July 17, 1956 E. A. SCHACHINGER 2,754,673

COMBINATION CHANGING LOCK WITH IMPROVED TUMBLER PINS AND SOCKET SLEEVE

Original Filed Nov. 14, 1950 2 Sheets-Sheet 1

Fig. 1

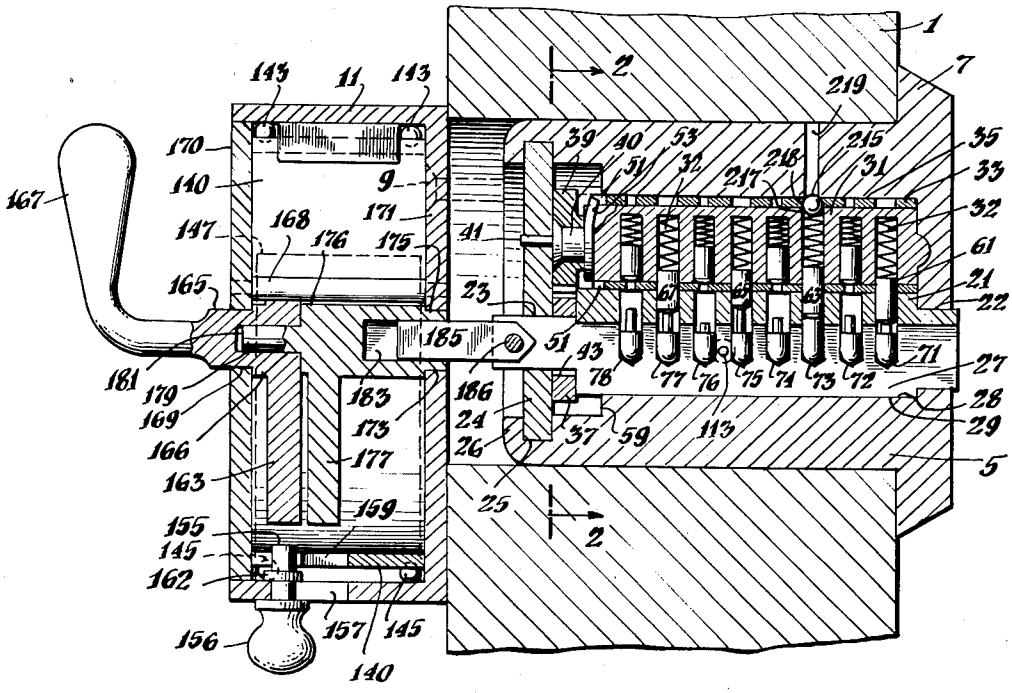
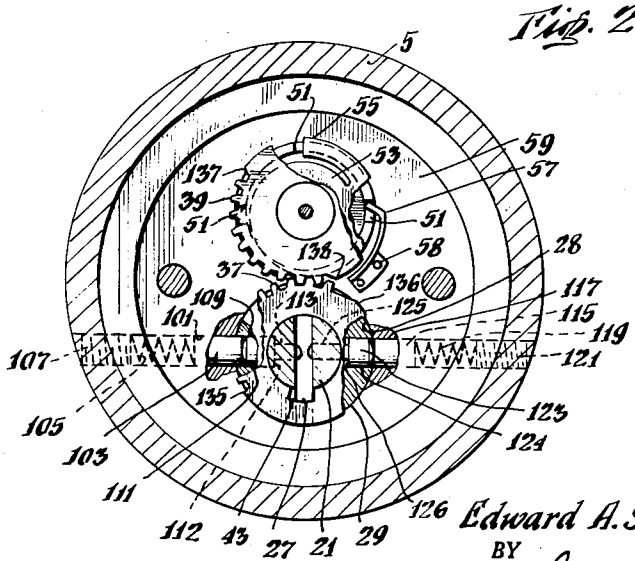


Fig. 2



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Fig. 3

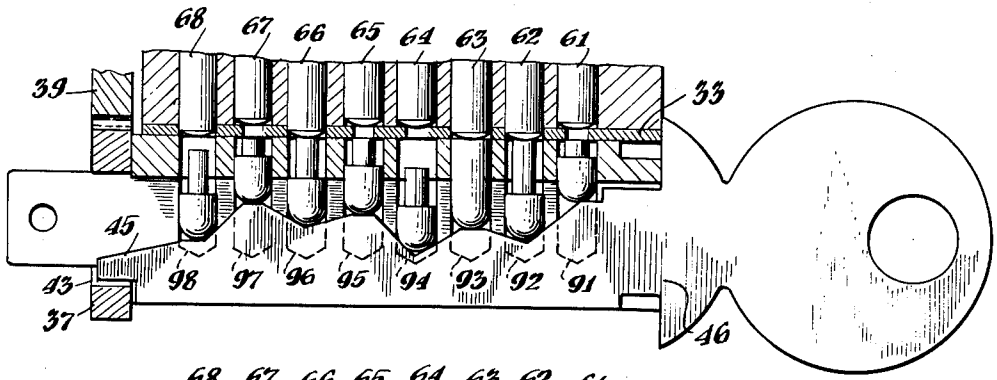


Fig. 4

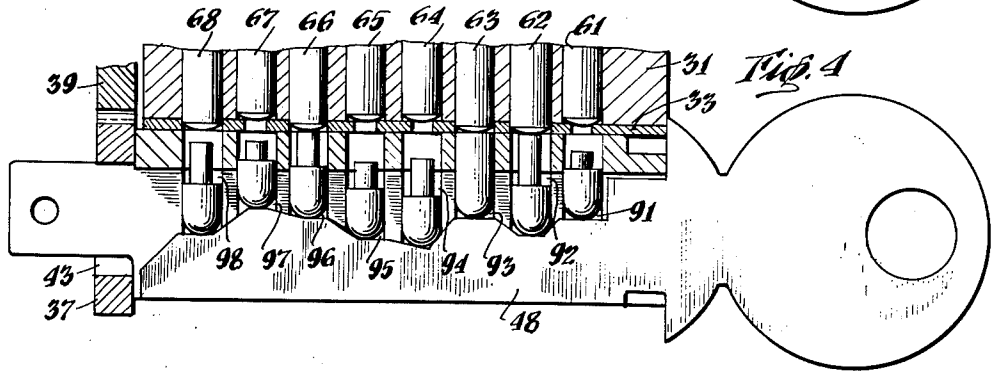
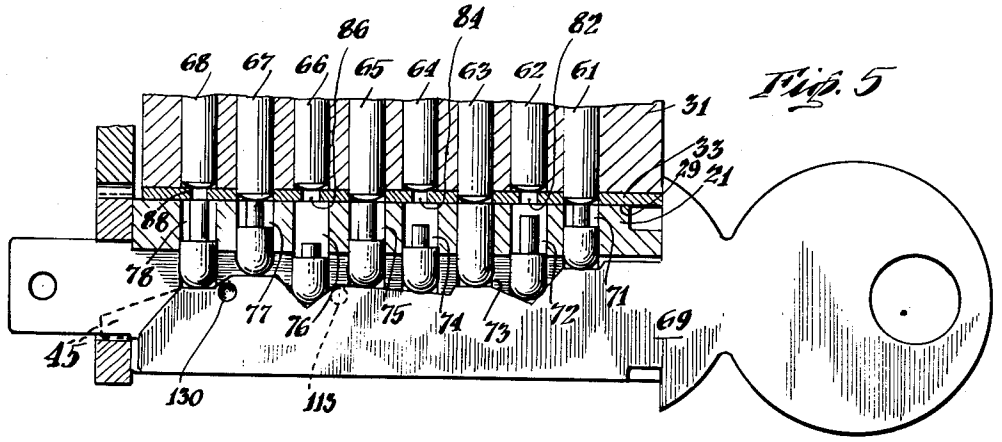


Fig. 5



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2,754,673

COMBINATION CHANGING LOCK WITH IMPROVED TUMBLER PINS AND SOCKET SLEEVE

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Original application November 14, 1950, Serial No. 195,568. Divided and this application April 24, 1953, Serial No. 350,844

15 Claims. (Cl. 70—383)

This invention relates to locks for doors and other purposes. The invention particularly relates to a lock of the tumbler pin combination type and especially to such a lock provided with means for changing the combination of the lock.

Among the deficiencies of conventional locks of the tumbler pin type is that it is possible in many cases to pick such locks without a key by manipulation of the tumbler pins. Such manipulation usually requires that the tumbler pins be lifted in the pinways so that each such pin or the pin in the magazine cooperating therewith is supported by the exterior surface of the keyway shaft adjacent the pinway, that is, the surface at the parting plane between the shaft and the barrel. This lifting of the pins is carried out for the successive sets of pins of the lock until all pinways have pins disposed with their ends at the parting plane. For this purpose slight rotation of the keyway shaft is produced utilizing the play between the pins and the pinways to expose a portion of the exterior surface of the keyway shaft as a shelf upon which to rest the lifted pins.

Another deficiency in conventional locks of the tumbler pin combination changing type results from the fact that the tumbler pins which are in the sockets of the magazine associated with the keyway shaft and which are adapted to register with pinways in the shaft are retained in this magazine by means of a sleeve or similar combination changing element when they are to be ineffective in a given combination. The pins in the shaft pinways are limited in their movement upon insertion of the key in the shaft keyway because the ends of these shaft pins come into contact with the sleeve and can not enter the corresponding sockets. In such a combination changing lock conventionally the longer pins in the shaft pinways are required to be disposed toward the end of the keyway shaft opposite to that at which the key is inserted in the keyway so that the highest bitting of the key which is adapted to cooperate with a short pin in a shaft pinway is not required to pass a long pin in its pinway as the key is moved along the keyway. The restriction is therefore imposed that both the number of the keys of different forms which are adapted to operate a lock having a set of pinways in which pins of different lengths may be disposed as well as the arrangement of these pins in these pinways are limited.

To overcome these and other difficulties, it is an object of the invention to provide a tumbler pin combination lock in which it is not possible to lift all of pins and to support them in keyway shaft releasing position in the operation of picking the lock.

It is another object of the invention to provide a combination changing lock in which picking is made substantially impossible because the position of the pins with respect to the parting plane is extremely difficult to determine.

It is a further object of the invention to provide a tumbler pin combination lock in which the number of keys that it is possible to make for operation of the lock is greatly multiplied.

It is a still further object of the invention to provide a lock in which the pins in the pinways of the keyway shaft are of predetermined different lengths and may be selectively disposed in different pinways, that is, in different arrangements, without otherwise altering the lock so as to modify and greatly increase the number of forms of keys which may be used for operation of the lock.

It is a feature of the invention that one or more of the sockets containing the tumbler pins in the magazine of the lock may be provided with openings adjacent the keyway shaft of less diameter than the diameter of the tumbler pin in such socket so as to retain this socket tumbler pin just as in conventional magazines such pin is retained by the solid wall of a sleeve or other combination determining element of the lock. Sockets of conventional form which may have pins of substantially the same diameter as the diameter of the socket opening and substantially of the same diameter as the diameter of the pinway formed in the keyway shaft and of the pin therein also may be and preferably are provided in the combination lock of the invention. These conventional sockets, pinways and pins, however, may be of different forms to determine the combination and may be arranged in different arrangements in the same magazine and keyway shaft to provide different combinations requiring keys having bittings at predetermined heights for operation of the lock but disposed at different positions along the key. The pins in the sockets of the magazine that are provided with openings of reduced size in relation to the diameter of the respective socket pins are inactive in the combination as are the pins in a conventional lock, for example, a combination changing lock in which the inactive pins are retained in the magazine by the wall of a sleeve out of engagement with the tumbler pins in the pinways of the keyway shaft. These sockets provided with reduced openings have a unique feature, however, in the lock of the invention.

In accordance with this unique feature of the invention the openings of reduced size provide for at least some of the magazine sockets to cooperate with the pins in pinways of the shaft that are adapted to register with these sockets. These keyway shaft pins are formed with shanks of reduced diameter with respect to the body of the pins in the portion of these shaft pins which is disposed toward the magazine, so that these shanks may enter the sockets of the magazine through the openings of reduced size until the shoulder formed between the shank and the body of the keyway shaft pin comes into engagement with the magazine or a sleeve or other combination determining element cooperating therewith. The length of the shaft pins may be such that the ends of the shanks are disposed at the parting plane when the lock operating key is inserted in the keyway shaft or they may be shorter than this length so as not to reach this parting plane. They may not be so long that the shanks extend through the corresponding openings of reduced size into the sockets when the key is fully inserted since the lock thereby would remain locked.

Preferably, the bodies of the different pins of the keyway shaft which have shanks of reduced diameter are the same length measured from the shoulder between the shank and the body to the end of the pin remotely disposed with repect to the magazine. Thus, all of the pins which are provided with shanks may be lifted to the same elevation until the shoulders bear against the magazine, thereby determining the height of the highest bitting of the key. This highest bitting may be disposed at any position along the key, it now being possible to lift any or all of the keyway shaft pins to this maximum elevation as the key is inserted since the shanks may pass upwardly through the openings of reduced size into the respective sockets until the shoulders of the respective pins engage

the magazine or the sleeve. For operation of the lock, however, it is necessary as above indicated that the bittings be properly arranged on the key and be of such height that no shank extends up into a socket while the active keyway shaft pins meet those of the sockets at the parting plane.

Another feature of the invention in the combination lock of the tumbler pin type is the provision of one or more auxiliary pinways and pin sockets respectively in the keyway shaft and in the barrel of the lock. In these auxiliary pinways and sockets are disposed tumbler pins cooperating with each other additionally to lock and unlock the keyway shaft. In the preferred embodiment the pin in the shaft pinway is adapted to engage the lateral face of the key inserted in the keyway to actuate these auxiliary pins to and from shaft releasing position. Preferably at least two such sets of auxiliary pinways sockets and the pins therein are provided. As hereinafter described one of these sets may serve to unlock the shaft when the end of the shaft pin bears against the adjacent flat lateral surface of the key. The other auxiliary set may serve to hold the shaft against unlocking movement when the key is inserted part way in the lock with the shaft pin bearing upon the flat lateral face of the key but is adapted to release the shaft when the shaft pin moves into a recess provided in this lateral face of the key when the key is fully inserted.

Other features and advantages of the invention will be understood more clearly from the description to follow of the drawings, in which:

Fig. 1 is a longitudinal cross section of the tumbler pin combination changing lock of the invention set in a door and cooperating with a bolt lock.

Fig. 2 is a transverse section of the tumbler pin combination lock taken on line 2—2 of Fig. 1, with portions broken away to show certain details.

Fig. 3 shows in partial longitudinal section a modification of the combination changing lock of the invention with the master key inserted therein.

Fig. 4 shows in partial longitudinal section the lock of Fig. 3 with a regular operating key inserted therein.

Fig. 5 shows in partial longitudinal section the combination changing lock of Fig. 1 with a regular operating key inserted therein.

As shown in Fig. 1, in a door or similar closure **1** a bore is provided in which the barrel **5** of the combination changing lock is disposed, this barrel being provided with the usual flange **7** bearing against the face of the door **1**. Fastened to the opposite face of the door by suitable screws or other fasteners **9** is the frame **11** of a bolt lock such as that disclosed in my copending application Serial No. 195,568, filed November 14, 1950, of which this application is a division. This bolt lock may have a sliding bolt carried by member **140** supported on balls **145** for movement parallel to the door and retained by balls **143**, both sets of balls rolling on the inner surfaces of the frame **11**. The bolt is actuated by cams **163**, **177** and is adapted in locking position to be received into a retaining member fastened to the door jamb.

The combination changing lock of Fig. 1 is provided with a keyway shaft **21** rotatably supported at the flange portion of the barrel in the bearing **22** and at the opposite end of the shaft in a bearing **23** in the plate **24** which is set in a recess **25** formed in the barrel, the end portion **26** of the barrel being spun over the plate **24** to retain this plate in fixed relation to the barrel. The shaft **21** is connected to cam **177** by a tongue **185** received in recess **183** of the hub of the cam **177** for rotation of the cam upon rotation of the shaft **21**. As in conventional locks the keyway shaft is of cylindrical form rotatably fitting in a bore **28** formed in the barrel **5**. In the embodiment of Fig. 1, the shaft **21** is provided with eight pinways extending transversely of the axis of the shaft and centered upon this axis in the conventional manner. This shaft also is provided with the usual keyway **27** for insertion therein of a key at the right hand end thereof in Fig. 1 so that the key comes into engagement with the pins provided in the pinways to lift these pins to shaft releasing position and for other effects in the manner more particularly to be described hereinafter.

The combination changing lock of Fig. 1 also is provided with a cylindrical magazine **31** rotatable on its axis and disposed with its axis parallel to the axis of the keyway shaft **21**. As is customary, this magazine is provided with longitudinally spaced sockets respectively in planes transverse to the keyway shaft axis through the centers of the pinways of this shaft, these sockets containing socket pins or tumblers which are urged outwardly of their sockets by springs **32**. Concentric with and in contact with the circumferential surface of the magazine **31** a cylindrical sleeve **33** rotatable on the magazine axis in a bore **35** formed in barrel **5** extends about the magazine. The magazine **31** and its sleeve **33** are arranged so that the outer circumferential surface of the sleeve substantially is tangential to the outer circumferential surface of the keyway shaft **21** in the conventional manner, the sleeve **33** being rotatable relative to the magazine as well as relative to the bore **35**.

The sleeve **33** is provided with a plurality of holes therein which are disposed in rows in the direction parallel to the axis of the magazine in locations which are in planes transversely of the axis of the keyway shaft through the centers of the pinways in this keyway shaft. At each location the sleeve is provided with a series of holes spaced circumferentially about the sleeve, the holes of the respective series being in longitudinal alignment in the rows parallel to the axis of the magazine. Thus, upon rotation of the sleeve relative to the magazine the respective rows of holes are brought into register with the sockets provided in the magazine. Means hereinafter described are provided to hold the sleeve in position relative to the magazine for each of these positions of registration. The magazine and the sleeve thus held in relation thereto are rotatable in one direction as a unit so as to bring a succeeding row of holes in the sleeve into register with the pinways in the pinway shaft. The magazine alone then is reversely rotatable to bring its sockets into register with the succeeding row of holes and with the shaft pinways.

Within the scope of the invention, the combination changing lock being described may be provided, as disclosed in my prior Patent No. 1,967,042, July 17, 1934, with a magazine which is manually movable relative to the sleeve for changing the combination or the lock may be provided with means as described in my prior Patent No. 2,427,814, September 23, 1947, for automatically changing the combination of the lock by rotating the sleeve relative to the magazine upon operation of the lock by a key of predetermined form.

In the embodiment of Fig. 1 automatic means are utilized which comprise the partial gear **37** which is rotatably supported on a shank portion of the keyway shaft adjacent the end thereof which bears in the bearing **23** formed in the plate **24**. This gear **37** meshes with a partial gear **39** which is fastened upon the shank **40** of the magazine adjacent the shaft end **41** of this magazine which rotatably bears in the plate **24**. Thus, upon rotation of the gear **37**, the magazine **31** may be rotated forwardly on its axis so that the sockets of this magazine are moved out of alignment with the pinways of the keyway shaft. The gear **37** is provided with a notch **43** into which, as shown in Fig. 3, the end **45** of a key, ordinarily a master key **46**, may enter to effect rotation of the gear **37** upon operation of the lock with this key to change the combination. When the lock is to be operated without changing the combination a key, such as the key **48** of Fig. 4, may be used which is not provided with an end extension **45**, so that in such regular operation of the lock the gear **37** is not rotated and the relation of the sleeve to the magazine is not changed.

In order to effect change of the combination, however, in a manner similar to that described in my prior Patent No. 2,427,814, the sleeve **33** is provided with end notches **51** in the same circumferentially spaced relation about the sleeve, as shown in Fig. 2, as are the rows of holes in the sleeve. To effect rotation of the sleeve upon rotation of the magazine when, as above described, the gear **37** is rotated by key **46**, a pawl **53** in the form of a flat washer having a finger or lip **55** circumferentially disposed thereon is fastened by suitable means to the magazine between the gear **39** and this magazine. The finger or lip **55** is bent sufficiently out of the plane of the washer to enter endwise into the notches **51** to effect rotation of the sleeve with the magazine upon rotation of the magazine in a given or forward direction and to be cammed out of these notches upon relative movement of the magazine with respect to the sleeve upon reverse rotation of the magazine. Upon rotation of the gear **39** and the magazine **31** in the counterclockwise direction, as viewed in Fig. 2, finger **55** of the pawl **53** will enter a notch **51** and rotate the sleeve with the magazine. The gear **37** in this operation must be rotated clockwise as viewed in Fig. 2, that is, from the left in Fig. 1. The key **46**, therefore, would be operated counterclockwise when viewed from the front of the lock at the right in Fig. 1. Upon return movement of the key the magazine will be rotated reversely by the gears, that is clockwise, viewed from the left in Fig. 1 to return the sockets to their initial position in register with the pinways of the keyway shaft. A detent **57** is provided, as shown in Fig. 2, which is supported by fasteners **58** upon the face **59** of a counter bore in the barrel **5** for engagement with the lengthwise part of the notches **51** of the sleeve **33** to hold this sleeve in the advanced position to which it is moved in the forward rotation of the magazine when the key **46**, as viewed from the front of the lock, is rotated counterclockwise as described above. It will be apparent that in this return movement of the magazine, the sleeve being held against movement, the socket of the magazine will be brought into register with the next row of holes in the sleeve, the row of holes having been brought into position to register with the pinways of the keyway shaft in the movement effected by the key **46** in which both the magazine and the sleeve were moved forwardly to the advanced position. The pawl **53** and the detent **57** provide simple means both cooperating with the notches in the sleeve to produce the successive forward movements of the sleeve and the relative movement between the sleeve and magazine as well as holding the sleeve and magazine in proper relation to each other for regular operation of the lock after changing the combination.

In accordance with the invention the sleeve **33** is provided with holes of reduced diameter with respect to at least some of the pins in the socket of the magazine, other holes in the sleeve being of such diameter that the socket pins associated therewith may project through and enter the corresponding pinways of the keyway shaft. Thus, in Fig. 1 pins **61**, **63**, **65** and **67** in the particular combination there shown in which the lock is set project through holes in the sleeve **33** that are substantially the same diameter as the diameter of the magazine sockets in which these pins are disposed and the corresponding pinways **71**, **73**, **75** and **77** also are substantially of the same diameter. When the key is removed from the lock the pins **61**, **63**, **65**, **67** serve to lock the shaft **21** against rotation thereof. Upon insertion of key **69**, as shown in Fig. 5, the pins in the pinways **71**, **73**, **75** and **77** are lifted so that the upper ends of these pins which are in contact with the corresponding socket pins **61**, **63**, **65** and **67** are in the parting plane between the outer circumference of the sleeve **33** and the outer circumference **29** of the shaft **21**. The lock, therefore, may be operated to unlocked position.

It will be noted, however, when the key is fully inserted

in the lock that the pins in pinways **72**, **74**, **76** and **78** either do not reach to the parting plane or, at least, the upper ends of these pins are not disposed above the parting plane in Fig. 5. It will be apparent also that the contour of the key in engagement with the pins in pinways **72**, **74**, **76** and **78** may be of greatly different forms provided only that the upper ends of these pins do not become positioned above the parting plane and therefore do not enter the openings **82**, **84**, **86** and **88** in the sleeve that are of reduced diameter with respect to the corresponding pins **62**, **64**, **66** and **68**, the other pins in the sockets and pinways functioning as above stated.

As is apparent in Figs. 1 and 5, pins **62**, **64**, **66** and **68** are retained by the sleeve in their respective sockets as effectively as if the holes of reduced size **82**, **84**, **86** and **88** were omitted and the solid wall of the magazine were utilized for thus retaining these socket pins. It will be noted further that, except for the pin in the pinway **71**, the highest bitting on the key **69** of the particular embodiment shown is that which elevates to the parting plane the pin in the pinway **77** in contact with the socket pin **67**. As now will be explained, this bitting nevertheless may lift and pass all of the pins in the pinways **71** to **76**, inclusive, even though the pin in pinway **72**, for example, is somewhat longer than the pin in pinway **77**. For this purpose the pins in all of the shaft pinways that are associated with sleeve holes **82**, **84**, **86** and **88** of reduced diameter in the embodiment and combination described are provided with shanks of such reduced diameter that these shanks may pass into the respective holes **82**, **84**, **86** and **88**. Of the shaft pins that are associated with the socket pins which determine the combination of Fig. 5 those disposed in pinways **71**, **75** and **77** are provided with shanks but engage pins **61**, **65** and **67** of full diameter through openings in the sleeve of the full diameter of the pinway and of the socket. The holes of reduced diameter shown in Figs. 1 and 5 are disposed in the respective series of circumferentially spaced holes above mentioned and in each of these series there may be holes of full diameter positioned in other rows of the holes in the sleeve and determining different combinations. Thus, any of the pins in the pinways of the shaft may become combination determining pins by cooperation with socket pins projecting through holes of full diameter in the sleeve. Any of these pins, however, may become inactive pins out of engagement with which corresponding socket pins are held by the sleeve since the socket pins cannot pass through the holes of reduced diameter. These holes of reduced diameter, however, permit the shanks of the corresponding keyway shaft pins where necessary to project upwardly through these holes during movement of the key into the keyway and until the key reaches its fully inserted position.

In the embodiment of Figs. 1 and 5 the bodies of the pins in the shaft pinways that are provided with shanks are of the same length. While within the scope of the invention these bodies may be made of different lengths, by forming them of the same length these pins all may be raised to the same elevation until the shoulder between the shank and the body engages the circumferential surface of the sleeve., This preferred embodiment makes possible the determination of the maximum height of the bittings of the keys which are capable of being inserted in the lock. It also is apparent that when a key provided with a bitting of maximum height is used, the pin in the shaft pinway operable by such highest bitting may be formed with no shank whether or not this pin is one which cooperates with a socket pin in unlocking operation of the combination lock.

In general, however, shanks provided on such pins would have a substantial length and the keys capable of operating the lock would be formed to suit these shank pins as well as to operate the conventional full size pins provided, as shown in Figs. 1 and 5, in the pinway **73** and pin **63** in the corresponding socket.

The same set of pins, however, may be used in the pinways of the combination lock of the invention rearranged in different pinways without otherwise changing the structure. In the embodiment of Figs. 3 and 4, it will be noted, as compared with Figs. 1 and 5, that the pins in pinways **91**, **92** and **93** are substantially the same as those in pinways **71**, **72** and **73** of the lock of Figs. 1 and 5, although the combination determined is different. The pins in pinways **94** and **95** are in reverse relation with respect to the pins in the pinways **74** and **75** of Figs. 1 and 5. That is to say that the pin in the pinway **94** has a long shank corresponding to the shank of the pin in pinway **75** of Figs. 1 and 5, whereas, the pin in the pinway **95** has a short shank corresponding to the pin in pinway **74** of Figs. 1 and 5. Similarly, the pins in pinways **96** and **97** are in reverse relation as to their shanks with respect to the pins in the pinways **76** and **77** of Figs. 1 and 5. The pin in the pinway **98** has a shank substantially the same as that in the pinway **78** of Figs. 1 and 5. It will be apparent that without changing the construction of the lock, merely by rearranging the pins in the pinways, a key of entirely different form is required for operation of the lock. The combination shown in Fig. 3 is such that the socket pins **62**, **63**, **66** and **68** are the active pins, the pins **61**, **64**, **65** and **67** being inactive in this combination. The key shown in Fig. 3 is the master key for this combination, all of the upper ends of the keyway pins being disposed at the parting plane when the key is inserted since the bittings on this key are of the proper height for this purpose. The keys shown in Figs. 4 and 5 are regular operating keys for the respective combinations. Each of these keys may be one of a large number of such operating keys respectively for the combinations of Figs. 1 and 3, it being possible to form at least some of the pins in the pinways **71** to **78**, inclusive, with shanks which may be of substantial length reaching to the sleeve as shown, for example, by the pin in pinway **92**, Fig. 4. Others of the pins may have short shanks, as shown for the pin in pinway **91**. The highest bitting in the key **48** may be at or adjacent the forward end of the key, for example, the bitting engaging the pin in the pinway **97**. Since all of the bodies of the shaft pins having shanks of reduced diameter are of the same length, it will be apparent upon consideration of Figs. 3 and 4 that this highest bitting may pass all of the pins in pinways **91** to **96**, inclusive, the shanks of the several pins passing through the corresponding openings of reduced size until the shoulders engage the sleeve **33**, if necessary for such clearance.

The number of keys, therefore, which may be made for operation of the lock of the same construction and the number of combinations which may be secured without change in the structure of the lock but merely in the arrangement of the pins is greatly increased with respect to conventional locks, thus greatly increasing the difficulty of making keys by trial and error which are capable of operating a lock as above described.

It also will be understood, in any endeavor to pick a lock by raising the individual pins in the pinways, that the pins themselves which are provided with shanks cannot be raised into the magazine so as to rest on the slight shelf which may be secured by slight rotation of the shaft due to play between the shaft and the barrel and between the magazine and the barrel. The shoulders which are formed on the pins provided with shanks prevent raising the body portions of these pins into the magazine where the holes in the magazine are of reduced diameter. Thus, a long pin, such as that in pinway **72** of Figs. 1 and 5 or in pinway **94** of Figs. 3 and 4, cannot be raised out of the way of the picking tool so as more easily to operate the pins along the keyway shaft from the end thereof at which the key is inserted. Moreover, since the shanks may pass through the opening of reduced size into the magazine, it is more difficult for the operator endeavoring to pick the lock to

To increase the difficulty of picking a lock as above generally described, the lock of the invention provides preferably at least one auxiliary shaft pinway and pins respectively therein that are adapted to be actuated by engagement of such auxiliary shaft pin with a lateral face of the key, as shown in Fig. 2. In socket **101** extending transversely of the axis of the keyway shaft is disposed an auxiliary pin **103** biased toward the keyway shaft **21** by a spring **105** retained by a suitable plug **107**. This socket and pin are disposed so as to register with auxiliary shaft pinway **109** in which is disposed shaft tumbler pin **111**. In the embodiment shown in Fig. 2, the pin **111** has a shank **113** of reduced diameter adapted to project slightly into the keyway **27** of keyway shaft **21** when the shoulder between this shank and the body of pin **111** bears upon a corresponding shoulder **112** in the auxiliary shaft pinway **109**. When the key is not inserted in the keyway **27** the contacting ends of the pins **103**, **111** are disposed within the circumference **29** of the keyway shaft, the pins being held in this position under the pressure of the spring **105**. In this position the shoulder between the body of the pin **111** and the shank **113** bears against the shoulder **112** in the pinway **109**. Upon insertion of the key, the flat face of the key bearing against the shank **113** moves the pins **111** and **103** toward the left, Fig. 2, so that the contacting ends of these pins are disposed in the plane tangential to the circumference **29** of the keyway shaft, thus providing for parting movement of the shaft **21** with respect to the barrel **5**.

Preferably a second auxiliary set of socket and pinway pins also is provided, as shown at the right in Fig. 2. The socket pin **115** disposed in socket **117** is biased toward the shaft **21** by spring **119** retained by plug **121**. The socket pin **115** is in contact with the end of the body of the pin **123** in pinway **124** of shaft **21**, the pin **123** having a shank **125** the end of which enters the keyway **27**. When the key is not in the keyway the shoulder **126** between the body **123** and the shank **125** of this auxiliary pinway pin bears against the corresponding shoulder in the shaft **21** to hold these pins in the position shown in which the contacting ends are disposed at the parting plane between the circumference **29** of the keyway shaft **21** and the bore **28** of the barrel **5** in which this shaft rotates.

It will be understood that upon insertion of the key the face thereof which is opposite to the face which engages the end of the shank **113** will force the pins **115** and **123** toward the right, Fig. 2, against the bias of spring **119**. As shown in Fig. 5, however, the key **69** is provided with a recess **130** disposed in position therealong so as to register with the shank **125** of pin **123** when the key is fully inserted in the keyway. The recess **130** is of such depth that the shank **125** may enter therein to bring the body **123** substantially against the shoulder **126** in the pinway **124** so that the contacting ends of the pins **115** and **123** again may be disposed at the parting plane. Thus, upon insertion of the key both sets of auxiliary tumbler pins become positioned for releasing the keyway shaft **21** for unlocking operation of the lock. It will be apparent that the presence of these auxiliary tumbler pins requiring the equivalent of a key to hold them in shaft releasing position increases materially the difficulty of picking a lock by manipulation of the magazine tumbler pins thereof. Preferably the two sets of pins are disposed toward the inner end of shaft **21** in spaced relation therealong, as shown in Figs. 1 and 5, but the two sets, if desired, may be disposed in axial alignment with each other at any suitable position along the shaft.

As shown in Fig. 2 the gears **37** and **39** are provided upon only a portion of circumferential extent thereof with teeth adapted to mesh each other in the two gears. The remainder of the circumferential extent is of full diameter such as may be provided by the blanks from which the gears are cut. The circumferentially spaced end portions **135** and **136** of the gear **37** thus respectively may engage

of the sleeve **33** forwardly and to limit the return rotation of the magazine **31** relative to the sleeve **33** as the finger **55** is cammed out of a notch **51** in changing the combination as above described. As shown in Fig. 2, although only four notches **51** are provided in the sleeve **33**, thus, in principle, only requiring 90° rotation of the magazine and sleeve, the extent of the teeth on the gears is somewhat greater than 90° but substantially less than 180°. This somewhat greater extent of the teeth permits the keyway shaft and the magazine and the sleeve to be rotated forwardly beyond the precise position in which the new row of holes is registrable with the pinways in the keyway shaft without carrying the sleeve forward to a position in which the second succeeding row of holes would be brought into registering position and held there by the detent **57**. Upon reverse rotation from this somewhat advanced position, however, the detent **57** will enter the corresponding notch in the sleeve to hold this sleeve in the desired position. This reverse rotation of the magazine may then continue, as above described, until the magazine sockets are in register with the pinways of the keyway shaft so that the active socket pins may enter the corresponding shaft pinways when the key is removed to lock the lock. The end portions **136** and **138** of the gears **37** and **39** by their engagement prevent undue movement beyond this locking position. Since in the regular operation of the lock by the keys **48** or **69** the gears **37** and **39** and the magazine and sleeve are not rotated, these keys may be operated either in the usual clockwise direction when viewed from the right in Fig. 1 or in counterclockwise direction to effect unlocking operation of the tumbler pin combination lock without limitation by the limited number of teeth on the gears **37** and **39**.

It will be understood from the above description and by reference to the drawings that, if desired, the keys **69** and **48** which are intended for regular operation of the lock in a given combination thereof may be provided with toes, such as the toe **45** of the key **46** of Fig. 3, and that when so provided, as shown in dotted outline by way of example for the key **69**, Fig. 5, upon operation of the lock with such keys, the combination will be changed from the combination in which the regular key is effective to unlock the lock to the next combination as determined by the sleeve **33**. When so operated by a given regular key having a toe the lock may not be operated again by this given key, or a key without such toe but for the same combination, until the sleeve **33** is successively rotated to the different combination determining positions again to reach the position determining the combination for the given key. By providing, however, a set of regular keys, four in number for the lock shown in the drawings, having bitings which are capable of operating the combination determining pins in the respective combinations, each of these four keys being provided with a toe **45**, operation of the lock by such keys in succession will be effective to change the combination to the succeeding combination in each such operation. Operation of the lock in this manner may be desirable in some cases, for example, in the operation of Watchman's tour stations as described in my prior Patent No. Re. 22,864, issued April 8, 1947. It also may be useful in the operation of a door lock where it is desired to secure control of opening and closing of the door by requiring a different key each time the lock is operated. It will be understood, however, that a set of regular keys, four in number in the embodiment shown, without toes **45** also may be provided, if desired, so that the lock may be operated repeatedly in any one of the four positions of the combination determining sleeve **33** selected by means of the master key **46**.

As shown in Fig. 1, a ball detent **215** may be provided in the combination changing lock for retaining the magazine in the position thereof in which the sockets are in register with the pinways of the keyway shaft and with the selected row of longitudinal spaced holes in the sleeve **33** during normal operation of the lock. As shown at **217**, one of the sockets in the magazine **31** extends entirely through the magazine and registers with a hole **218** in the sleeve **33** which may advantageously be located in one of the rows of longitudinal spaced holes provided for combination changing purposes and preferably is of a diameter large enough to receive one of the full diameter pins **73** when in register therewith. The detent **215** is normally positioned at the top of the open ended socket **217** partly within the hole **218** and is urged outwardly by the spring **32**. A hole **219** of somewhat smaller diameter than the detent **215** extends through the side wall of the barrel **5** in alignment with the open ended socket **217**, and the walls of the barrel **5** at the inner end of the hole **219** provide a seating recess for the detent. The diameters of the magazine socket, the ball detent **215** and the hole **219** and the thickness of the wall of the sleeve **33** are all so selected as to insure that the detent will not be seated so deeply within the hole **218** and the mouth of the hole **219** as to make it impossible to cam the detent out of its seat in the hole **219** and also out of its position in the hole **218** when the magazine and the sleeve are rotated relatively at the desired stage in a combination changing operation.

Conventional means not shown in the drawings may be used to hold the barrel **5** of the combination lock in the bore provided in the door or other closure supporting this lock. This lock in the form of a combination changing lock as above described may be constructed for operation in the direction and sequence of operation as above described or in the reverse direction and sequence by suitably forming the notch **43** with respect to the plane of the keyway shaft and by forming the pawl **53** in the opposite hand and positioning detent **57** at the opposite side of the sleeve or so as oppositely to engage the notches **51**.

Within the scope of the invention the combination determining means represented by the sleeve **33** may be made in other forms providing openings of reduced diameter relative to the magazine tumbler pins and adapted to cooperate with tumbler pins in the shaft pinways which are formed with shanks adapted to pass through these openings of reduced size. Such a combination determining element within the scope of the invention may be arranged for movement other than coaxial movement of the magazine **31** to bring holes of full size as well as of reduced size into registering position with the magazine sockets and with the pinways. All such variations and others within the skill of the art which may be made as modifications of the structures disclosed herein and which embody the features of the invention above described are intended to be covered by the claims appended hereto.

I claim:

1. A combination tumbler lock comprising a keyway shaft having a keyway and a plurality of pinways communicating with said keyway, tumbler pins in the respective pinways of said keyway shaft, a tumbler pin magazine having a plurality of pin sockets arranged along said shaft respectively registrable with said pinways of said shaft, tumbler pins in the respective sockets of said magazine, means providing for at least a given one of said magazine sockets an opening at the end thereof adjacent said keyway shaft of reduced size with respect to the tumbler pin in said given magazine socket to prevent said pin therein from leaving said magazine socket, the tumbler pin in said shaft pinway which is registrable with said given magazine socket being provided with a shank of reduced diameter and sufficient length in the portion thereof disposed toward said magazine so that said shank may enter said given magazine socket through said opening of reduced size upon movement of said shaft pin toward said magazine when the key is inserted in said keyway.

2. A combination tumbler lock as defined in claim 1 in which a plurality of said tumbler pins in said keyway shaft pinways are provided with shanks of reduced diameter and the bodies of said tumbler pins which are provided with said shanks are substantially of equal length between the shoulder adjacent said shank and the

end of said body disposed remotely with respect to said magazine.

3. A combination tumbler lock as defined in claim 1 in which a plurality of said keyway shaft tumbler pins are formed with said shanks and the shanks of the different shaft pins are of different lengths measured from the shoulder formed between the shank and the body of the pin to the end of the shank disposed toward said magazine.

4. A combination tumbler lock as defined in claim 3 in which the bodies of said shaft pins are of equal length between said shoulder and the end of the pin disposed remotely with respect to said magazine.

5. A combination tumbler lock as defined in claim 1 in which a selected shaft pinway and the tumbler pin therein are of substantially the same diameter as the tumbler pin in the magazine with which said shaft pinway is in register, the opening of the magazine socket registrable with said selected shaft pinway being of substantially the same diameter as said selected shaft pinway.

6. A combination changing tumbler lock comprising a keyway shaft having a keyway and a plurality of pinways communicating with said keyway, tumbler pins in the respective pinways of said keyway shaft, a tumbler pin magazine having a plurality of pin sockets arranged along said shaft and registrable with the respective pinways of the shaft, tumbler pins in the respective sockets of said magazine, and a tumbler combination determining element disposed adjacent said shaft and said magazine and operable to a plurality of positions with respect to said magazine and said shaft and having openings therein to provide access of selected tumbler pins of said magazine in each such position of said element to respective pinways of said shaft so as to be actuatable by a key in said keyway engaging said pins in said shaft pinways, said element having at least one opening corresponding to a given magazine pin that is of reduced size with respect to said given magazine pin so as to prevent passage of said given magazine pin therethrough, at least the pin in the shaft pinway which is disposed so as to be brought into register with said given magazine pin being provided with a shank of reduced diameter in the portion thereof disposed toward said magazine so that said shank may pass through said opening of reduced size in said element, the shoulder between said shank and the body of said pin upon engagement with said element preventing said selected tumbler pin from passing fully into said magazine.

7. A combination changing tumbler lock as defined in claim 6, which comprises means providing an operative connection between said keyway shaft and said element to effect movement of said element to a selected pin tumbler combination determining position upon operation of said lock by a selected key.

8. A combination changing tumbler lock comprising a keyway shaft having a keyway and a plurality of pinways communcating with said keyway, tumbler pins in the respective pinways in said keyway shaft, a tumbler pin magazine having a plurality of pin sockets arranged along said shaft and respectively registrable with said pinways of said keyway shaft, tumbler pins respectively in said sockets of said magazine, means for resiliently urging said socket tumbler pins along said sockets toward said keyway shaft, and tumbler combination determining means actuatable successively to predetermined positions relative to said shaft and to said magazine and in selected positions engaging certain tumbler pins in said sockets to restrain them from entering said pinways in said shaft while providng for others to enter the respective registering pinways, said combination determining means providing for at least a given one of said restrained socket tumbler pins an opening of reduced size with respect to the size of said given socket tumbler pin, the pin in the pinway of said keyway shaft which is registerable with said given socket pin being formed with a shank of reduced diameter in the portion thereof disposed toward said magazine to provide for said shank entering said opening of reduced size in said combination determining means to engage said given magazine socket tumbler pin in its socket.

9. A combination changing tumbler lock comprising a body, a keyway shaft rotatably supported in said body and having a keyway lengthwise of said shaft for receiving a key therein, said shaft being provided with a plurality of pinways arranged along said keyway and extending transversely thereof and communicating with said keyway, tumbler pins in the respective pinways of said keyway shaft, a tumbler pin magazine rotatably supported in said body upon an axis parallel to the axis of said keyway shaft and disposed adjacent said keyway shaft, said magazine having therein a plurality of pin sockets arranged along and extending transversely of the axis thereof, said magazine being disposed in relation to said keyway shaft so that said pin sockets are brought into register with the respective pinways of said shaft upon rotation of said shaft and said magazine to positions with said sockets and said pinways in a common plane, tumbler pins respectively in said sockets of said magazine, a combination changing sleeve supported in said body and rotatable on the axis of the sleeve and disposed with respect to said keyway shaft and said magazine so that a circumferential extent of said sleeve is disposed between said magazine and said shaft and is substantially tangent to said shaft at the line joining the axes of said magazine and said shaft, said sleeve being provided with a plurality of openings adapted respectively selectively to register with pin sockets in said magazine to determine the combinations of the lock upon rotation of said sleeve relative to said magazine to different predetermined positions, at least one of said openings which is adapted to register with a given pin socket in said magazine being of reduced size with respect to the diameter of the pin in said socket so as to prevent passage therethrough of the tumbler pin in said given socket, at least the tumbler pin in the shaft pinway which is adapted to register with said opening of reduced size of said sleeve being provided with a shank of reduced diameter at the portion thereof disposed toward said magazine so that said shank may pass through said opening of reduced size in said sleeve to engage the pin in said given magazine socket, the shoulder between said shank and the body of said pin upon engagement with said sleeve preventing said pin from passing fully into said magazine.

10. A combination changing tumbler lock comprising a body, a keyway shaft rotatably supported in said body and having a keyway lengthwise of said shaft for receiving a key therein, said shaft being provided with a plurality of pinways arranged along said keyway and extending transversely thereof and communicating with said keyway, tumbler pins in the respective pinways of said keyway shaft, a tumbler pin magazine rotatably supported in said body upon an axis parallel to the axis of said keyway shaft and disposed adjacent said keyway shaft, said magazine having therein a plurality of pin sockets arranged along and extending transversely of the axis thereof, said magazine being disposed in relation to said keyway shaft so that said pin sockets are brought into register with the respective pinways of said shaft upon rotation of said shaft and said magazine to positions with said sockets and said pinways in a common plane, tumbler pins respectively in said sockets of said magazine, a combination changing sleeve extending about said magazine and supported in said body for rotation on the axis of said magazine relative thereto and disposed with respect to said keyway shaft so that an outer circumferential extent of said sleeve substantially is tangent to the circumference of said keyway shaft, said sleeve being provided with a plurality of series of holes circumferentially spaced with respect to each other in each series about the axis of said magazine, said series respectively

being disposed in spaced relation along said magazine so that the holes of each series may be brought successively into register with the respective magazine sockets upon rotation of said sleeve relative to said magazine, at least a given hole of one of said series being of smaller diameter than the diameter of the tumbler pin in the registrable magazine socket so that said tumbler pin in said registrable socket may not enter through said hole, another of said holes in said sleeve being of a diameter sufficient for the pin in the magazine socket registrable therewith to enter therethrough into the corresponding shaft pinway brought into register therewith, the pinway in said shaft registrable with said other hole being of a diameter sufficient to receive therein said magazine tumbler pin entering through said other hole in said sleeve for effecting locking of the lock, at least the tumbler pin in said pinway which is adapted to be brought into register with said given hole being formed with a shank of reduced diameter with respect to the body of said pin in the portion of said pin disposed toward said magazine so that said shank may enter through said given hole of reduced diameter in said sleeve into the corresponding socket of the magazine upon movement of said shaft pin toward said magazine when the key is inserted in the keyway.

11. A combination changing tumbler lock comprising a keyway shaft having a keyway and a plurality of pinways communicating with said keyway, tumbler pins in the respective pinways in said keyway shaft, a tumbler pin magazine having a plurality of pin sockets arranged along said shaft and adapted to be registrable with the respective pinways of said shaft, tumbler pins in the respective sockets of said magazine, a tumbler combination determining element operable to a plurality of predetermined positions with respect to said magazine and having a plurality of series of openings therein, each series being disposed in said element so that the openings thereof respectively are brought into register with the corresponding socket of said magazine upon movement of said element to said different predetermined positions, selected openings in the respective series in different predetermined positions being of a size to provide for entry of the corresponding magazine socket pins therethrough to determine the combination of the lock, said element upon such movement thereof being brought into predetermined positions with respect to said keyway shaft so that said magazine pins entered through said selected openings of said series enter into the registering pinways of said keyway shaft, other openings in the different series in said element being of reduced size with respect to the pins in the sockets of said magazine to prevent entry therethrough of the corresponding magazine socket pins, at least the pins in said shaft pinways which are adapted to be brought into register with said openings of reduced diameter being formed with shanks of reduced diameter in the portion of said shaft pins disposed toward said magazine so that said shanks respectively may enter through said openings of reduced size in said element into the corresponding sockets of said magazine.

12. A combination changing tumbler lock comprising a body, a keyway shaft rotatably supported in said body and having a keyway lengthwise of said shaft for receiving a key therein, said shaft being provided with a plurality of pinways communicating with said keyway arranged along said keyway and extending transversely thereof in a plane through the shaft axis, tumbler pins in the respective pinways of said keyway shaft, a tumbler pin magazine rotatably supported in said body upon an axis parallel to the axis of said keyway shaft and disposed adjacent said keyway shaft, said magazine having therein a plurality of pin sockets arranged along and extending transversely of the axis thereof in a plane through said magazine axis, said magazine being rotatable into a position with said plane thereof containing said keyway shaft axis so that said sockets are brought into register with the respective pinways of said shaft upon rotation of said shaft to the position thereof with its pinways in the plane containing said axes, tumbler pins respectively in said sockets of said magazine, a combination changing sleeve extending about said magazine and supported in said body for rotation on the axis of said magazine relative thereto and disposed with respect to said keyway shaft so that an outer circumferential extent of said sleeve is substantially tangent to the circumference of said keyway shaft substantially at said plane containing said magazine and said shaft axes, said sleeve being provided with a plurality of series of holes adapted to be brought in succession in each series into register with the respective sockets in said magazine to provide entry therethrough of tumbler pins of said magazine sockets into registering pinways of said keyway shaft when said magazine sockets and said shaft pinways are in said plane containing said axes to determine the combinations of the lock, a gear supported for rotation on the axis of and independently of said keyway shaft, means operatively connected to said gear and engageable by a key inserted in said keyway for effecting forward and reverse rotation of said gear upon operation of said keyway shaft by said key, a gear supported for rotation on its axis and meshing with said first gear and operatively connected to said magazine to effect reciprocating rotation of said magazine upon reciprocating rotation of said first gear, at least one of said gears having teeth upon a part only of the circumference thereof meshing with the teeth of the other gear to limit the reciprocating rotational movement of said magazine between the normal position thereof in which said magazine sockets and said shaft pinways are in said plane containing said axes and a forward position angularly displaced from said normal position, means operatively connecting said magazine and said sleeve for effecting unidirectional rotation of said sleeve successively forwardly to predetermined positions upon repeated rotation of said magazine from said normal position to said forward position, and means for restraining said sleeve against reverse rotation thereof upon rotation of said magazine reversely to said normal operating position thereof.

13. A combination changing tumbler lock as defined in claim 12, in which said sleeve is provided with notches in the end thereof, and an element operatively connected to said magazine and having a lip adapted to engage said end notches to effect rotation of said sleeve upon said rotation of said magazine in said forward direction, said lip being adapted to withdraw from the engaged notch upon said reverse rotation of said magazine, said means for restraining reverse rotation of said sleeve comprising a detent supported by said body and adapted to engage said notches of said sleeve to hold said sleeve against rotation upon said reverse rotation of said magazine.

14. A combination changing tumbler lock comprising a body, a keyway shaft rotatably supported in said body and having a keyway lengthwise of said shaft for receiving a key therein, said shaft being provided with a plurality of pinways communicating with and arranged along said keyway and extending transversely of the shaft axis, tumbler pins in the respective pinways of said keyway shaft, a tumbler pin magazine in said body disposed adjacent said keyway shaft and having a plurality of pin sockets arranged along said shaft, said keyway shaft being rotatable forwardly from and reversely to a given position thereof in which said pinways are in register with the respective magazine sockets, tumbler pins respectively in said sockets of said magazine, a combination changing sleeve extending about said magazine and being rotatable on its axis parallel to said keyway shaft axis, said sleeve being disposed so that an outer circumferential extent of said sleeve is substantially tangent to the circumference of said keyway shaft, said sleeve being provided with a plurality of series of holes adapted to be brought in succession in each series into register with the respective sockets in said magazine to provide entry therethrough of the tumbler pins in said magazine sockets

into registering pinways of said keyway shaft when said shaft is in said given position to determine the combination of the lock, a gear supported for rotation on the axis of and independently of said keyway shaft, means connected to said gear and operatively connectible to a key inserted in said keyway shaft for effecting forward and reverse rotation of said gear upon operation of said keyway shaft by said key, a gear supported for rotation on its axis and meshing with said first gear, at least a selected one of said gears having teeth upon a part only of the circumference thereof meshing with the teeth of the other gear to limit the reciprocating rotational movement of said gears between a normal position thereof corresponding to said given position of said keyway shaft and a forward position of said gears angularly displaced from said normal position, means operatively connecting said gears to said sleeve for effecting unidirectional rotation of said sleeve successively forwardly to predetermined positions thereof upon repeated rotations of said gears

from said normal position to said forward position, and means for restraining said sleeve against reverse rotation thereof upon rotation of said gears reversely to said normal position thereof, thereby to change the combination.

15. A combination changing tumbler lock as defined in claim 14 in which on said selected one of said gears abutments are provided respectively adjacent the end teeth of the circumferential row of teeth thereon respectively engaging the teeth of the other gear to limit the forward and reverse rotational movements of said gears.

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