective view of a catch member incorporated in the lock shown in FIG. 1.

DETAILED DESCRIPTION

The lock shown comprises a casing **14** within which is located a rotor structure **15**. The lock **14** has an actuating knob **110** at one end. This end is, in the ensuing description, referred to as the "forward" end of the lock and any usage in this description, or in the appended claims, of "forward" or "rearward" or like positional terms is to be construed accordingly. It is to be understood that this usage is merely to simplify terminology and is not to be construed as limiting.

Rotor structure **15** is illustrated in FIG. **14**. It comprises an intermediate, generally cylindrical, part **17** from one end of which extends an integral shaft **18**. A skirt portion **19** of annular cross-section extends rearwardly from the other end of part **17**. Three peripheral grooves **20, 21, 22** are provided in the outer surface of part **17** and a plurality of slots **23** extend lengthwise thereof. Each slot extends radially and is of generally rectangular in cross-section.

Portions of the slots at the forward end of part **17** are enlarged by circular bores **24**. There are, in the present embodiment **11** equi-spaced circular bores **24** but only 10 slots **23**. The bore **24** which is not associated with a slot **23**, instead, leads into another radially extending slot **27** in intermediate part **17**. Slot **27** is different in configuration to slot **23** and extends inwardly from the outer surface of portion **17**. A bore **28** extends coaxially within the rotor and slot **27** extends into this. Bore **28** is enlarged at its rearmost end to define the inner surface of skirt **19**.

The slots **23** extend over the whole longitudinal length of part **17**, and the enlarged portion **29** of bore **28** also extends into these, so that a shoulder **31**, at the plane of disjunction between the narrower and enlarged portions of bore **28**, is spaced a short distance forwardly of the rear end of the slots.

Shaft **18** is provided with a slot **32** at its forward end. This slot is generally rectangular in transverse cross-section and extends radially of the shaft. Shaft **18** is also provided with two radial bores **34, 35**. These are tapped and a pin **58** is threadably engaged in one of them. As is best seen from FIG. **7** the axes of the two bores **34, 35** are displaced 90° from each other. The purposes of these bores, and of pin **58** are detailed hereinafter.

Within each slot **23** is a separate locking element **36**. The locking elements are all of identical form and one is illustrated in FIG. **16**. Each is of elongate rectangular form and is pro-

vided with a cut out portion 37 which extends from one edge face of the element. The side wall 38 of this cut out portion is disposed midway between the two end faces 39, 41 of the element and the elements are placed within the slots 23 with the cut out portions 37 facing outwardly and with either a face 41 or a face 39 disposed towards the forward face 30 of part 17 on rotor 15.

The selection of which ends 39 or 41 of the various members are disposed towards face 30 is determined by the lock "-combination" as is hereinafter described. The elements 36 are each slidable axially of the length of rotor 15 and are retained within the rotor by means of a circular helical spring 42 which is housed in groove 20 in rotor 15. This spring bears lightly against the outer edge faces 43 of the elements 36.

The elements are of lesser length than the length of slots 23 and are movable between two lengthwise displaced positions (see FIG. 12 for example). In one of these positions those faces of the elements which are to the rear of the lock abut against the rear end face 40 of the slots 23. In the other position the rearmost faces are aligned in the plane of the shoulder 31 on rotor 15. The cut out portions 37 are aligned with the centrally placed groove 21 on part 17 in either one of the two lengthwise displaced positions depending upon the specific orientation of the elements 36 in their slots. In particular, each of the elements 36 which is arranged with its face 39 to the rear will have its cut out portion 37 aligned with groove 21 when it is in a forward displaced position, illustrated for example by the upper element in FIG. 12. On the other hand, each of the elements 36 which has its face 41 to the rear will have its cut out portion 37 aligned with groove 21 when it is in a rearmost position as illustrated by the lower element 36 shown in FIG. 12.

A resetting member 46 is mounted within rotor 15. It comprises a first cylindrical shaft portion 47 which is engaged within bore 28 and an enlarged head 48 of circular cross-section. Head 48 is of somewhat lesser diameter than the interior diameter of skirt portion 19 but of greater radius than the distance between the innermost radial faces 45 of the slots 23 and the axis of the rotor. The shaft portion 47 of member 46 is provided with an aperture 49 which extends diametrically therethrough. Aperture 49 is of rectangular transverse cross-section but the side walls 51, 52 are convex. An actuating lever 53 is mounted within slot 27 in rotor 15 and extends into aperture 49. It is retained in position by means of a flat circular spring clip 54 mounted in groove 22 on rotor 15.

Lever 53 is provided with a portion 56 which engages a forward side face 57 of aperture 49 so that the lever is pivotal about the point of contact. The lower end 59 of the lever bears against face 52 of aperture 49. The other end 61 of the lever projects forward slightly into the bore 24 associated with slot 27. A helical compression spring 63 is housed within bore 28 and bears against the end of shaft 47 and the end face of the bore. This spring biases member 46 to a position where the forward face 64 of head portion 48 is slightly rearwardly disposed relative to the plane defining the end faces 40 of slots 23. The extreme rearward position of this movement is established by engagement of a flat face 66 of lever 53 with the rearwardly disposed face 66*a* of slot 2. It will be appreciated that it is possible, by pressing against the end portion 61 of lever 53, to move member 46 against the bias of spring 53 to shift the head 48 of member 46 so that the face 64 thereof engages any element 36 disposed so as to project rearwardly of shoulder 31, to move such member to its forward position.

Skirt 19 on rotor 15 is provided with a radial tapped bore 67 and an end cap 69 of generally cup-shaped configuration is secured to skirt 19, so as to close the end thereof. The securement is effected by means of a screw 71 which passes through an opening 72 in the side wall of the cap and which is engaged in tapped bore 67. Cap 69 is provided with a slot 74 in the transverse wall 75 thereof. Slot 74 is centrally disposed in the wall and is of elongate rectangular form, extending generally radially of the axis of rotor 15. A latch actuating member 76, which is indicated generally by dotted lines, is mounted in the slot 74 for rotation together with rotor 15. It is however movable axially within the slot.

The body portion 14 includes a generally cylindrical barrel part 78 which has an open rear end 79. The intermediate part 17 of rotor 15 is retained within barrel part 78 and the rotor 15 is supported at one end by engagement of shaft 18 in a bearing 83 and at the other end by engagement of the skirt portion 19 in a bearing 84 provided on a bearing member 86 mounted within barrel 78. Bearing member 86 is of generally cup-shaped configuration and is removably held in position by means of a circular spring clip retained in an annular groove 88 on the inner surface of barrel portion 78.

A pair of abutment members 91, 92 are held in position within barrel 78, being held between a step 93 on the interior of the barrel and marginal edge portion 94 of bearing member 86. These abutment members are of complementary form and are shown in detail in FIG. 15. Each has a semi-circular outer surface 97 and a semi-circular internal surface 98. When the two members are assembled together (FIG. 4) they are located positively within the barrel 78 by means of a rib 99 on the interior of the barrel which engages a recess 101 defined by two adjacent cut out portions 102 on the members. The interior surfaces 98 of the two members 91, 92 together define a circular opening 103 through which the intermediate portion 17 of the rotor passes. This circular opening is of only slightly greater diameter than the internal diameter of portion 17 at groove 21 and abutment members 91, 92 project into groove 21. Each abutment member 91, 92 is provided with five notches 104 in surface 98 and these are disposed so that when the two members are mounted in position the notches are disposed at 10 of 11 equi-angularly disposed positions. The positions thus correspond to the positions of the 10 elements 36.

As will be apparent from a consideration of FIGS. 2, 3, and 4 for example, the dispositions of the abutment members 91, 92 is such that the rotor may be prevented from rotation, by engagement of any element 36 with the side walls of an associated notch 104, whenever that element is in a lengthwise position such that the cut out portion 37 therein is not aligned with the members 91, 92 and groove 21. However when such element is moved to its other lengthwise position the cut out portion 37 thereon will be aligned with the groove 21 and members 91, 92 and rotation of the rotor will not be prevented by that element.

The transverse wall 81 on lock body 14 is provided with 11 equi-spaced circular apertures 106. These are axially aligned respectively with the adjacent ends of the elements 36 and with the end 61 of lever 53.

The exterior surface of bearing 83 is provided with a series of 11 lengthwise extending grooves 107 these being radially aligned with the respective apertures 106. The purpose of these grooves is described hereinafter. The forward end of bearing 83 is provided with an elongate part-circumferential slot 108 and pin 58 on rotor 15 is engaged within this slot. The length of the slot is such as to limit the rotation of rotor 15 to extreme positions approximately 90° apart.

The forward end of bearing 83 is provided with a slot 109 which extends rearwardly and inwardly from the end face 100 thereof. A locking member 111 is engageable in this slot and in the slot 32 in rotor 15. Locking member 111 is illustrated in FIG. 20. It is of generally hook-shaped configuration comprising a pair of limbs 113, 114 which extend generally parallel to each other an which are connected by a bridge 116. Limb 114 is longer than limb 113 and is enlarged at its free end, the root portion of limb 114 being cut away as indicated by reference numeral 118 to define a reduced section portion. Member 111 is slidable in slot 109 to a position (FIG. 8 for example) in which the bridge portion 116 is engaged within the two slots 32 and 109 to lock the rotor to the body. This locked position corresponds to a position in which the pin 58 is at the extreme clockwise extent of its allowed movement in slot 108 and in which that bore 24 in rotor 15 into which lever 53 is engaged

is aligned with one of the apertures **106**. The latter aperture **106** is identified by a mark **117** on a forwardly extending annular flange portion **119** of transverse wall **81** on body **14**.

The locking member **111** is movable forwardly from the position in which it locks the rotor to a position in which the bridge portion **116** is no longer engaged within slot **32**, thereby freeing the rotor for rotation. The forward end of bearing **83** is provided with an inwardly projecting lip **119** and, in the last mentioned position of member **111**, the cut out portion **118** accommodates this lip to enable the rotor to turn. This last condition is illustrated in FIG. **2** for example.

Knob structure **110** comprises two interconnected parts **121** and **122** which are illustrated respectively in FIGS. **17** and **18**. Part **122** is of generally cup shaped configuration, having a cylindrical wall **123**, closed at one end by a transverse wall **124**, and an outwardly flared skirt portion **126** extending from the other end of wall **123**. The transverse end face **127** of flared skirt portion **126** is provided with a notch **128** which extends to the inner surface of the skirt. The internal surface of the skirt is also provided with a part-circumferential groove **129** within which is housed a circular spring clip **131** (FIG. **6**). A tapped hole **132** is provided in the end surface **127**, this being arranged so that it communicates, along a side portion thereof, with the inside surface of skirt **126**. The hole **132** is disposed at a position generally intermediate the ends of spring clip **131**. A rotatable slotted member **133** is received in tapped hole **132**. Member **133** has a flat longitudinal surface **134** so that, depending upon the rotational position of the member in hole **132**, the degree of projection of the side thereof into the the interior of part **122** may be varied. When the member extends into the interior, it bears against spring clip **131** to move the spring clip partially out of groove **129**.

Part **121** of knob **110** comprises two integral generally annular parts **136**, **137** having a common internal diameter but defining a stepped outer diameter. The internal surface is defined by a bore **137** which receives bearing **83**. There is provided on the external surface of portion **136**, a part circumferential groove **138** and also a radially extending projection **139** of complementary configuration to the notch **128** in part **122**.

Part **121** is locatable within part **122** and relative rotation of the two members is prevented by interengagement of projection **139** and notch **128**. The parts are secured together by turning screw **132** to force spring **131** radially inwardly at a point intermediate its ends, so that it is partially engaged within both grooves **138** and **129**. This may be effected, after the two parts have been positioned together on bearing **83**, by inserting a screw driver through a hole **115** in transverse wall **81** of body **14**.

The reduced diameter portion of portion **137** extends within cylindrical portion **123** of part **122** but in spaced relation thereto.

A sleeve **141** of generally cylindrical form is interposed between portions **137** and **123**. A disc **142** is mounted within cylindrical part **123** and is resiliently biased in a rearward direction by a helical compression spring **144** interposed between the disc and the end wall **124** of knob part **122**. The disc **142** is normally resiliently biased against the forward end surface **100** of bearing **83** but is movable away from this surface by axial forward movement of knob **110** so that the end surface **143** of sleeve **141** engages the disc.

Part **121** of knob **110** is provided with two radially extending notches **146** in the forward faces thereof. The axes of these are disposed 90° apart and are of complementary form to the outer surface of pin **58** so that, by manipulation of knob **110**, pin **58** may be received in one of these notches **146** to couple knob **110** and rotor **15** together for rotation.

The interior bore **137** of part **121** is provided with a longitudinally extending slot **148** which extends from end to end thereof, and with an annular slot **149** which communicates with slot **148**. As will be apparent from FIG. **7**, bearing **83** is provided with a pin **151** on its external surface. This pin is engageable within slots **148** and **149** by appropriate longitudinal and rotational manipulation of knob **110** on bearing **83**. Part **122** of knob **110** is provided on its rearward internal surface with a radial bore **152** (FIG. **12**) within which is retained a ball **154**. Ball **154** is biased, by means of a spring **153** also in bore **152**, radially against the outer surface of bearing **83**. Ball **154** acts as a locating member which selectively allows rotation of knob **110** to preferred positions corresponding to location of ball **154** in grooves **107** on bearing **83**. When the ball is located in a groove **107** knob **110** is guided for longitudinal movement in the groove and axially of the lock.

The rear face **136** of part **121** of knob **110** is provided with a pin **156** which pin is, when ball **154** is engaged in a groove **107**, aligned with an aperture **106** in transverse wall **81**. The location of this pin is indicated by a mark **158** on the external portion of knob **110**. By rotating knob **110** to each of the preferred positions established by engagement of ball **154** within the separate slots **107** the pin **156** is alignable with each of the separate apertures **106**. The positions of knob **110** relative to mark **117** on body **14** and corresponding to each of these positions are indicated by marks **159** on knob **110**.

It will be seen that, by moving knob **110** rearwardly at any of its established rotational positions pin **156** may enter aperture **106** to extend into that bore **24** in rotor **15** which is aligned therewith, to move the associated element **36** from its forward to its rearward position and also, at one rotational position, to engage lever **53** to move resetting member **46** to engage the elements and push them from the rearward to forward positions.

The operation of the lock will now be described.

FIGS. **2** and **3** show the lock in its closed condition with knob **110** been moved forward axially to clear the locking member **111** from slots **32** and **109**. This movement is accomplished by engagement of the forward annular face **161** on part **121** with the free end of arm **113** of locking member **111**. Thus, as the knob reaches the forward extremity of the movement and, as engagement of pin **58** in notch **146** occurs, the bridge part **116** of the locking member is freed of the slots **32** and **109**. Despite this removal of member **111**, the rotor cannot be turned relative to body **14** because certain elements **36** are positioned such that the cut out portions **37** thereof are not arranged at the axial position of abutment members **91**, **92**. These elements are indicated, in FIG. **4**, by reference numerals **36*a***.

Assigning the numeral 0 to that rotational portion of knob **110** at which marks **117** and **158** are aligned, and numerals 1 to 10 respectively to the successive progressive anticlockwise rotational positions of knob **110** at which the separate marks **159** are aligned with mark **117**, the positions of elements **36*a*** correspond to position 2, 5, and 8 respectively.

To open the lock it is necessary to rotate rotor **15** to thereby rotate latch actuating member **76** axially through an angle of approximately 90°. To do this it is clear that what is required is to first shift the elements **36*a*** from their forward positions to the rear positions to align the slots **37** with the abutments **91**, **92**. This is done by first moving knob **110** rearwardly to position the knob for "dialing" (FIG. **8**), and then rotating knob **110** successively to each of the positions 2, 5, and 8 and, at each position, moving the knob rearwardly so that the pin **156** passes through the adjacent aperture **106** to engage the associated element **36*a*** and push it rearwardly until the rearmost face of that element abuts against the seat surface **40** of the associated slot **23** (FIG. **9**).

The movement of the knob **110** from the position shown in FIG. **3** to the dialing position, shown in FIG. **8**, can only be accomplished when the knob is at its 0 position, since it is only at this position that the pin **151** is aligned with groove **148**. If rearward movement is attempted at other rotational positions, the pin **151** will abut against the groove **149** thereby preventing the movement.

At the dialing position of knob **110** free rotation of the knob is possible because pin **151** is clear of both slots **148** and **149**.

The order in which the three elements **36*a*** are moved by the dialing operation is not important but it is important that only

these elements be shifted since, if one of the elements **36** positioned at the other locations is moved, the effect will be to shift this slot **37** thereon out of alignment with abutment members **91, 92** thereby preventing subsequent rotation of rotor **15** by virtue of engagement of the element with the side walls of one of the notches **104**.

Once having shifted the required locking elements, knob **110** is rotated to align marks **117** and **158**. This alignment ensures that pin **151** is adjacent slot **148** as been shown in FIG. **12**. The knob may then be withdrawn so that pin **58** is engaged in a recess **146** and pin **151** enters slot **148**. This occurs in the same manner as is shown in FIGS. **2** and **3**. During this movement, the rotor is also unlocked by withdrawal of locking member **111** as previously described. At the position of full engagement of pin **58** and recess **146**, pin **151** is aligned with circumferential groove **149** so that the knob **110** may then be rotated (as best shown in FIG. **10**) in a counterclockwise direction when viewed from the front to cause corresponding rotation of rotor **15** and of latch actuating member **76**. During this movement pin **151** moves in groove **149** and pin **58** moves in slot **108**, between the extremities thereof. The latch actuating member **76** may be connected to a suitable latch mechanism which is actuated by the movement thereof.

To reset the lock, knob **110** is turned to the 0 position, in which pin **151** is again aligned with slot **148**, by turning the rotor back to the position it occupied before rotation thereof and aligning pin **156** with that aperture **106** which is aligned with lever **53**. The knob is then pushed forwardly so that pin **156** engages end **61** of lever **53** so as to force resetting member **46** forwardly of the lock against spring **63** so that the head of the actuating member engages the rear faces of the various locking elements to position them at their forward positions thereby locking the rotor. This operation is illustrated in FIG. **11**.

The described lock is designed to prevent the lock from reaching certain undesired conditions due to improper manipulation, and the means whereby this result is achieved is now described. It will be noted from FIG. **10**, for example, that once the engagement of pin **58** with recess **146** has taken place, and the knob is turned, the knob cannot be moved in a rearward direction because of engagement of the pin **151** in groove **149**. Thus, once the rotor has been freed, and turned, it is not possible to engage pin **156** through an aperture **106** without first returning the knob to the 0 position in which marks **117** and **158** are aligned, i.e., the position in which pin **151** is again within groove **148**. Whenever pin **151** is within groove **149**, the knob and rotor are locked together for rotation together and lengthwise reciprocation of knob **110** is precluded. If groove **149** and pin **151** were not provided, it would be possible for the rotor, once having been freed and turned by knob **110**, to be held in that turned position and, when the knob was returned to its 0 position and the resetting maneuver completed, instead of lever **53** being operated, one of the elements **36** would instead be moved thus locking the rotor in its open position. It would be difficult to free the rotor from this condition since the normal lock "combination" 2, 5, 8 would not suffice to unlock it.

While the above arrangement ensures that rotor **15** is always returned to its 0 position immediately before the resetting operation can be carried out it does not ensure that the rotor will be in this 0 position when the maneuver is carried out. There remains still the possibility that the rotor could again be turned back after disengagement of the pin **58** from recess **146** but immediately before the resetting operation was carried out. Locking element **111** avoids this difficulty since it operates to lock the rotor in the 0 position when it is returned to that position by knob **110**. That is, as soon as pin **151** leaves groove **149**, the rotor is locked by engagement of the locking member. The pin **151** and member **111**, together with their cooperating grooves and slots thus provide protection against improper use of the lock; particularly against rotational manipulation of the latch actuating member otherwise than in consequence of movement of knob **110**.

The lock may be used to operate a spring loaded latch arrangement in which case the rotor **15** would normally be returned to its 0 position after actuation of the latch. This is not essential however.

Resetting of the lock can, in the present embodiment, be accomplished by manipulation of latch actuating member **76**. That is to say, by pushing the latch axially forwardly it can be arranged to bear against resetting member **46** to effect resetting.

The lock, in the form described, is arranged for anticlockwise unlatching movement of latch actuating member **76**. However, the lock can easily be adapted to clockwise movement by removing pin **58** from the bore **35** in which it is shown engaged and inserting it in the bore **34**.

The "combination" of the lock may be altered at will merely by reversing the longitudinal orientation of desired elements **36**.

A particular advantage of the lock is that it is possible to incorporate into it an alarm system to enable an indication to be given when the lock is tampered with. To do this, an electric switch is secured within rotor **15**. The switch is arranged to be actuated by rotor **15** when it moves resetting member **46** to reset the lock. The switch is connected into an electric circuit so that operation thereof causes a suitable alarm indication, such as the ringing of a bell.

Now, if even a single element **36** of the lock is moved, the lock cannot be opened without a subsequent resetting operation so that, in practice, it is practically impossible to open the lock without setting off the alarm, unless one has a knowledge of the lock combination. It should be noted that if only a single unsuccessful attempt to open the lock is made without a following resetting operation, it will subsequently be possible to detect that an attempt was made, since it will prove impossible to open the lock, even with a knowledge of the correct combination, without resetting and consequent operation of the alarm.

If the lock is fitted to, say, a safe door, it is possible to arrange a suitable switch within the safe so that the alarm system can be turned off temporarily after opening to allow a following resetting without operation of the alarm.

It will be appreciated that there is little prospect of opening the described lock in a reasonable period of time without a knowledge of the particular positions of the locking elements **36**. Because of the described construction of the locking elements it is not possible to observe, as by listening, whether each locking element is being moved into or out of a locking condition when shifted by movement of knob **110** so that no assistance in unlocking the lock can be obtained by aural means.

Although there is only a comparatively small number of actuating elements in the described example there are a great number of possible lock "combinations" which may be selected by appropriate positioning of elements **36**. Larger locks could of course be constructed having much greater numbers of combinations if desired.

I claim:

1. A combination lock having a casing structure having a plurality of abutments, a rotor mounted for rotation within said structure, a plurality of locking elements carried in openings arranged about the axis of said rotor and substantially parallel to the axis thereof, actuating means and resetting means, said locking elements each being slidably movable in said openings between first and second locations and each, in one of these locations, preventing substantial rotation of said rotor within said casing structure by cooperating with said abutments and in the other location being cleared of said abutments and not precluding such rotation, said actuating means being operable to move said elements or any selected one or more thereof one by one from the first location to the second location; said actuating means comprising a knob mounted on said casing structure for rotation about the axis of said rotor and relative to the rotor, said knob also being movable axially of the casing structure and being pro-

vided with a projecting actuating member which is selectively movable by axial movement of the knob so as to effect said movement of the locking elements by engagement with facing ends of the locking elements; said resetting means being operable to move all of said locking elements from said second to said first location and including a member having a stem portion which is slidable in a generally axial bore in said rotor and a head, said head being movable axially in said bore and towards said knob to engage end surfaces of said elements opposite to said facing ends to effect the movement thereof from said second location to said first location, and said resetting member being resiliently biased in a direction away from said knob, the lock also including a lever pivotal at a point intermediate its length, about an axis which is substantially fixed relative to said rotor, one end thereof being engageable with said stem and the other end being positioned so that it may be depressed axially away from said knob, by engagement therewith by said actuating member.

2. A combination lock as claimed in claim **1** wherein said casing structure is provided with a wall extending transversely of the axis of rotation of the rotor intermediate said knob and said elements and provided with a plurality of apertures therethrough, the apertures being positioned so that when the rotor is in a locked condition, being a condition in which it is prevented from rotation within the casing structure by engagement of one or more of said locking elements with a cooperating abutment or abutments, the said apertures are longitudinally aligned each with a separate one of said openings, said actuating member being moved through said apertures to effect said movement of the locking elements and through one of said apertures or a further aperture in said wall to effect said depression of said lever.

3. A combination lock as claimed in claim **2** wherein the said other end of the lever and the said openings are equi-angularly disposed in said rotor and all of the said apertures including the said further aperture are correspondingly arranged in said wall.

4. A combination lock as claimed in claim **3** wherein said knob is mounted for rotation upon a boss extending from said wall in an opposite direction to said elements, which knob being freely rotatable on said boss and movable axially relative thereto to a coupled position further away from said wall than a position in which said actuating member is just clear from said wall, said rotor having an extension extending coaxially within said boss, and said knob engaging said rotor extension, in said coupled position, to couple said rotor to said knob for rotation together as a unit.

5. A combination lock as claimed in claim **4** wherein the said extension is provided with a first pin or other projection which extends through a part circumferentially extending opening in said boss and is engageable with a recess in a transversely extending portion of said knob to effect said coupling between the rotor and knob.

6. A combination lock as claimed in claim **5** wherein there is provided means for preventing said coupling from taking place except when said knob is positioned so that said actuating member is aligned with a particular one of said apertures and further aperture.

7. A combination lock as claimed in claim **6** wherein said means for preventing said coupling comprises a second pin or projection fixed upon the outer surface of said boss and a lengthwise extending slot formed in the inner periphery of said knob, said second pin or projection being received in said lengthwise extending slot during movement of said knob to said coupled position and when the said actuating member is aligned with said one particular aperture, but movement of the knob to the coupled position being precluded, when said actuating member is not aligned with said one particular aperture, by engagement of said second pin or projection with said transversely extending portion.

8. A combination lock as claimed in claim **7** and including means for preventing decoupling of the knob and rotor except when said knob is positioned so that said actuating member is aligned with said one aperture.

9. A combination lock as claimed in claim **8** wherein said means for preventing decoupling comprises a circumferential or part circumferential groove on the inner periphery of said knob in which said second pin or projection is accommodated during turning of the coupled knob and rotor.

10. A combination lock as claimed in claim **5** wherein there is provided locking means locking said rotor relative to said casing structure in a disposition in which said one particular aperture is aligned with the said other end of said lever, said locking means operating independently of said locking elements when said knob is decoupled and releasing upon movement of said knob to said coupled position.

11. A combination lock as claimed in claim **10** wherein rotation of said rotor in said casing structure is limited, by engagement of said first pin or other projection with opposite ends of said part-circumferential opening, for rotation in one direction away from said disposition, and rotation in the opposite direction back to said disposition.

12. A combination lock as claimed in claim **10** wherein said locking means includes a lengthwise extending first slot in said rotor extension, said first slot extending to that end of the rotor extension remote from said wall, a lengthwise extending second slot in said boss, extending to the end thereof remote from said wall, and a locking member having an arm thereof retained in said first slot and a transverse portion extending outwardly of the axis of the rotor; the said locking member being slidable in said first slot to and from a locked condition in which said transversely extending portion is engaged in the second slot to effect locking.

13. A combination lock as claimed in claim **12** wherein said locking means further includes means resiliently biasing said locking member towards said wall and operating to displace the locking means so that said transverse portion enters said second slot when the rotor is positioned at said disposition and the knob is advanced towards said wall; said transverse portion being engageable by the transversely extending portion of said knob when said knob is moved to said coupled position to move said locking member in a direction away from said wall to disengage said transverse portion from said second slot.

14. A combination lock as claimed in claim **13** wherein said lever is engaged in a generally radial third slot in said rotor, said third slot extending from the outer surface of the rotor into said bore, and said lever being provided with shaped surfaces which engage axially spaced surfaces of said third slot whereby the lever is pivotable about these surfaces, the lever being removably retained in the third slot by a removable clip which closes the outer end thereof.

15. A combination lock as claimed in claim **14** wherein said abutments extend inwardly and generally radially of said casing structure, said locking elements each having a notch extending inwardly of a surface thereof which is disposed radially outermost of the axis of rotation of the rotor, each said notch, when the corresponding locking element is in its location allowing rotation of the rotor, being disposed at the axial location of said abutments, and clear of these during rotation of the rotor, each said notch being, when the corresponding locking element is in its rotation precluding location, axially displaced of said abutments; rotation of the rotor being precluded by engagement of an unnotched portion of the locking element with an abutment.

16. A combination lock as claimed in claim **15** wherein one side face of each said notch is disposed in a transverse plane of the associated locking element, this plane being disposed at a point midway between the axial ends thereof.

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