Oct. 21, 1969 J. GERARD 3,473,353

COMBINATION LOCK

Filed Dec. 26, 1967 7 Sheets-Sheet 1

Fig. 1

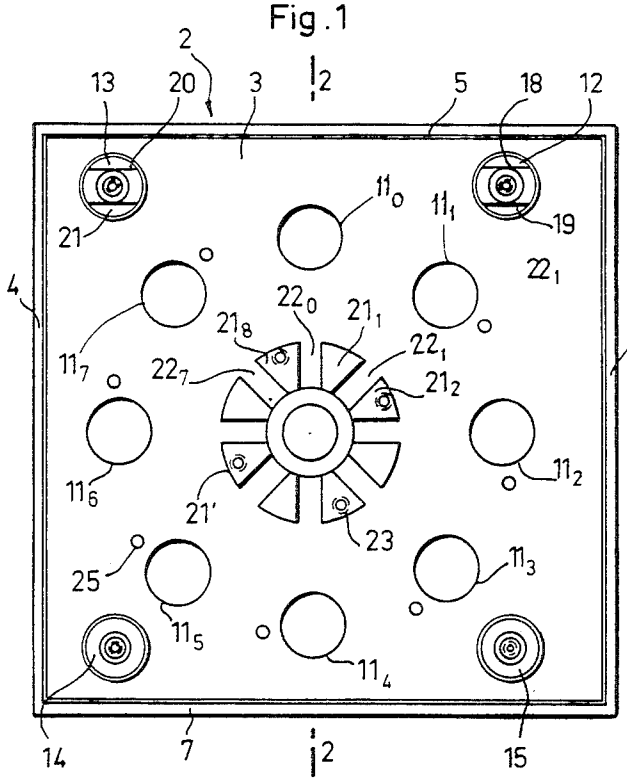
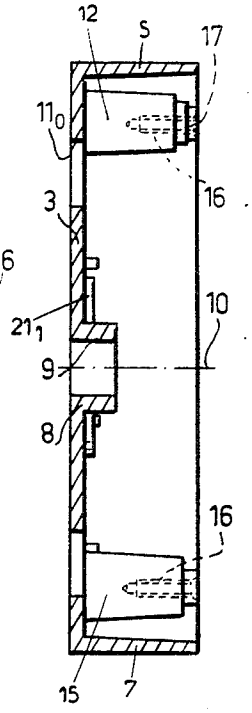


Fig. 2



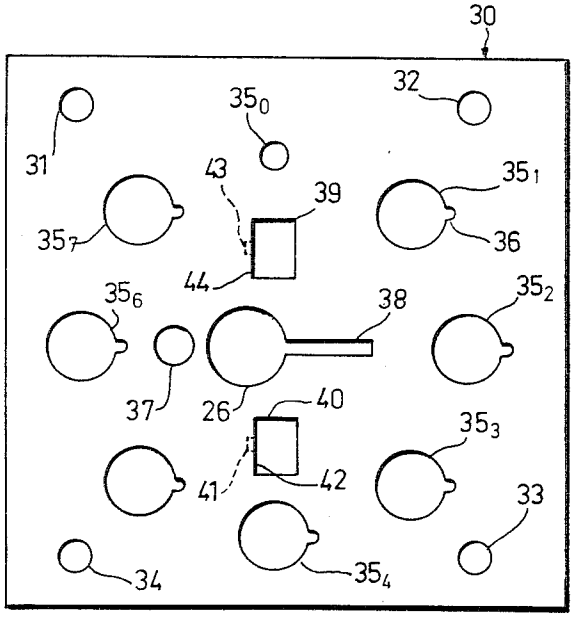


Fig. 3

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Oct. 21, 1969 J. GERARD 3,473,353

COMBINATION LOCK

Filed Dec. 26, 1967 7 Sheets-Sheet 3

Fig. 4

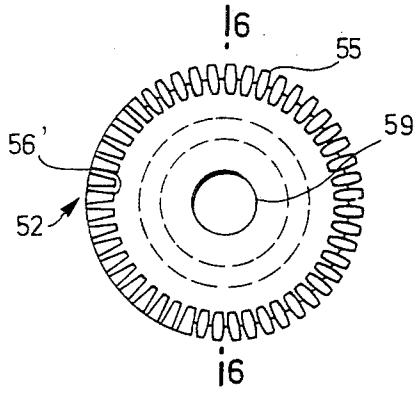


Fig. 5

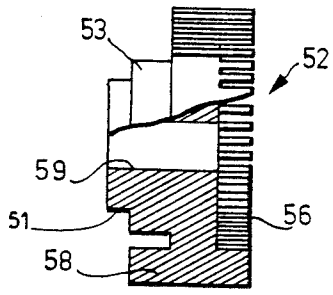


Fig. 6

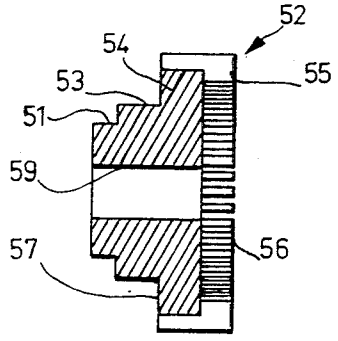


Fig. 7

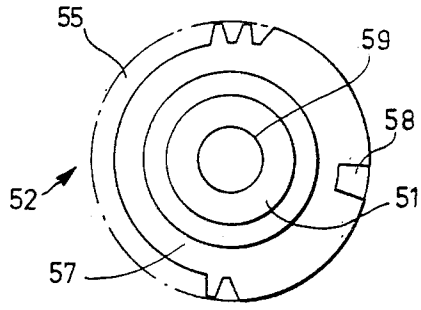


Fig. 8

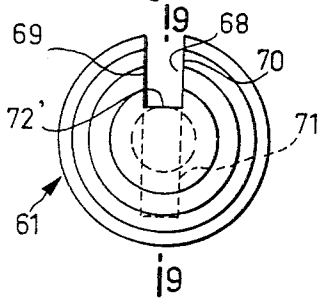
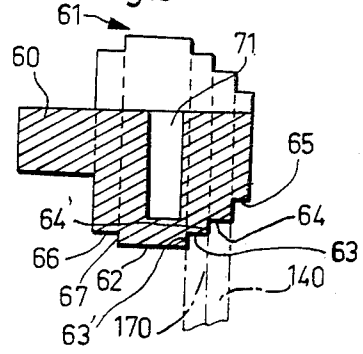


Fig. 9



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Oct. 21, 1969 J. GERARD 3,473,353

COMBINATION LOCK

Filed Dec. 26, 1967 7 Sheets-Sheet

Fig. 26

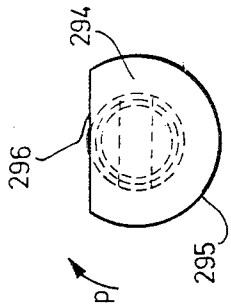


Fig. 11

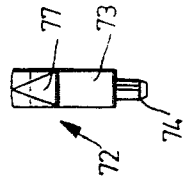


Fig. 10

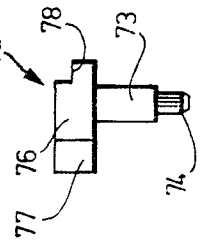


Fig. 25

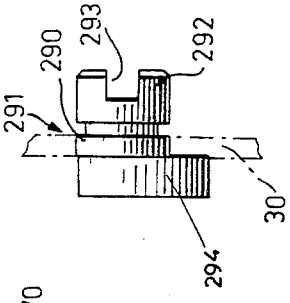


Fig. 12

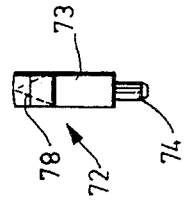


Fig. 24

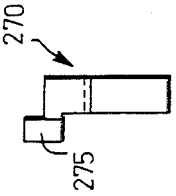


Fig. 14

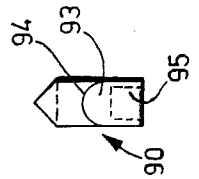


Fig. 23

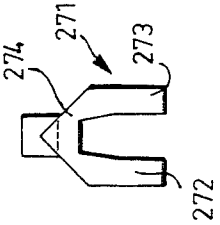
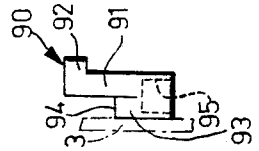


Fig. 13



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Oct. 21, 1969 J. GERARD 3,473,353

COMBINATION LOCK

Filed Dec. 26, 1967 7 Sheets-Sheet 4

Fig. 15

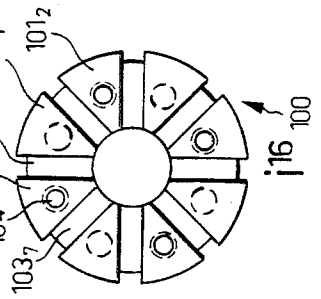


Fig. 16

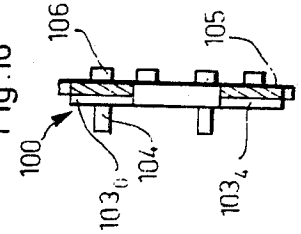


Fig. 20

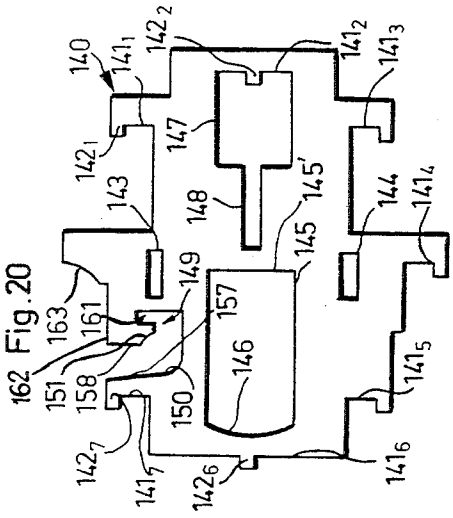


Fig. 22

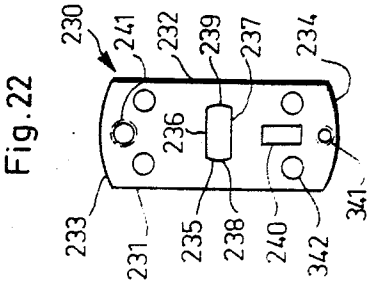


Fig. 21

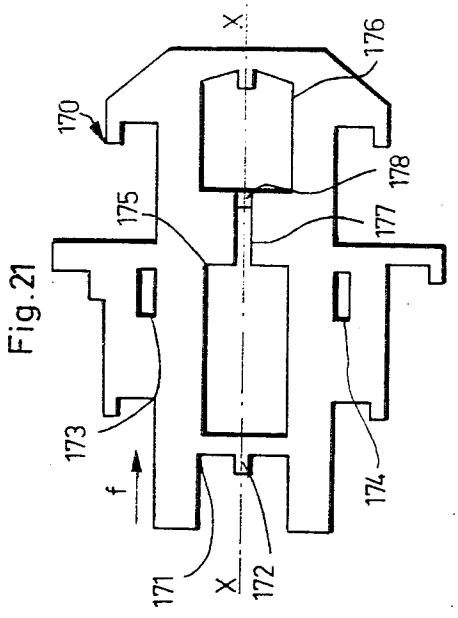
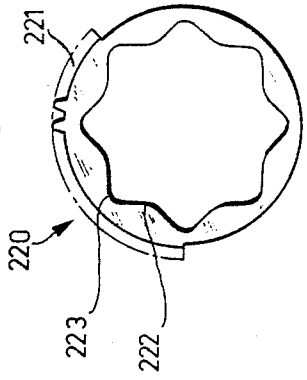


Fig. 17



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Oct. 21, 1969 J. GERARD 3,473,353

COMBINATION LOCK

Filed Dec. 26, 1967 7 Sheets-Sheet 5

Fig.18

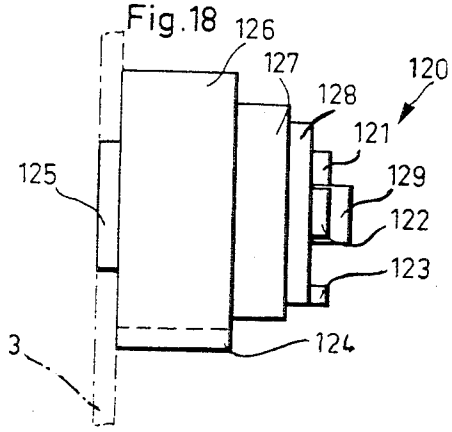


Fig.19

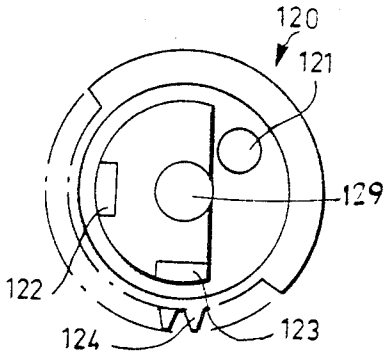
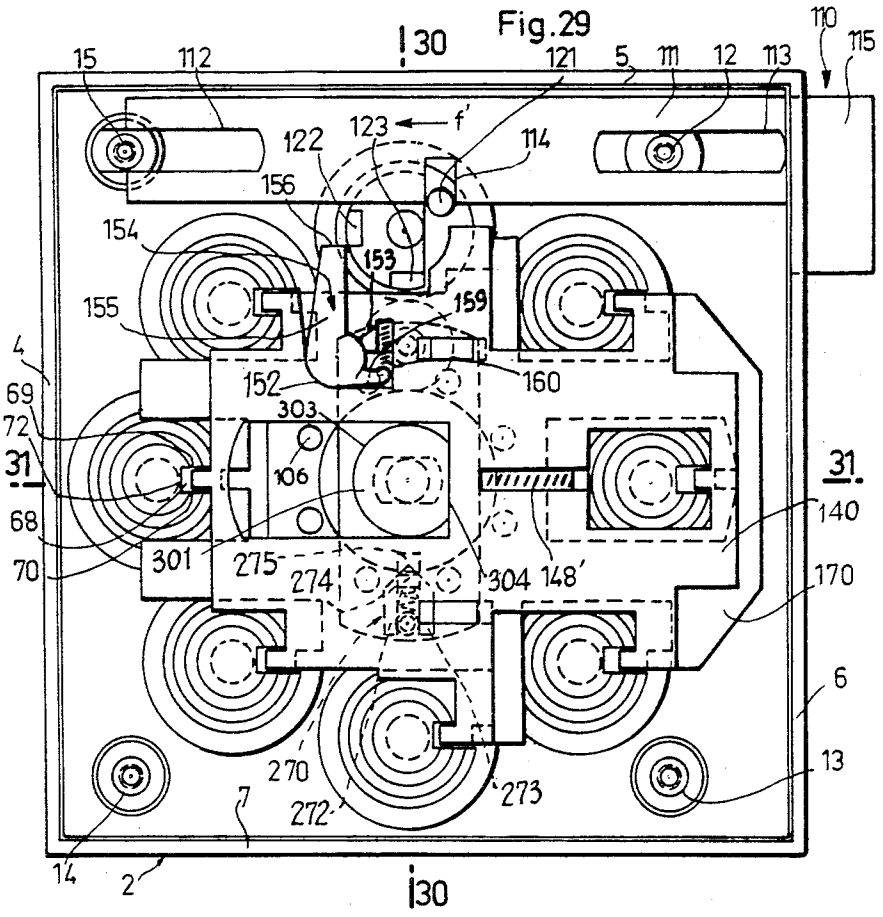


Fig.29



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Oct. 21, 1969 J. GERARD 3,473,353

COMBINATION LOCK

Filed Dec. 26, 1967 7 Sheets-Sheet 6

Fig.32

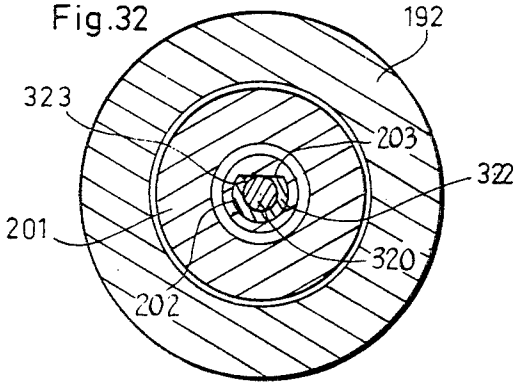


Fig.27

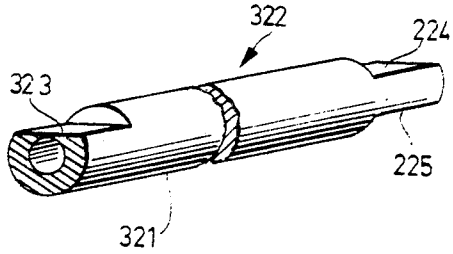
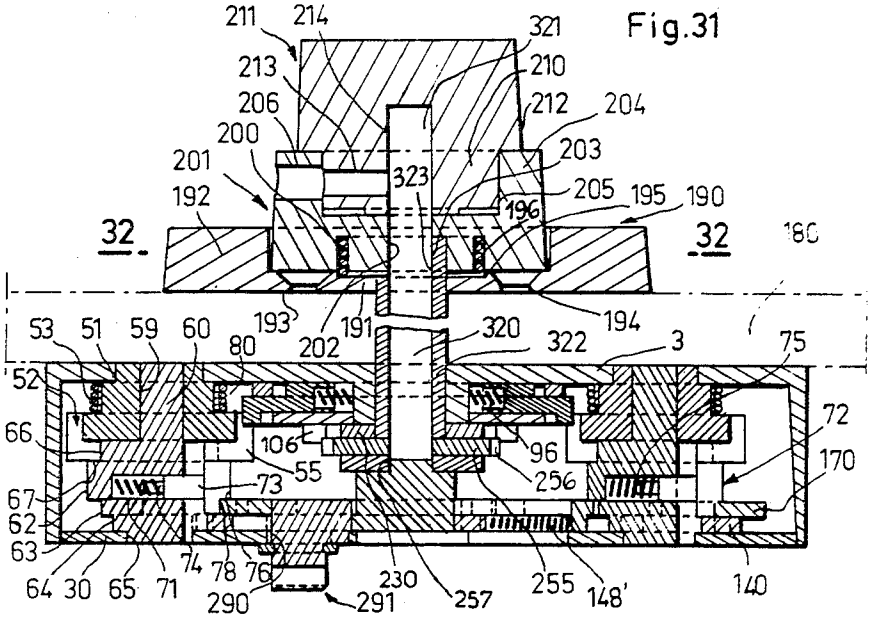


Fig.31



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Oct. 21, 1969 J. GERARD 3,473,353

COMBINATION LOCK

Filed Dec. 26, 1967 7 Sheets-Sheet 7

Fig.30

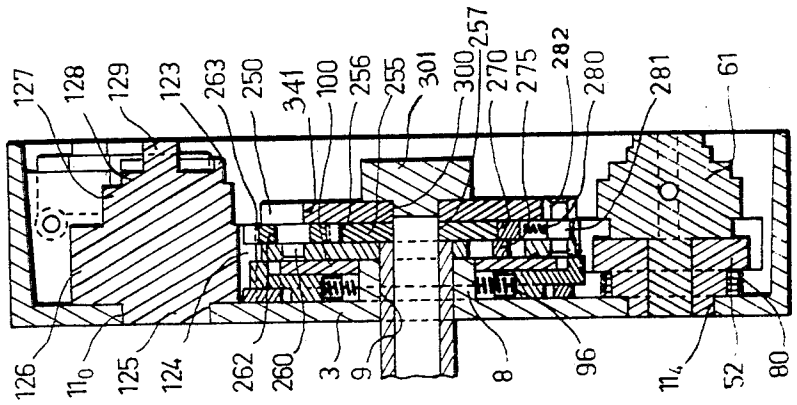
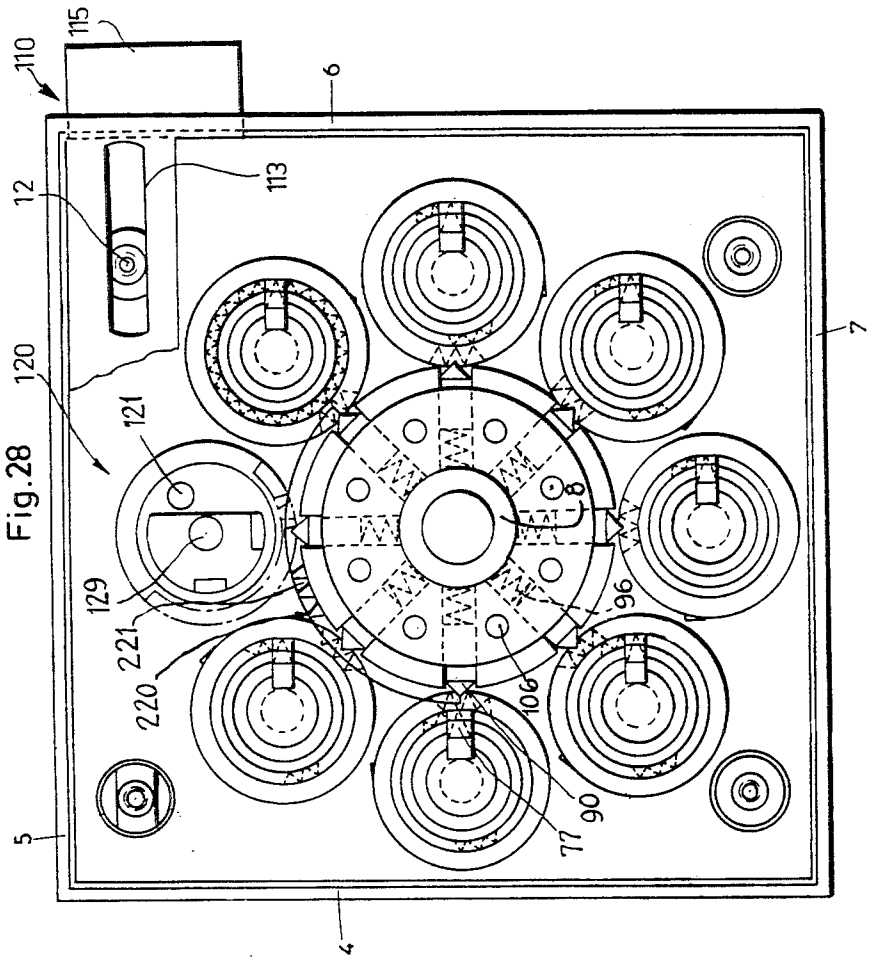


Fig.28



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United States Patent Office 3,473,353 Patented Oct. 21, 1969

3,473,353

COMBINATION LOCK

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Filed Dec. 26, 1967, Ser. No. 693,508
Claims priority, application France, Dec. 27, 1966, 88,905
Int. Cl. E05b 37/02
U.S. Cl. 70—305 14 Claims

ABSTRACT OF THE DISCLOSURE

A combination lock in which a bolt-driving mechanism is mounted upon a base plate or support in circular alignment with a plurality of angularly equispaced combination counters. An actuating device is rotatable about the axis of the array and can be manipulated to operate on one or another of the counters and upon the bolt-driving mechanism.

The invention has for an object a combination lock.

It is an object of the invention to provide a combination lock which enables a considerable number of combinations to be obtained by means of multiple counters, but maintaining an extremely simple control.

It is also an object of the invention to provide a combination lock which can be operated by means of a single control device, although it comprises a plurality of counters, and which enables as many combinations to be obtained as multiple control locks, if not more.

It is also an object of the invention to provide a combination lock in which control is effected by a single bushing of the wall with which the lock is equipped, hence without weakening said wall.

It is also an object of the invention to provide a combination lock which ensures, in spite of a single control device, independence between the control of the counters and that of the opening or of the closing of the lock.

It is, in this respect, an object of the invention to provide a combination lock in which the independence of the control of the counters and of that of the opening and of the closing is ensured as effectively as in locks with multiple control members.

It is a further object of the invention to provide such a lock in which, moreover, the counters are, at the beginning of the opening movement of the bolt, automatically reset to zero.

It is also an object of the invention to provide a combination lock in which the closing of the bolt automatically causes the resetting of the counters to zero, at least for those which have not been reset to zero at the moment of opening of the bolt.

It is therefore an object of the invention to provide such a lock in which the resetting to zero of the counters does not need to be separately controlled manually.

It is also an object of the invention to provide a combination lock for which the realization of the combination can be ensured without the user having to read figures or letters, thus enabling operation in darkness.

The combination lock according to the invention, especially applicable to a safe door or the like and in which the opening of the bolt can only be effected if each counter of a plurality of combination counters is previously brought into a predetermined angular position, is characterised in that the operation of each counter of the plurality of counters is effected from a single actuating member, made operational, at will, on one or any other of the counters.

According to another characteristic of the invention, the actuating member is rotary knob driving a transmission which comprises a mechanism mounted to rotate and to slide, subject to the action of elastic means exerted longitudinally which urge it towards an operational position, in which said mechanism is adapted to enable the actuation of the counter of the plurality of counters which corresponds to the angular position into which the said mechanism has been brought in a previous actuation by a rotation controlled by an annular knob concentric with the actuating knob.

According to yet another characteristic of the invention, for a predetermined single angular position and by means of a control similar to that which has enabled the manipulation of the counters, the opening or the closing of the bolt is effected.

The transmission members between the control device of the counters on one hand, and of the bolt on the other hand, are therefore common for the two types of control.

The invention will be more fully understood by the description which follows, given by way of example with reference to the accompanying drawings, in which:

FIGURE 1 is a rear elevational view of a housing for a combination lock according to the invention;

FIGURE 2 is a view in cross-section along line **2—2** of FIGURE 1;

FIGURE 3 is a rear view of a cover or lid for the housing;

FIGURE 4 is a rear view of a combination ring of a lock according to the invention;

FIGURE 5 is a side view, with partial cutaway, of said ring;

FIGURE 6 is a sectional view along line **6—6** of FIGURE 4;

FIGURE 7 is a front view of said ring;

FIGURE 8 is a back view of another combination ring of a lock according to the invention;

FIGURE 9 is a sectional view along line **9—9** of FIGURE 8;

FIGURE 10 is a view in elevation of a combination catch;

FIGURE 11 is a side view;

FIGURE 12 is a side view, but through another face of the lock;

FIGURE 13 is a view of a positioning catch;

FIGURE 14 is a front view thereof;

FIGURE 15 is a front view of a positioning disc;

FIGURE 16 is a cross-sectional view along line **16—16** of FIGURE 15;

FIGURE 17 is a view of a jamming pinion;

FIGURE 18 is a view of the bolt driver of a lock according to the invention;

FIGURE 19 is a rear view of said bolt driver;

FIGURE 20 is a view of the to-and-fro blocking member;

FIGURE 21 is a view of the to-and-fro word-changing member;

FIGURE 22 is a view of a positioning plate;

FIGURE 23 is a rear view of the positioning catch of the control pinion;

FIGURE 24 is a corresponding side view;

FIGURE 25 is a view of the word-change knob;

FIGURE 26 is a corresponding front view in elevation;

FIGURE 27 is a perspective view of a control tube;

FIGURE 28 is a general view of the rear of a combination lock according to the invention, the cover being removed and certain parts having been omitted for the purpose of clarity;

FIGURE 29 is a general rear view of a combination lock according to the invention, the cover being removed;

FIGURE 30 is a cross-sectional view along line 30—30 of FIGURE 29;

FIGURE 31 is a cross-sectional view along line 31—31 of FIGURE 29, showing, furthermore, the actuating device; and

FIGURE 32 is a cross-sectional view of the actuating device along line 32—32 of FIGURE 31.

The housing 1 of the combination lock according to the invention, is of generally parallelepipedic form. It comprises a rectangular casing 2 (FIGURES 1 and 2), for example square, with a bottom or front wall 3 and side faces 4, 5, 6, 7. To the bottom 3 is rigidly fixed a short tube or boss 8, defining a central passage 9, with an axis 10 (FIG. 2). The bottom 3 has holes 11 whose centers are equidistant from the axis 10 and which are angularly distributed in a regular manner about axis 10, i.e. angularly equispaced therearound, these holes being eight in number in the example shown, and designated 11_0, 11_1, 11_2, etc. . . . 11_7. In the region of each of the holes 11_1–11_7, small pins 25 are provided. On the front wall 3 are set up, near the corners of the square, pillars or posts 12, 13, 14, 15. These pillars have internal tappings 16 with which screws 17 provided for fixing the cover of the housing 1, or lid 30, on the casing 2, are adapted to co-operate. On two pillars, the upper pillars 12 and 13 in the drawing, are provided slide paths 18, 19 and 20, 21″, respectively. The front wall 3 has, furthermore, around the tube 8, projections in the form of sectors, of the same number as that of the holes 11, and which are designated as 21_1, 21_2, etc. . . . 21_8; said projections leave between them radial passages 22_0, 22_1, etc. . . . 22_7, aligned respectively with the centers of holes 11. The sectors 21 of even pairs (or, optionally the sectors of odd pairs) each have a hole 23, said holes forming the corners of a rectangle. Suitable means (not shown) are provided for fixing the casing 2 through its bottom 3 on the rear face of the strong wall, for example, the door of a safe.

The casing 2 is closable by a cover or lid 30 (FIGURE 3) having near the corners holes 31, 32, 33, 34 for the fixing on the casing by means of screws 17 co-operating with threadings 16, as well as holes 31_1, 35_2, 35_3, etc. . . . 35_7, of the same arrangement as holes 11_1, 11_2, etc. . . . 11_7, and of the same diameter with the exception of a semi-circular notch 36, the various semi-circular notches being located at a same end of parallel diameters of the holes, for example, of horizontal diameters, on the right-hand side in FIGURE 3. A hole 35_0 co-axial with the hole 11_0 is of smaller diameter than the latter and is not provided with a notch. The cover 30 has also a circular hole 37 the center of which is aligned with the center of holes 32_2 and 35_6, as well as a rectangular opening 38, the large axis of which passes through the centers of holes 37, 35_2 and 35_6 and which opens into a circular hole 26 of a diameter greater than that of the circular hole 37. The cover 30 has also, symmetrically with respect to the line of the centers of holes 35_2 and 35_6, the rectangular openings 39 and 40. A tongue 41, obtained by folding towards the interior of the case, borders the side 42 of the opening 40, and a tongue 43, also folded towards the interior, borders the side 44 of the opening 39.

In each of the holes 11_1–11_7 of the bottom 3 of the case is located, by its collar 51, a front combination ring 52 (FIGURES 4 to 7), in the general shape of a disc with several diameters, which comprises an intermediate collar 53, and a cup 54 of which a little more than half the outer lateral surface has a denture 55 (FIGURE 7). The posterior frontal face 56 has a denture (toothed ring) 56′ the teeth of which extend the teeth of the denture 55 and which runs over the whole circumference. The anterior face 57 of the cup has a stop projection 58 adapted to co-operate with a pin 25 associated with the hole 11 in which the ring is located and of which the height is equal to that of the intermediate collar 53. A central bore 59 extends through the ring 52.

Co-axially with each of the anterior combination rings is rotatably mounted, by its hub 60 engaged in the central bore 59 of the ring 52, a posterior combination ring 61 (FIGURES 8 and 9) having a central cylindrical collar 62 to which are adjacent on the posterior side, three cylindrical collars of smaller diameter 63, 64 and 65. An anterior collar 66, adjacent the central collar 62, bounds a shoulder 67 which, when the posterior combination ring 61 is introduced by its hub 60 into the bore 59 of the ring 52, comes into abutting co-operation with the face 56 of this latter. In each ring 61 is formed a slot 68 of rectangular section extending parallel to the axis of the ring and having parallel opposite faces 69 and 70. A diametric cylindrical bore 71, is formed in the body of the ring 61 and opens on the bottom 72′ of the slot 68, its diameter being appreciably equal to the width of the slot, that is to say equal to the distance separating the opposite parallel faces 69 and 70.

Each bore 71 receives the body 73 of a combination catch 72 (FIGURES 10–12) terminating in a shank 74 around which is located a small spiral spring 75 (FIGURE 31) seated in the cylindrical bore 71 and being supported on the bottom of the latter. The head 76 of the catch, directed perpendicularly to the axis of the body, on each side of this latter, has, at one end, a triangular tooth 77 and at the other end a support face 78, rounded and appreciably perpendicular to the axis of the body. When the combination catch 72 is only subjected to the action of the spring 75 which is associated with it, the lateral face 78 extends the collar 63 of the combination ring 61 in which the catch is introduced, and this due to the introduction of the triangular tooth 77 of said catch into an interdental interval of the denture 56′ of the anterior combination ring 52; the lateral face of the head 76 extends the collar 62 of ring 61 and the crest of the prismatic part or tooth 77 projects slightly with respect to the collar 66 of which the diameter is appreciably equal to the internal diameter of the cup 54 of ring 52.

On each anterior combination ring 52 is attached a spring 80 (FIGURE 31) working in torsion, fixed at one of its ends to the projection 58 of said ring and by its other end to the pin 25 provided on the bottom 3 of the case and neighbouring the hole 11 in which said ring is located; the spring 80 tends, when the rings 52 and 61 are not rigidly fixed rotationally by the catch 72, to make the ring 52 turn with respect to the ring 61. On the other hand, when the rings 52 and 61 are rigidly fixed rotationally by the catch 72, the spring 80 tends to make turn the assembly constituted by the two rings when a positioning catch 90, which will now be described, does not immobilize the ring 52 as regards rotation.

With the denture 55 of each ring 52, co-operates a positioning catch 90 (FIGURES 13 and 14) located in a radial passage 22 arranged in the bottom 3 of the casing 2. The catch 90 has a body 91 having a projection 93 with a rounded edge 94 on its part in contact with the bottom 3; at the end of the body 91, a beak 92 is adapted to cooperate with the denture 55 of ring 52. A housing 95 is provided in the body of the catch 90 to receive a spiral spring 96 (FIGURES 28 and 31) of which one end is supported on the bottom of the housing 95 and the other end on the tube 8 of the bottom 3 of the casing 2.

The maintenance of the catches 90 in the radial passages 22 is ensured by the placing in position of a positioning disc 100 (FIGURES 15 and 16) in the form of a flat disc, which has sectoral platforms 101_1, 101_2, etc. . . . 101_8, superposable on the sectoral platforms 21_1 . . . 21_8 of the bottom 3 of the casing 2, of greater radial dimension than these latter and which form between them radial channels 103_0, 103_1, etc. . . . 103_7 receiving the catches 90 and their associated springs 96. For the positioning of the part 100 certain of the sectoral platforms 101 carry on their anterior faces projecting studs 104, four in number in the embodiment shown, which are introduced into holes 23 provided on the sectoral platforms 21 of the

bottom 3 of the casing. The posterior face 105 of the positioning disc 100 is planar and has bosses 106, eight in number regularly arranged angularly around the axis of the disc.

Around the cylindrical surface constituted by the succession of external surfaces 21' of the sectoral platforms, is mounted rotatably an annular gear or jamming pinion 220 (FIGURE 17) which comprises an external peripheral denture 221 extending over part of its circumference, namely over about 135°. The internal surface of the annular gear comprises a succession of rounded projections 222 by which said gear is rotatably mounted on the external face 21' of the sectoral platforms, and rounded grooves 223, the projections (and therefore the grooves) being eight in number and regularly distributed from the angular point of view. The projections 222 are adapted to co-operate with the rounded edges 94 of the positioning catches 90, to shield these latter against the action of the spiral springs 96 when the jamming pinion is driven in rotation.

The bolt 110 (FIGURES 28 and 29) comprises a shank 111 constituted by a plate in which are formed a slot 112 which co-operates, for guiding said plate, with paths 20, 21'' of the pillar 15, and a stud hole 113, which, to assist in the guidance of said plate, co-operates with the paths 18 and 19 provided on the pillar 12 erected on the bottom 3 of the casing. A cut-out 114, substantially perpendicular to the longitudinal direction of the shank 111, is provided for driving the bolt 110 by a bolt driver 120 which will be described below. The head 115 of the bolt is in the form of a parallelepipedic block and projects with respect to the lateral surface 6 of the housing 1, through a conjugate opening provided in the latter.

The bolt drive 120 (FIGURES 18 and 19) is in the form of a disc or ring with several diameters and comprises a stud 121 (FIGURE 29), co-operating with the cut-out 114, as well as two projections 112 and 123 on its periphery staggered angularly by 90° from one another. It is rotatably mounted by its collar 125 in the hole 11_0 of the bottom 3 of the casing 2. Its body 126, of greater diameter than that of the collar 125, and which carries a denture 124 over substantially half its periphery, is extended by a collar 127 of smaller diameter than that of the body, said collar being extended in its turn by a collar 128, semi-circular, of smaller diameter, and the frontal face of which carries the projections 122 and 123 as well as the stud 121. The shaft 129 which is extended from the frontal face of the collar 128, is adapted to co-operate with the hole 35_0 of the cover or lid 30 for the rotatable mounting of said bolt drive.

The projections 122 and 123 of the bolt drive 120 are adapted to actuate a to-and-fro or reciprocation blocking member 140 (FIGURE 20) constituted by a plate of generally rectangular form with cutouts, projections and internal openings, and which rests on the shoulders 64' formed between the collars 64 and 63 by the combination rings 61 (as shown in dash-dotted line in FIGURE 9). The plate is cut out in such manner that the to-and-fro member 140 has seven sides or vertical edges 141_1, 141_2 . . . 141_7 from each of which a tooth projects, respectively 142_1, 142_2 . . . 142_7, all the teeth being directed on the same side. The to-and-fro member has an upper rectangular opening 143 and a lower rectangular opening 144 with which are adapted to co-operate the tongues 43 and 42, respectively, of the cover 30 for the longitudinal sliding guidance of said to-and-fro member 140. It has in its middle part a window 145 of generally rectangular form, but of which one end edge 146 is curved. Another rectangular window 147 of which one of the sides is constituted by the edge 141_2 having the tooth 142_2, is extended by a slot 148 in which is seated a small spiral spring 148' (FIGURES 29 and 31).

On its upper edge, the to-and-fro member 140 is cut out along a seating 149 with two curved parts 150 and 151, of the same radius, for the reception of two conjugate curved parts 152 and 153 respectively of a blocking elbow lever 154 (FIGURE 29). The latter is constituted by a stamped out plate and plays the role of a lever one arm 155 of which, having an end stop surface 156, is located with a certain play between the two edges 157 and 158 of the seating 149. The other arm 159 of the lever 154 is provided for receiving the action of a small spiral spring 160 located in a cutout 161 of the to-and-fro member 140. The end of the arm 155 forms a projection with respect to the edge 162 of the to-and-fro member where the seating opens 149, said edge being extended by a rounded part 163 (FIGURE 20).

Close to the anterior face of the to-and-fro member 140 there is provided a to-and-fro member 170 for changing the word or figures of the combination (FIGURE 21), also constituted by a plate of generally rectangular form with cutouts and openings. The word changing to-and-fro member 170 rests on the shoulders 63' of the combination rings 61 connecting the collars 63 and 62. It has sides as shown in 171, transversal to the direction of displacement of said plate shown diagrammatically by the arrow *f*, from each of which projects a tooth 172, all the teeth being directed towards the same side as the teeth 142; said sides 171 and said teeth 172 are seven in number, equal to that of the counters. The to-and-fro member 170 has moreover two rectangular openings 173 and 174 superposable on the openings 143 and 144, substantially symmetrical with respect to the center line X—X of said to-and-fro member, and with which are adapted to co-operate the tongues 43 and 41 respectively, provided on the lid 30 of the case. The to-and-fro member 170 has also two openings 175 and 176 connected by a narrow interval 177 and a stud 178, transversal to the plane of the plate, extends in the connecting zone between the slot 177 and the opening 176, serving as a stop for one end of the small spiral spring 148'.

On the other side of the strong wall 180 shown diagrammatically in dash-dotted lines in FIGURE 31, that is to say on the side on which the casing is not fixed, the lock is provided with a dial 190 (FIGURE 31) of circular form, bounded by a rim 192. The dial 190 has a bottom 191, on which are provided two holes 193 and 194 for fixing the dial on the outer face of the strong wall, for example, of the door the opening and closing of which must be dependent upon the locking mechanism. The central part of the bottom 191 of the dial has a shoulder 195 helping to hold a spiral spring 196, located in a circular groove 200 which has a positioning knob 201 in the form of a cup. The latter is received in the interior of the housing formed by the rim 192 and it is pierced axially by a hole 202 which has a flat 203. The rim 204 of the cup-shaped knob defines a seating 205; it is traversed by a radial bore 206.

In the seating 205 is placed the body 210 of a counter knob 211 with a milled outer surface 212; a radial bore 213 of the said body 210 is aligned, on mounting, with the bore 206. The knob 211 is rigidly attached to a shaft 320 through a threaded pressure (not shown), located in bore 213 of which the head has a slot for engagement with a screw-driver, and which does not project into the bore 206, enabling thus independent rotation of the knob 211, and of the knob 201. The shaft 320 extends into a bore 214 of the counter knob 211, through its end 321, and the said shaft 320 is, in its part outside the knob 211, surrounded by a tube 322 at the anterior end of which is formed a flat 323, the other end having two flats 224 and 225 (FIGURE 27) diametrically opposed. The tube 322 is rigidly fixed to the positioning knob 201, by the co-operation of its flat 323 with the conjugate flat 203 formed on said knob, as is clearly seen in FIGURE 32.

At its end with two flats 224 and 225, protruding in casing 2, the tube 322 carries a positioning plate 230 (FIGURE 22), of generally rectangular form with two long rectilinear sides 231 and 232, the two other sides,

233 and 234 being circular. The plate 230 has a central aperture 235 the form of which is conjugated of that of the end with two flats of the tube 322, with two rectilinear edges 236 and 237 and two curved edges 238 and 239. It has, also, directed along a diameter perpendicular to the sides 236 and 237, a rectangular opening 240 and circular holes 241 and 341. Circular holes 342, placed at the corners of a rectangle, are provided to co-operate with the bosses 106 of the positioning plate 100.

Between said plate 230 and a posterior displacement plate 250 (FIGURE 30) rigidly fixed with plate 230, is placed an annular control gear 255 having a peripheral denture 256 extending over its whole circumference. The gear 255 is engaged, by a central orifice 257 it presents, on the shaft 320 with which it is rigidly fixed in rotation, for example, by co-operation of grooves and channels.

The hole 241 of plate 230 receives the end 260 of a shaft of an intermediate tooth gear, 262, thus rotatably mounted between the plate 230 and the plate 250 and of which the denture 263 is in engagement with the denture 256 of the control gear 255, on one hand, and is, on the other hand, adapted to co-operate with the denture 55 of a combination ring 52 when the control mechanism of the combination lock is brought into the position of actuating one of the counters.

A positioning catch of the control gear, 270 (FIGURES 23 and 24), comprises a U-shaped body 271 with two branches 272 and 273, the connecting part 274 being extended by a prismatic head 275. Said positioning catch 270 is placed between the plate 230 and the plate 250, the prismatic head 275 being located in the rectangular opening 240 arranged in the plate 230. It is subject to the action of a spring 280 which is supported by a guide foot of the catch 281 mounted in the hole 341 of the plate 230 and the diameter of which is substantially equal to the distance of arms 272 and 273 of the catch for the longitudinal guidance of the latter. The guide foot of the catch 281 has, at its end which is not fixed in the plate 230, a rounded head 282 which is adapted to prevent the extraction of the catch during operation.

On the upper displacement plate 250 is fixed, in the central hole 300 of said plate, a to-and-fro positioning foot, 301, in the form of a cam with a cylindrical surface 303 and a flat 304 (FIGURES 29 and 30). This positioning foot is engaged in the rectangular apertures 145 and 175 of the blocking and word changing to-and-fro members 140 and 170, respectively.

In the hole 37 of the cover is rotatably mounted, by its collar 290, a word changing knob 291 (FIGURES 25 and 26) having at one end a head 292 with a slot 293 for engagement by a screwdriver, and at the other end a cam 29 in the form of a disc, with a circular part 295 and a flat 296.

The operation is as follows:

For the opening of the lock, the various counters are first brought into their position which corresponds to the combination which has been pre-established and then the opening proper is effected by actuation of the bolt.

FORMING OF THE COMBINATION

To form the combination, the knob 211 is pressed in by overcoming the force exerted by the spiral spring 196, which displaces longitudinally the whole actuating mechanism constituted by the knob 211, the knob 201, the shaft 320, the tube 322 and the parts rigidly fixed to said shaft and said tube respectively. By this pressing action, which causes the displacement of the tube 322, the holes 342 of the positioning plate 230, rigidly fixed to said tube, are disengaged with respect to the pins 106 of the positioning disc 100, so that said mechanism, which, in the non-depressed state of the knob 211, was immobilized with regard to a rotary movement, can be turned about its axis. The rotation is effected by manipulating the knob 201 so as to bring a mark shown by the latter opposite one of the figures of a scale from 0 to 7 borne on the front face of the dial 190. When pressure is discontinued on the knob 211, the actuating mechanism undergoes a sliding motion in the reverse direction, by the action of the spring 196 placed under compression, and, at the end of this sliding movement, the denture 263 of the intermediate gear comes into mesh with the denture 55 of the combinatioin ring 52 of the counter corresponding to the number of the scale. By reason of the angular setting which is ensured for the intermediate gear 262, through the control gear 255 and the catch 270 on one hand, and for the denture 55 of the combination ring 52 through a catch 90 on the other hand, engagement without difficulty is ensured of the denture 263 of the intermediate pinion and the denture 55 of the combination ring.

The control knob 211 is then rotated, which causes, through the control shaft 320, rigidly fixed to the control gear 255 meshing with the intermediate pinion, the rotation of the combination ring 52 of the counter corresponding to the previously selected number of the scale.

The ring 52 which, in the initial condition, was in position 0, turns step by step by reason of the action of the positioning catch 90 and the operator can thus count, to bring the counter with which said ring is associated into the position which corresponds to the figure or the letter selected for the said counter.

In an alternative operation, the control knob 211 is driven in a reverse direction of rotation. The combination ring 52 is then rotated in reverse direction and, of course, the counting will be the complement of the maximum FIGURE 12 for example, that the counter can indicate.

The counting of a first counter being thus effected, the operator presses again the knob 211 and consequently the knob 201, which disengages the intermediate gear 262 from the denture 55 of the combination ring 52 with which it cooperated. The operator then turns the knob 201 so as to bring the mark borne by the latter in front of the scale corresponding to another counter which is not necessarily that which follows angularly the counter already actuated. He then releases his pressure and, in a similar manner to that which has been explained, the denture of the intermediate gear 262 engages with the denture of the combination ring 52 of this second counter. By the rotation of the control knob 211, the second counter is brought into the required position by counting.

And so on for all the counters.

When for a counter there has been counted the number which corresponds to the combination (or its complement) the notch 68 of the ring 61 of the said counter, rigidly fixed in rotation with the combination ring 52 by co-operation of the catch 72 with the denture 56 of said ring, takes the position shown in FIGURE 28, that is to say that in which the notch has its surfaces 69, 70, parallel to the surfaces 5, 7 of the casing 2, the opening of the notch being opposite the wall 6 of the casing. When all the counters have been actuated, all the notches of the rings 61 of the counters are in the same position, which is that shown in said figure.

During the actuation of the counters, at any moment neither the teeth 142 of the to-and-fro blocking member 140, nor the teeth 172 of the to-and-fro member for changing the word 170, are in contact with the opposite collars, 62 and 63 respectively, of the combination rings 61. This is due to the fact that the to-and-fro blocking member is urged away from the rings by the action of the positioning foot 301 the cylindrical surface 303 of which co-operates with the edge 145' bounding the rectangular opening 145, the to-and-fro word changing member 170 being urged away from the rings by the action of the spring 148' located in the groove 148 provided on the to-and-fro member 140. The said to-and-fro members are thus in their right end positions (in the figures) for which the stop surfaces 156 of the blocking lever 154 is facing the projection 122 of the bolt driver 120. The

latter is, therefore, immobilized and it is impossible to make it turn.

OPENING OF THE BOLT

When all the counters have been brought into their position corresponding to the combination of the lock, the positioning knob **201** is again pressed in and turned so that its mark comes opposite the zero graduation on the front face of the dial **190**. The to-and-fro positioning foot **301** rigidly fixed to the plate **250**, itself rigidly fixed to the tube **322** driven in rotation by the knob **201**, has then its flat **304** opposite the rectilinear edge **145'** of the opening **145** formed in the to-and-fro blocking member **140**. When the knob **201** is released the denture of the intermediate pinion **262** comes into engagement with the denture of the bolt driver **120**. The to-and-fro member **140** held until then in its right end position by reason of the action of the spring **148'** on one hand, and on the other hand, by reason of the co-operation of the edge **145'** of its opening **145** with the cylindrical surface **303** of the to-and-fro positioning foot **301**, is displaced from the right towards the left (in FIGURE 29) until the rectilinear edge **145'** comes into contact with the flat **304**. Its teeth **142** penetrate into the notches **68** of the combination ring **61** which then face the teeth. In the course of the movement of the to-and-fro member **140** the stop surface **156** of the member **154** moves in front of the projection **122** of the bolt driver **120** (FIGURE 29). The latter, which was immobilized by the member **154** co-operating with the projection **122**, can then turn.

When the operator turns the actuating knob **211**, he rotates the bolt driver **120** by means of the control gear **255** and of the intermediate gear **262** the teeth of which then co-operate with the teeth **124** of said driver. The latter turns around its axis and the pin **121**, co-operating with the notch **114**, displaces the bolt **110** in the direction of the arrow *f'* (FIGURE 29), effecting the opening. As soon as the projection **122** of the bolt driving device has cleared the plane of the front stop surface of the lever **154**, the other projection **123** co-operates with the curved edge **163** of the to-and-fro blocking member, which brings back the latter towards the right, against the action of the spring **148'**. The spring **160** enables the lever **154** to follow the circular contour of the stop **122** in the course of this movement. After a quarter of a turn of the bolt drive **120**, the bolt is brought into its opening position. The projection **123** holds the to-and-fro blocking member by co-operation with the curved edge **163** of the latter. Projection **122** has taken the position which was initially occupied by the projection **123**.

From the beginning of the rotation of the bolt driver **120**, the latter has, by engagement of the anterior part of its denture **124** with the denture **221** of the pinion **220**, driven the latter in rotation. Although, in the initial condition the head or projection **93** of a catch **90** co-operates with a hollow **223** of the blocking pinion, thus rendering operative, under the action of spring **96**, the beaks **92** for fixing the position of the combination rings **52**, the placing in rotation of the blocking pinion **220** causes the support surfaces **94** of said catches to co-operate with the projecting parts **222**, which drive back the catches against the action of their respective springs **96** and cause their heads to escape the dentures **55** of the combination rings **52**. Said combination rings **52**, not held by their associated catches **90**, return to their initial condition, that is to say, that in which the stops **58** which they have on their anterior faces are in contact with the pins **25** provided on the bottom of the casing, under the action of the springs **80** placed under tension during the counting.

Return to the initial condition of the combination rings **52** is rendered possible by the fact that the teeth **142** of the to-and-fro blocking member **140** have been extracted from the notches **68** during the recoil movement towards the right of said to-and-fro member by co-operation of the projection **123** of the bolt driver **120** with the curved edge **163** of the to-and-fro blocking member **140**. From the first movement of opening of the bolt, therefore, the combination of the counters is destroyed.

When it is desired to close the lock, it is sufficient to turn the control knob **211** in reverse direction. The bolt drive ring **120** is driven in rotation in reverse direction, and the pin **121** brings back the bolt **110** towards its closing position. At the end of the movement, the projection **122** pushes aside the lever **154**, by its action against the arm **155** of the latter taking advantage of the resiliency of spring **160**. When the bolt drive **120** assumes again its initial position, shown in FIGURE 29, lever **154** comes back into its blocking position, under the action of spring **160**, its stop face **156** being again opposed to any movement of the bolt drive in the opening direction.

CHANGE OF COMBINATION

The change of combination is carried out when the door of the lock according to the invention is opened. The cover **30** is then visible, as well as the word changing knob **291** of which the head **292** projects with respect to the cover. Each of the counters is first brought into its position corresponding to the old combination. A screw-driver is then introduced into the slot **293** of the head **292** and the latter is turned in the direction marked by the arrow *p* in FIGURE 26. The rotation of head **292** displaces, by the action of the cam **296** of disc **294**, the to-and-fro word changing member **170** from the right towards the left against the action of the spring **148'** located in the gap **148** of the to-and-fro blocking member **140**. The teeth **172** of this to-and-fro member co-operate then with the surfaces **78** of the catches **72**, driving back said catches to the interior of rings **61** against the action of the spiral springs **75**, which has the effect of unlocking, one with respect to the other as regards an angular movement, the two combination rings **52** and **61**. By means of the control knob, the ring **52** can then be made to turn to bring it into a position corresponding to the new figure or the new letter selected for the counter.

When all the counters have been adjusted, the word changing knob is restored to its usual position.

I claim:

1. A combination lock intended to equip a door of a safe, strong room or the like, comprising a support, a plurality of combination counters in circular alignment mounted for rotation on said support, a locking element movably mounted with respect to said support, a mechanism for displacing said element mounted on said support on the same alignment as said counters, an actuating device mounted for rotation about the axis of said alignment to be rendered operational on one or another of said counters and on said mechanism, and a cut-out plate or to-and-fro blocking member movable parallel to said support and co-operating projections and recesses with said counters so as to be able to pass from a locking position to an unlocking position only when said counters have been brought into a predetermined angular position.

2. A lock as defined in claim **1** wherein said support is a base plate mounted on said door, said locking element is a bolt slidingly movable on said plate, and said mechanism is a bolt-driving mechanism.

3. A lock as defined in claim **2**, further comprising an angle lever mounted pivotally on said to-and-fro blocking member, a stud on said bolt-driving mechanism, resilient means for applying in abutting contact said angle lever against said stud, the displacement of the to-and-fro blocking member into said locking position bringing the angle lever out of contact with said stud.

4. A lock as defined in claim **2** wherein said projections are teeth formed on the to-and-fro blocking member and said recesses are slots formed in said combination counters.

5. A lock as defined in claim 2 wherein the to-and-fro blocking member is further provided with an opening in which is located a cam rigidly fixed to said actuating device, said cam assisting in holding said to-and-fro blocking member in said locking position as long as the actuating device is not rendered operational for controlling the bolt-driving mechanism.

6. A lock as defined in claim 2 wherein the bolt-driving mechanism comprises a pin adapted to co-operate with the to-and-fro blocking member to bring the latter into said locking position after the bolt-driving mechanism is manipulated.

7. A lock as defined in claim 2 wherein each of said combination counters comprises two rings capable of turning one with respect to the other, the respective angular positions of the two rings of one counter defining the figure or the letter of the combination of said counter.

8. A lock as defined in claim 2 wherein each of said counters comprises: a front ring, a rear ring, a slot in said rear ring, a denture in said front ring and a positioning catch for the counter which co-operates with said denture.

9. A lock as defined in claim 2 wherein each of said combination counters comprises: a front ring, a rear ring, a slot formed in said rear ring and a combination catch subject to the action of resilient means, seated in a bore opening into said slot, to fix rigidly with respect to one another said front ring and said rear ring.

10. A lock as defined in claim 2 wherein each of said counters is subject to the action of resilient means placed under tension on the manipulation which brings said counter into said predetermined angular position.

11. A lock as defined in claim 2 wherein each of said counters comprise: a front ring, a denture in said ring, a positioning catch for said counter which co-operates with said denture, resilient means associated with each counter placed under tension on the manipulation which brings said counter into said predetermined position and an annular pinion in engagement with a denture of the bolt-driving mechanism for the control of the withdrawal of the positioning catches governing the return of each counter to its initial position under the action of said resilient means.

12. A lock as defined in claim 12 wherein each of said counters comprises: a front ring, a rear ring, a combination catch subject to the action of resilient means to fix rigidly with respect to one another said front ring and said rear ring and means for withdrawing said combination catch to modify the relative position of the two rings of a same counter for changing the combination.

13. A lock as defined in claim 2 wherein each of said combination counters comprises: a front ring, a rear ring, a combination catch subject to the action of resilent means to fix rigidly with respect to one another said front ring and said rear ring and a cut-out plate presenting teeth or to-and-fro word-changing member mounted for translation parallel to said base plate between a first resting position and a second position in which said teeth simultaneously shield the combination catches of all the counters for changing the combination of the lock.

14. A lock as defined in claim 2 wherein each of said combination counters comprises: a front ring, a rear ring, a combination catch subject to the action of resilient means to fix rigidly with respect to one another said front ring and said rear ring, and a plane cut-out plate presenting teeth or to-and-fro word-changing member mounted for translation parallel to said base plate between a first resting position and a second position in which said teeth simultaneously shield the combination catches of all the counters for changing the combination of the lock and a cam means controllable by a knob projecting on the erar plate of the lock to bring said to-and-fro word-changing member from said first position into said second position thereof.

References Cited

UNITED STATES PATENTS

125,475	4/1872	Moffet	70—299
2,083,782	6/1937	Grubb	70—299

FOREIGN PATENTS

620,497	1/1927	France.
735,479	8/1932	France.

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U.S. Cl. X.R.

70—310, 317