May 15, 1928. 1,670,042

S. D. MOTT

COMBINATION LOCK

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Fig. 2.

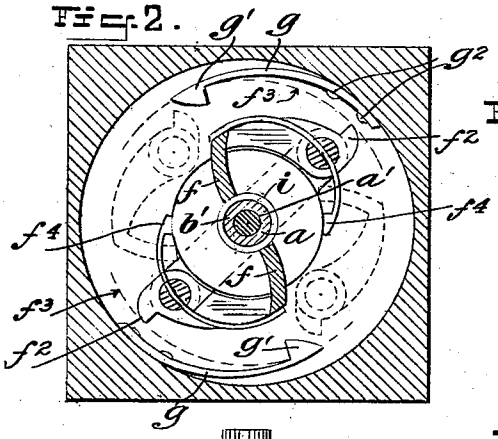


Fig. 3.

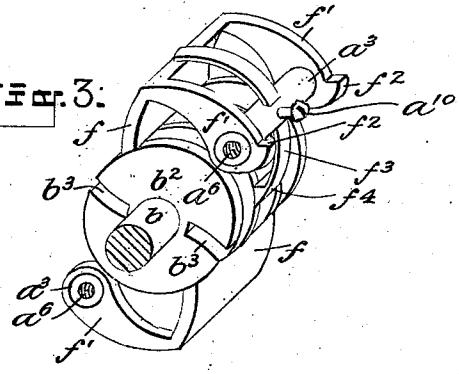


Fig. 4.

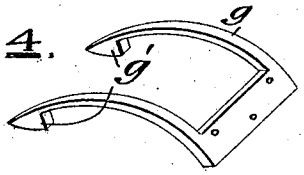


Fig. 1.

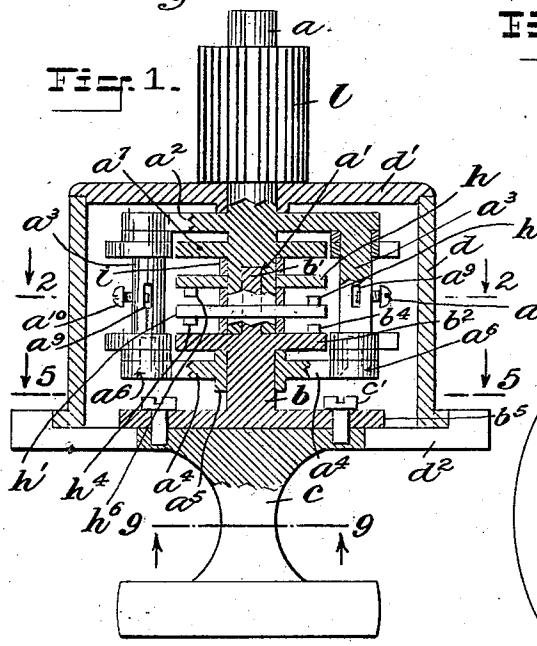
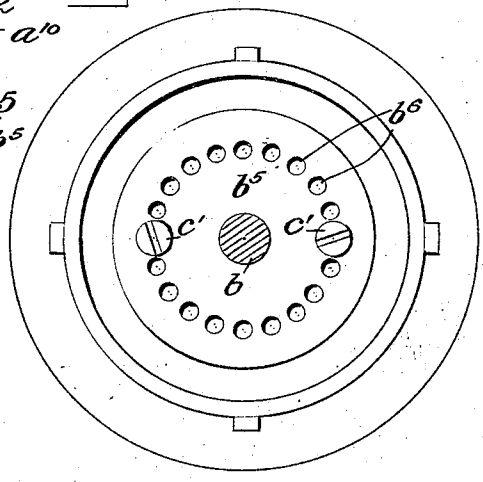


Fig. 5.



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Fig. 10.

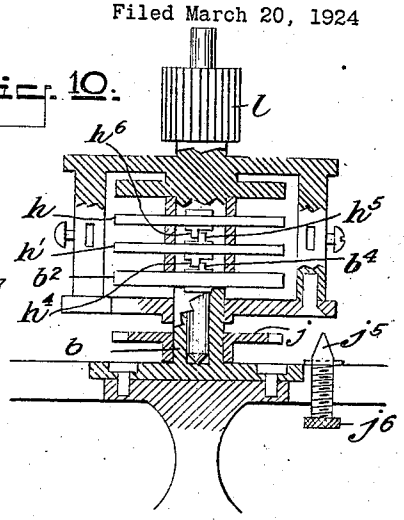


Fig. 7.

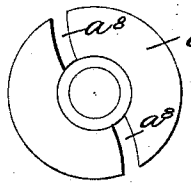
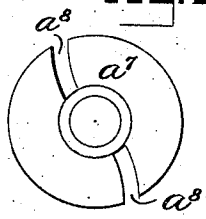


Fig. 8.



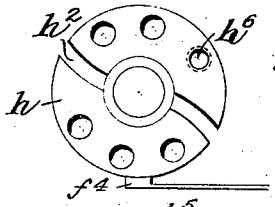
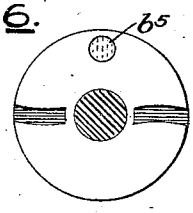
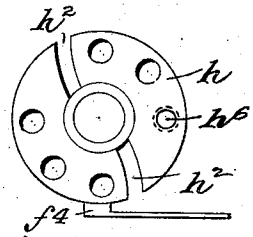


Fig. 6.





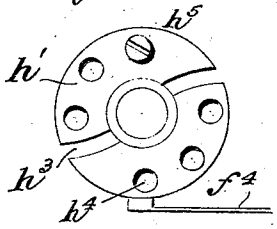
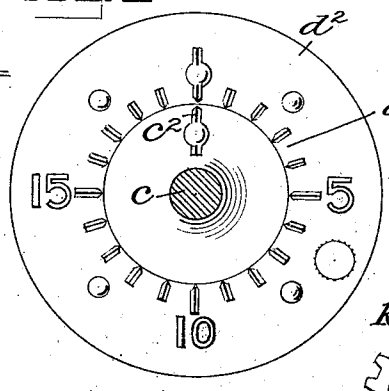
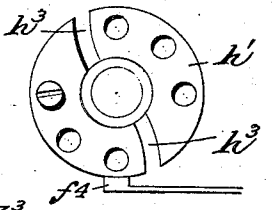
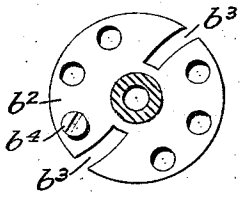


Fig. 9.







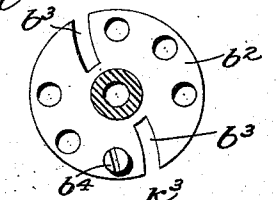


Fig. 11.

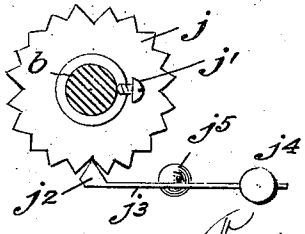
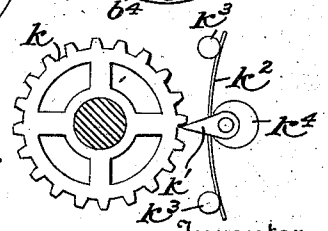


Fig. 12.



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COMBINATION LOCK

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Fig. 13.

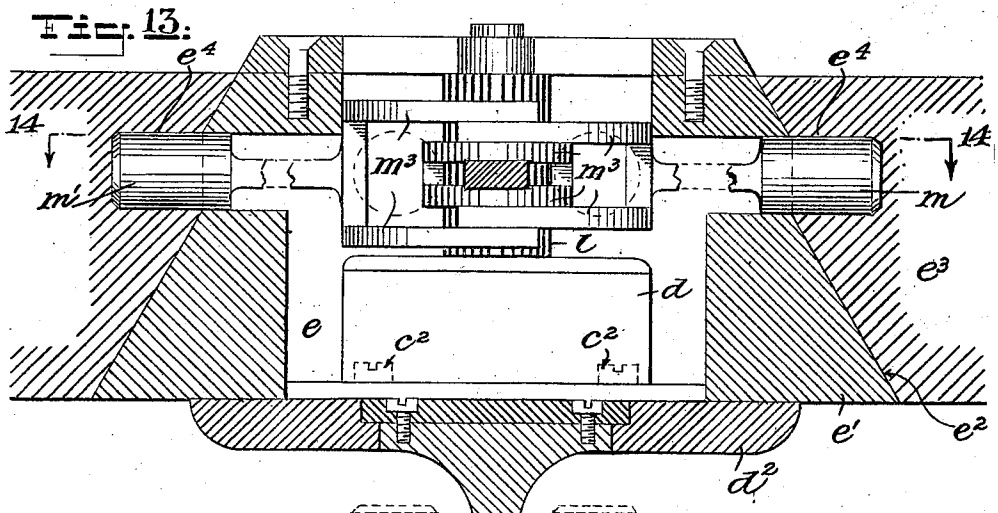
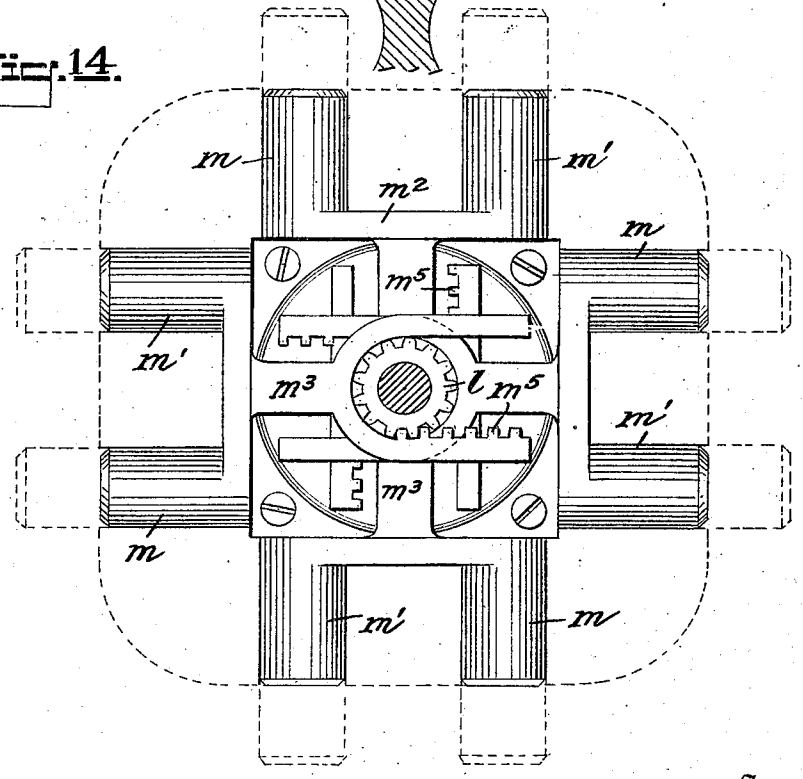


Fig. 14.



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Patented May 15, 1928. 1,670,042

UNITED STATES PATENT OFFICE.

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COMBINATION LOCK.

Application filed March 20, 1924. Serial No. 700,740.

This invention relates to means for coupling a plurality of aligned shafts by co-operating parts dependent upon the principle of permutations and combinations and more particularly to the incorporation thereof in a combination lock. The invention seeks to provide a noiseless lock of the character described which cannot be picked nor operated by any sound or feel of the co-operating elements incident to their assuming on operative position. To this end the lock is so arranged that no automatic operation of the co-operating parts is initiated which would convey an indication of the movement of the parts into operative position until the combination is completed. Broadly, the invention comprises aligned driven and driving shafts carrying, respectively, driven and driving elements and common means to automatically engage the elements on both shafts when they are in predetermined positions. More specifically, when applied to a combination lock, the aligned driving and driven shafts each carry a disc formed with a slot and a connecting element or dog is automatically adapted to enter the slots when the discs are in predetermined positions whereby the two shafts may be rotated as a unit. In order to increase the selectivity of the operation of the device one or a plurality of independent discs having corresponding slots may be mounted upon the aligned shafts and interposed between the aforementioned discs and means may be provided to cause each independent disc to adopt a predetermined position whereby the slot formed therein may offer a clearance for the movement of the connecting member. The bolt or other locking element which is to be actuated by the lock may, of course, be actuated by suitable connections with the driven shaft.

These and other objects of the invention will be apparent from the following detailed description taken in connection with the accompanying drawings illustrating a preferred embodiment of the invention and in which:

Figure 1 is a view partly in section showing the co-operating parts of the combination lock in assembled relation.

Figure 2 is a view taken in the plane indicated by the line 2—2 and looking in the direction of the arrows and showing the connecting element or dog in operative position to transmit driving torque between the aligned shafts.

Figure 3 is a view in perspective showing the discs or tumblers and the connecting element or dog in inoperative position.

Figure 4 is a detail view showing a trip for moving the dog out of operative position.

Figure 5 is a view taken in the plane indicated by the line 5—5 in Figure 1 and looking in the direction of the arrows and showing one way of changing the combination of the lock.

Figure 6 is a view showing, in end elevation, the series of tumblers or discs in Figure 1 or 10 in what may be termed the initial position from whence the various tumblers are moved in succession out of their relative position in working out the combination.

Figure 7 is a view of the several tumblers or slotted discs indicated in Figure 1 as they might appear when in inoperative or miscellaneous positions so that the alined shafts are uncoupled and showing further means for changing the combination.

Figure 8 is a view showing the tumblers or slotted discs in operative position wherein the slots are alined for the reception of the connecting element or dog after the combination has been worked out.

Figure 9 is a view taken in the plane indicated by the line 9—9 of Figure 1 and looking in the direction of the arrows and showing the dial upon which the combination is worked out.

Figure 10 is a fragmentary sectional view similar to Figure 1, but on a somewhat smaller scale showing a modification of the bearing between the alined shafts and also showing means for giving an audible indication of the position of the counter with respect to the graduations on the dial for use at night when the dial is normally not visible.

Figures 11 and 12 are views showing modifications of the aubible indicating means.

Figure 13 is a sectional view of lock mechanism to which the present invention is applicable.

Figure 14 is a view taken in the plane indicated by the broken line 14—14 in Figure 13 and looking in the direction of the arrows.

The invention will be described with refer-

ence to a noiseless combination lock, but it will be apparent as the description proceeds that the invention will be equally applicable in any situation in which a plurality of aligned shafts are to be coupled by mechanism operating upon the principle of permutations and combinations. Referring more particularly to Figure 1 the driven shaft is represented at a and the driving shaft at b. Forming a part of the driving shaft b and secured thereto by screws c' is a knob or knurled head section c. Shaft a is formed at its innermost end with a centrally disposed circular recess a' which is adapted to receive and form a bearing for the circular extension b' of the shaft b. The aligned shafts a and b are axially disposed within a cylindrical recess formed in a housing d, shaft a being journaled in a rear wall d' and the knurled head portion c of shaft b being journaled in a front wall d^2. The front and rear walls may be secured to the housing in any convenient manner but since in practice the front wall d^2 will serve as the face of the lock and will be carried on the outer surface of a wall, door or the like, it will be found preferable to secure the front wall to the housing by means of screws, for instance, entering from the rear, in order that no means may be afforded for removing the front wall of the housing from the outside, the heads of screws for this purpose being indicated at c^2 in Figure 13 wherein the housing d is illustrated as contained within a recess e in a door e' closing an opening e^2 in the wall e^3.

Shaft b is freely rotatable with respect to shaft a and the means for coupling the two shafts to turn as one are contained within the housing d. Shaft a is formed with a pair of diametrically disposed arms a^2. At the extremities of these arms and either unitary therewith or secured thereto in any convenient manner are a pair of shafts a^3 extending forwardly and in parallel relationship with the aligned shafts. Secured to the ends of the shafts a^3, respectively, are the ends of a pair of diametrically disposed arms a^4 carried with a bushing a^5 journaled loosely upon the shaft b. Screws a^6 are indicated securing the ends of the arms a^4 to the shafts a^3. Also integral with the shaft a is a disc or transmitting tumbler a^7 formed with diametrically disposed slots a^8 of curved outline as indicated in Figures 7 and 8, the curved surfaces of the slots being circumferential with respect to the axes of the respective shafts a^3. Shaft b is formed with a similar disc or master tumbler b^2 also having diametrically disposed slots b^3 of curved outline corresponding in configuration to the slots a^8 in the disc a^7. It will be apparent that the arms a^2, disc a^7 and disc b^2 need not be formed integral with the respective shafts, but on the contrary may be keyed thereto or otherwise secured in any conventional manner.

If a connecting element were inserted in the slots b^3 and a^8, it will be apparent that the aligned shafts would turn as a unit. Such a connecting element or dog is illustrated in perspective at f in Figure 3 and in section in Figure 2. The dog is shaped to slide easily into and out of the slots by forming its surface circumferential with respect to the axis of shaft a^3 and is preferably formed integral with a pair of levers f' pivotally mounted on the shafts a^3. Two such dogs are shown in the interest of strength but it will be apparent that one or any number might be used each carried by a respective shaft. When two dogs are provided they are disposed upon opposite sides of the discs in such position as to enter the respective diametrically disposed slots and are yieldingly held against the perimeters of the tumblers so that immediately the slots in the respective tumblers are aligned, the dogs will enter to form a coupling therebetween. In order to uncouple the shafts means are provided for withdrawing the dogs from the slots. In the preferred embodiment of the invention the levers f' are formed on the opposite sides of the fulcrums with extended portions f^2. When the dogs are fully within the slots, the outer extremity of the arms f^2 are adapted to travel in the arcs indicated by the dotted lines f^3 in Figure 2. A trip in the form of a hoop-shaped resilient member g formed with a hooked end g' is secured as by rivets or screws g^2 on the interior of the housing in such manner that the hook g' extends into the path of the arm f^2. When the shaft is rotated hook g' engages the arm f^2 thereby causing the lever to turn about its fulcrum and withdraw the dog from the slot. As two levers f' having extensions f^2 are shown on each shaft a twin trip may be formed as illustrated in Figure 4 in the interest of convenience and simplicity of manufacture and assembly. Two of these trips are shown diametrically disposed within the housing to determine the angle through which the shafts may rotate as a unit and beyond which the shafts may not be turned without effecting the disengagement thereof one from another. In order to provide for the yielding engagement of the dogs with respect to the perimeters of the discs springs f^3 are provided which pass through slots a^9 in the respective shafts a^3 and have a bearing as at f^4 against the two idler tumblers. Such a bearing serves not only as provision for reaction against the spring to cause it to press the dogs always against the perimeter of the discs but in addition serves as a brake upon the two idlers in order that they may be held substantially against rotation except when intentionally turned through

the medium of the studs. The springs f^3 are rigidly retained in the slots a^9 by means of screws a^{10}, for instance.

There has thus been described the simplest aspect of the invention since a coupling is not only provided between two aligned shafts, but in order to effect such coupling, it is necessary to place the respective discs in predetermined position with respect to each other.

For practical purposes it will be found advisable to increase the number of tumblers and thus increase the number of steps to be taken in working out the combination. To this end additional tumblers are inserted between the discs b^2 and a^7. These discs are indicated at h, h' and are shown as journaled upon the aligned shafts and freely rotatable with respect thereto. While only two, what may be termed idler tumblers, are shown for the purpose of illustration, it will be understood that any number of such tumblers may be used, spaced from each other and from the discs a^7 and b^2 by bushings i each additional idler tumbler adding a number to the combination. The idler tumblers are shown more clearly in Figures 7 and 8 and are each formed with diametrically disposed slots h^2 and h^3, respectively, corresponding in every particular with the slots a^8 and b^3. It will be apparent, in order that the dog may serve as a connection between the discs b^2 and a^7 that the slots h^2, h^3 must be aligned with the slots a^8 and b^3. Means for bringing the slots into alignment and moving them out of such alignment will now be described. The master disc or tumbler b^2 is formed on its inner face with a stud b^4. This stud may be formed in any convenient way on the disc, but it is preferred that the stud take the form of a screw whereof the shank enters a hole such as b^5 (Figure 6). Disc h' is provided with a pair of studs on opposite sides, respectively of the disc as illustrated clearly in Figure 1. On the side of that disc adjacent the disc b^2 is the stud h^4 and on the opposite side thereof is the stud h^5. On the side of the disc h adjacent the disc h' is a stud h^6. Studs b^4 and h^4 extend outwardly from their respective discs a distance sufficient to enable them to engage each other with the discs and are rotated with respect to each other while the studs h^5 and h^6 are similarly formed. The outer surface of wall d^2 is graduated to constitute a scale d^3 as indicated in Figure 9 and a pointer or index c^2 is indicated in suitable fashion on the surface of the element c.

The combination is worked out in a manner similar to other usual combinations that is, the knurled head c is turned in clockwise and counterclockwise directions to bring the pointer c^2 to predetermined positions upon the scale d^3. To illustrate more in detail, the positions of the four discs shown in Figure 7 may be taken as any positions in which the discs may chance to be when the lock is in inoperative position with the dogs removed from the slots and in Figure 8 the position of the four discs are shown when the slots are aligned to permit the dog to enter the slots. It will be assumed that the combination is 5—15—10 from the initial or zero position. The knurled head is first turned in a counterclockwise direction for several revolutions in order that the stud b^4 shall pick up the stud h^4 and the stud h^5 pick up the stud h^6 thus causing the three discs b^2, h' and h to rotate together in the initial position shown in Figure 10. Still continuing to rotate the knob in a counterclockwise direction, the pointer c^2 is turned past the point marked 0 and is brought to rest opposite the graduation marked 5 on the scale. The knob is then turned in a clockwise direction. This will cause the stud h^5 to be moved out of contact with the stud h^6 when the disc h' is finally turned whereby the disc h remains stationary in the position shown in Figure 8 under the braking action of the spring. As the stud h^6 has been placed at a predetermined position upon the disc h the slot h^2 is aligned with the slot a^8. Continuing to turn the knob in a clockwise direction through 360 degrees, the rotation of the disc h' being also retarded by the spring f^3, the stud b^4 will be caused to pick up the stud h^4 on the opposite side thereof. The rotation of the knob is then continued in the same direction until the pointer comes to the graduation marked 15. This will bring the slot h^3 in line with the slots h^2 and a^8 as illustrated in Figure 8. The knob is then turned again in a counterclockwise direction until the pointer is travelled through 90 degrees and is brought to rest opposite the graduation marked 10 at which time the disc b^2 takes the position shown in Figure 8 and all four slots are aligned. The dogs which are yieldingly maintained against the perimeters of the discs are now permitted to enter the slots whereby the two shafts will turn as a unit.

Various means may be adopted for changing the combination of the lock. For instance, the shaft b may be formed at its outer end with a plate portion b^5. An annular series of holes b^6 may be provided in order that the knob portion c may take any one of a series of positions with respect to the plate b^5, the screws c' passing through any pair of diametrically disposed holes in the series and entering the holes c^3 in the knob. It will thus be apparent that by changing the knob portion c with respect to the plate b^5 the entire combination may be changed. In addition, any or all figures of the combination may also be changed by

changing the relative position of the studs on the tumblers. To this end an annular series of holes may be formed in each of the tumblers b^2, h and h' as indicated clearly in Figures 7 and 8 and by changing the studs from one hole to another, each number of the combination may be changed.

It may sometimes happen that the combination must be worked in the dark in the absence of a light or luminous marking on the dial. To this end audible indicating means may be provided which will give a sound, such as a sharp click, as the pointer c^2 passes over each graduation on the scale. This will not serve to give away the combination as the clicks will merely indicate the relative position of the index with respect to the scale and will have no connection with the relative positions of the various studs. In Figure 10 there is shown a ratchet wheel j secured in any convenient manner upon the shaft b as by means of the screw j'. A dog j^2 carried on the end of a spring j^3 which is mounted in any convenient manner in the housing as at j^4 is yieldingly held against the ratchet so that as the dog snaps into the depressions between the teeth on the ratchet an audible sound is given. If desired every fifth depression between adjacent teeth may be formed of greater depth than the rest. This will result in the dogs j^2 snapping into the deeper depression with greater force thereby giving a different sound. The ratchet wheel may then be disposed on the shaft so that the deeper depressions correspond to the position of the pointer at the points marked 0—5—10—15 on the scale. A pin j^5 is shown in Figures 10 and 11 threaded into the front wall of the housing and provided with a conical point. By moving the pin axially by means of its knurled head j^6 more or less of the conical point is brought to bear against the spring j^5 to determine the tension thereof and the force with which the dog j is snapped into the depressions between the teeth on the ratchet wheel. In Figure 12 there is illustrated a modification of the audible indicating means comprising a gear wheel k adapted to be rigidly connected to the shaft in any convenient manner while a pointer k' is adapted to be yieldingly held against the teeth through the intervention of the spring k^2 held between the studs k^3, k^3 and the eccentrically pivoted base portion k^4 supporting the pointer k'. The tension of the spring is adjusted by the cam k^4.

Referring to Figures 1 and 10, it will be observed that the innermost end of the driven shaft a is provided with a pinion l. This pinion l is rigidly secured to the shaft in any convenient manner and is adapted to transmit motion from the shaft to the bolts constituting the lock elements of the lock.

In the illustrated embodiment shown in Figures 13 and 14, the lock is carried in a closure e' for the aperture e^2 in the wall e^3 which wall is formed with recesses e^4 for the reception of the bolts. In the drawings bolts reciprocal at right angles to each other are disposed in pairs m and m' carried with a connecting element m^2 mounted on a forked member m^3 one arm of which is formed with teeth as at m^5 to co-act with the pinion l. When therefore the shafts are connected to turn as one the pinion l will, when the knurled head c is turned force each forked member radially to cause the bolts to enter the recesses e^4 in the wall. Movement of the knurled head in the opposite direction will of course cause the retraction of the bolts in the same manner. It will be understood of course that the rotation of the two shafts as a unit is limited in the embodiment illustrated to an angle of 90 degrees and that so soon as the knurled head c is turned through an angle greater than 90 degrees the end f^2 (Figure 3) will be moved into engagement with the trip g' to cause the withdrawal of the dog from the slots in the tumblers and the disconnection of the two shafts.

It will thus be seen that a lock has been provided which is absolutely noiseless in its operation since there is no automatic movement of the parts, as for instance, the movements of the dog into the slots of the tumblers, until the combination is completely worked out the combination from the sound or feel of the co-operating parts moving into operative position. Various modifications may be made in the manner of affording changes in the combination as well as in the uses to which the present lock is to be put and it is not to be limited to the precise bolt mechanism shown in the drawings but is equally applicable in any situation in which two alined shafts are to be connected by devices dependent for their operation upon the theory of permutations and combinations.

What I claim is:

1. A coupling for aligned shafts comprising, in combination, a driving shaft, a driven shaft, driving means carried with the driving shaft, driven means carried with the driven shaft and common means adapted to automatically engage the means on both shafts when they are in predetermined positions.

2. A coupling for aligned shafts comprising, in combination, a driving shaft, a driven shaft, driving means carried with the driving shaft, driven means carried with the driven shaft, idler means, and common means adapted to automatically engage the driving and driven means when said means and the idler means are in predetermined positions.

3. A coupling for aligned shafts compris-

ing, in combination, a driving shaft, a driven shaft, a disc formed with a slot carried with the driving shaft, a disc formed with a slot carried with the driven shaft and means adapted to enter said slots when the discs are in predetermined positions.

4. A coupling for aligned shafts, comprising, in combination, a driving shaft, a driven shaft, a disc formed with a slot carried with the driving shaft, a disc formed with a slot carried with the driven shaft, means normally maintained yieldingly against the perimeters of said discs, and means to cause said first mentioned means to enter the slots when the discs are in predetermined positions.

5. A coupling for aligned shafts, comprising, in combination, a driving shaft, a driven shaft, a disc formed with a slot carried with the driving shaft, a disc formed with a slot carried with the driven shaft, an idler disc formed with a slot, means normally maintained yieldingly against the perimeters of said discs, and means to cause said first mentioned means to enter the slots when the discs are in predetermined positions.

6. A coupling for aligned shafts comprising, in combination, a driving shaft, a driven shaft, a disc formed with a slot and carried with the driving shaft, a disc formed with a slot and carried with the driven shaft, a plurality of idler discs each formed with a clearance and rotatably mounted on the shafts between said first mentioned discs, means to transmit motion from the disc on the driving shaft to the idler discs, a coupling element maintained yieldingly against the perimeters of the discs, and means to cause said coupling element to enter the slots when the discs are in predetermined positions.

7. A coupling for aligned shafts comprising, in combination, a driving shaft, a driven shaft, a disc formed with a slot and carried with the driving shaft, a disc formed with a slot and carried with the driven shaft, a member pivoted eccentrically of the shafts and means to automatically cause said member to enter said slots when the discs assume predetermined positions.

8. A coupling for aligned shafts comprising, in combination, a driving shaft, a driven shaft, a disc formed with a slot and carried with the driving shaft, a disc formed with a slot and carried with a driven shaft, a member pivoted eccentrically of the shafts and means to automatically cause said member to enter said slots when the discs assume predetermined positions, and means to withdraw said member from said slots upon the rotation of the aligned shafts through an angle in excess of a predetermined angle.

9. A coupling for aligned shafts, comprising, in combination, a driving shaft, a driven shaft, a disc formed with a slot and carried with the driving shaft, a disc formed with a slot and carried with the driven shaft, an idler disc rotatably mounted on the shafts between the first mentioned discs and formed with a clearance, a shaft parallel with said aligned shafts but spaced therefrom, an arm rotatably mounted upon said last mentioned shaft, a dog carried with said arm yieldingly held against the periphery of the discs, and adapted to enter said slots when the discs assume predetermined positions, a trip to withdraw the dog from the slot upon rotation of the shafts through an angle greater than a predetermined angle and means to transmit motion between the discs.

10. A coupling for aligned shafts comprising, in combination, a driving shaft, a driven shaft, a disc formed with a slot and carried with the driving shaft, a disc formed with a slot and carried with the driven shaft, a plurality of idler discs rotatably mounted on the shafts between the first mentioned discs and formed with a clearance, a shaft parallel with said aligned shafts but spaced therefrom, an arm rotatably mounted on said last mentioned shaft, a dog carried with said arm yieldingly held against the periphery of the discs, and adapted to enter said slots when the discs assume predetermined positions, a trip to withdraw the dog from the slots upon rotation of the shafts through an angle greater than a predetermined angle, means to transmit motion between the discs, a bolt and connections between the driven shaft and the bolt.

11. A coupling for aligned shafts comprising, in combination, a driving shaft, a driven shaft, a disc formed with diametrically disposed slots and carried with the driving shaft, a disc formed with diametrically disposed slots and carried with the driven shaft, a plurality of idler discs rotatably mounted on the aligned shafts between said first mentioned discs and formed with diametrically disposed clearances, a pair of parallel shafts carried with the driven shaft at opposite sides and spaced from the aligned shafts, a lever rotatably mounted upon each aligned shaft, a dog carried with one arm of each lever and adapted to enter the slots in the discs, a spring secured to each parallel shaft to press the dog against the periphery of the discs and bearing against the ilder discs, a trip to engage the other arm of the lever to move the dog against the action of the spring, means to transmit motion between the driving disc and the idler discs, a bolt and operative connections between the bolt and driven shaft.

12. In combination, a driving shaft, a driven shaft, the end of one shaft being journaled in the end of the other and permutation means to clutch the driving shaft with

the driven shaft substantially as described.

13. In combination with a tumbler carried with a shaft and having a slot, of a clutching element carried with an arm pivoted eccentrically of the shaft, and means to yieldingly maintain the clutch element against the periphery of the tumbler.

14. In combination a shaft, a shaft eccentric to said first mentioned shaft, a tumbler carried with said first mentioned shaft and formed with a slot whereof the surfaces are concentric with respect to the second mentioned shaft, an arm carried with said second mentioned shaft, an engaging element carried with said arm and formed with surfaces concentric with respect to said second mentioned shaft, and means to yieldingly maintain the engaging element in contact with the periphery of the tumbler.

15. In a permutation lock, a plurality of elements positioned upon a common axis, a frame pivoted on the axis on either side of the elements and means on the frame for circumferentially engaging the elements.

16. In a permutation lock, a plurality of elements positioned upon a common axis, a frame pivoted on the axis on either side of the elements, means on the frame for circumferentially engaging the elements and means for releasing the engaging means at will.

This specification signed this 14th day of February A. D. 1924.

SAMUEL D. MOTT.