

Nov. 22, 1966

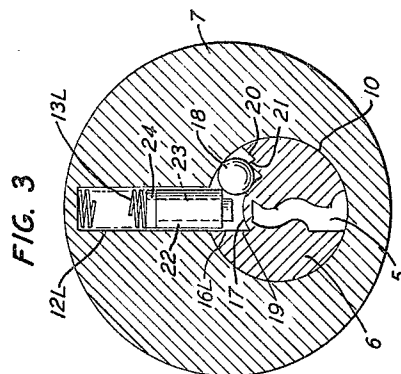
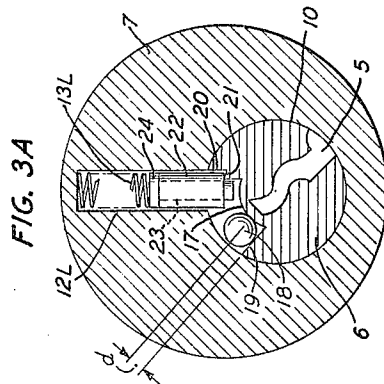
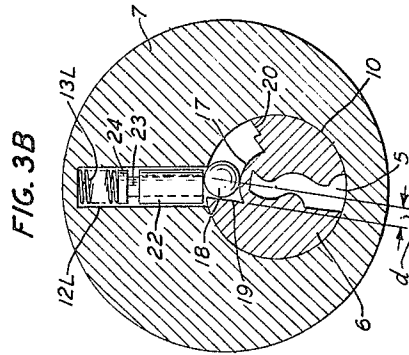
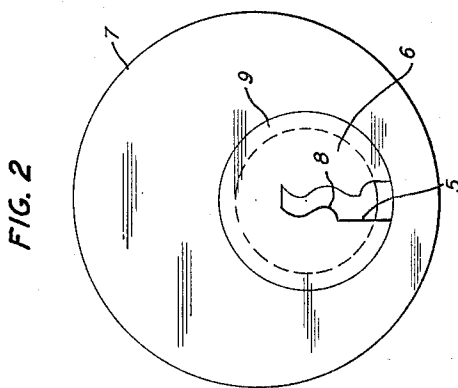
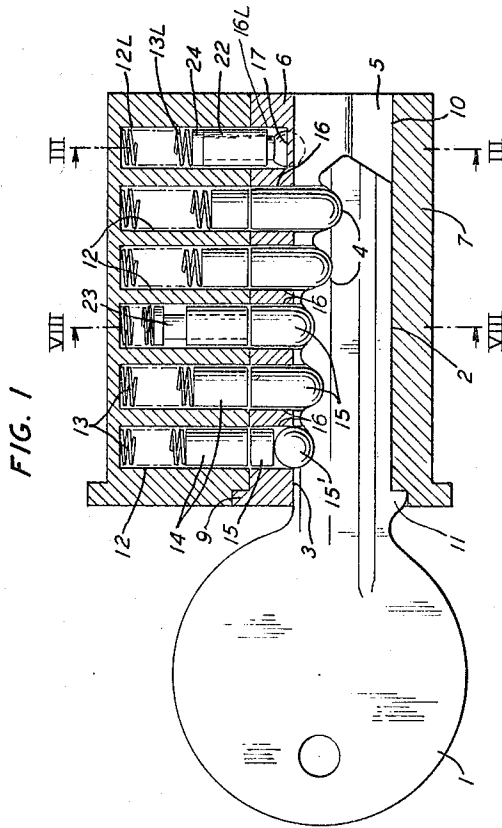
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3,286,494

PICK-PROOF PIN-TUMBLER LOCK MECHANISM

Filed March 23, 1964

2 Sheets-Sheet 1



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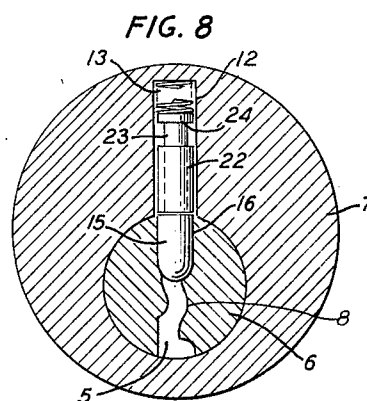
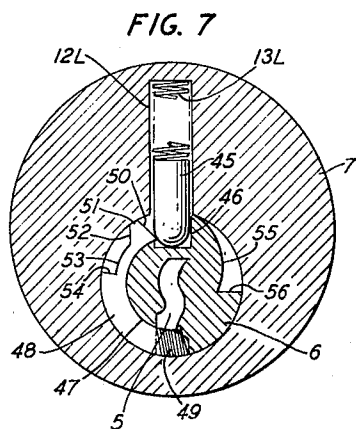
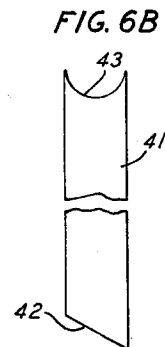
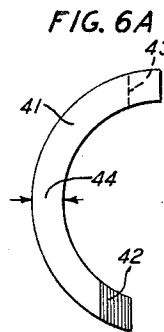
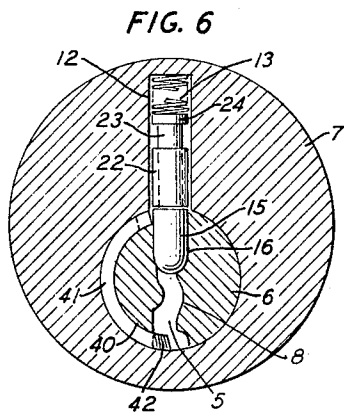
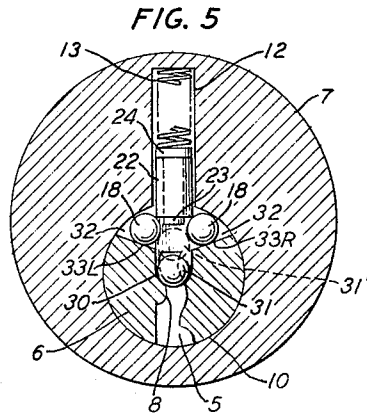
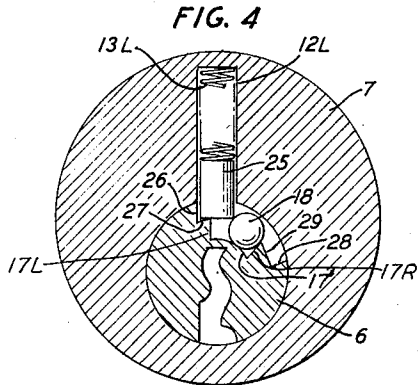
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PICK-PROOF PIN-TUMBLER LOCK MECHANISM

Filed March 23, 1964

2 Sheets-Sheet 2



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3,286,494

PICK-PROOF PIN-TUMBLER LOCK MECHANISM

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10 Claims. (Cl. 70—419)

This invention relates to pin tumbler locks employing a plurality of pin tumblers positioned longitudinally aligned with, and spaced from, each other in a radial plane of a cylindrical lock housing body, and cooperating with associated radial bores in a rotatable plug longitudinally within such housing, the bores extending from the cylindrical surface to the keyway of the rotatable plug.

An object of the invention is to provide a pick-proof mechanism which prevents productive movement of the locking hardware should the pin tumblers be picked or manipulated by any means to register at the shear line in the absence of the proper key.

A further object is to provide a pick-proof device in pin tumbler locks which prevents opening such locks even though all the pin tumblers have been aligned without the benefit of the proper key; the pick-proof mechanism preferably being not accessible for surreptitious picking or manipulation through the keyway but which may be so accessible, and, whether so accessible or inaccessible, the pick-proof mechanism will misalign keylessly aligned pin tumblers and consistently relock the unit after each attempt to productively rotate the plug to open the locking hardware in the absence of the proper key.

Still a further object is to provide a pick-proof mechanism in pin tumbler locks in which all the parts of the usual pin tumbler lock, other than the rotatable plug, require no modification while the modification of the plug involves but nominal expense and being easily effected.

Another prime object is to provide in pin tumbler locks a pick-proof device with a relocking means that will not render the lock inoperable when picking attempts have been made but will instantly respond to the proper key while relocking ad infinitum when means other than the proper key are employed.

Still a further object of the invention is to provide a pick-proof mechanism in pin tumbler locks utilizing all the parts of pin tumbler locks presently not provided with such mechanism, together with the addition of some other parts which are relatively inexpensive, easily manufactured and readily installed.

Still a further object is to provide a pick-proof mechanism in pin tumbler locks without at all affecting present master keying systems.

Another object of the invention is to provide a pick-proof mechanism in pin tumbler locks which involves no change whatsoever in the length of the prior art paracentric key, or any other dimension, to operate pin tumbler locks provided with the pick-proof mechanism of my invention.

Still another object of the invention is to provide means by which additional protection by way of a pick-proof mechanism may be effected independently of, and incorporated directly in, the regular tumbler pins of a pin tumbler lock.

The foregoing, and other, objects and features of my invention will be more readily understood from the following description of several illustrative embodiments

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thereof when read in conjunction with the appended drawing, in which:

FIGURE 1 is a longitudinal section through the keyway of a five pin tumbler lock with the proper key fully inserted and provided with a first embodiment of the pick-proof mechanism of my invention; the mechanism of this embodiment being inaccessible through the keyway of the lock, and in which the unlocking direction of rotation of the plug is a limited initial rotation counterclockwise and then wholly clockwise;

FIGURE 2 is a front view of the lock housing body and the rotatable plug of the embodiment of FIGURE 1;

FIGURE 3 is a section along line III—III of the first illustrative embodiment of my inventive pick-proof mechanism, in its position when the lock is in its normal locked position with the keyway upright vertical;

FIGURE 3A shows the elements of FIGURE 3 when the plug is rotated a small amount counterclockwise, and FIGURE 3B shows such elements as the plug is rotated clockwise after it has initially been rotated counterclockwise the required amount shown in FIGURE 3A;

FIGURE 4 is a section like that of FIGURE 3 through a slightly modified form of the first illustrative embodiment of my pick-proof mechanism which is operable in the same manner as that embodiment and likewise inaccessible through the keyway; the elements of the modification being shown in their positions when the pin tumbler lock is fully locked and the keyway is upright vertical;

FIGURE 5 is a section, similar to that of FIGURE 3, through a second embodiment of my pick-proof mechanism utilizing two balls in an arcuate peripheral groove of the rotatable plug, and a third, preferably slightly smaller, ball in a radial bore in the plug therebetween, the third ball being movable radially upward in the bore when contacted by the tip of the key on full insertion of the latter into the keyway; again with the lock in its locked condition with the keyway upright vertical;

FIGURE 6 is a section, likewise similar to FIGURE 3, through one unit of a third embodiment of my invention, which embodiment may be a single-unit or multi-unit type, one unit thereof being installed at one or more pin tumbler locations of the rotatable plug to register and coact directly with the pin tumbler of an individual peripheral groove in which half-round members are movable, the bottom tips only of the half-round members being accessible through the keyway;

FIGURE 7 is a section through still a fourth illustrative embodiment of my pick-proof mechanism of the single unit type showing such embodiment in the locked position of the lock; this fourth embodiment being installable, like the first embodiment, in present-day pin tumbler locks without modification of the pin tumbler chambers in the body of the lock; the parts per se of the mechanism being inaccessible through the keyway and the unlocking rotation of this embodiment as shown being in the counterclockwise direction; and

FIGURE 8 is a section along line VIII—VIII of FIGURE 1 showing a regular tumbler pin unit utilizing as the upper pin the two-part pin of my invention which I have utilized in several of the illustrative embodiments of my pick-proof mechanism.

Referring to the drawing, the embodiment of my pick-proof mechanism shown in FIGURE 1, paracentric key

1 is fully inserted in a multipin tumbler lock having five pin chambers, the lock incorporating such embodiment of my pick-proof mechanism. Key 1 has a linear flat lower portion 2 along which it slides on insertion into lock keyway 5, and an upper portion 3 having a plurality of key cuts 4 varying in depth to accommodate the bottom pins of the respective pin tumblers. The number of key cuts in any given key is equal to the number of pin tumblers of the lock, five being shown in FIGURE 1. The key is insertable into the longitudinal keyway of rotatable plug 6, positioned within cylindrical body or housing 7, and is of substantially serpentine cross-section, as is well known. Of such serpentine cross-section key 1, the lateral faces are sliding fits on the longitudinally opposed faces of the keyway. At least one of the keyway faces has a longitudinal ridge 8 registering with the upper loop portions of such serpentine-shaped section of the key, the radial bores of the plug for the respective pin tumblers terminating short of this ridge. Ridge 8 restricts the downward movement of the lower pins of the tumblers assuring always that they remain above the ridge for key insertion. The forward end of rotatable plug 6 is provided with an annular shoulder 9 of somewhat larger diameter than the remainder of the longitudinal body of the plug, the latter being a sliding fit in longitudinal bore 10 of cylindrical housing 7, and extending rearwardly from such bore 10 at which extending end region the plug is connected to the locking hardware, not shown, but which may be of any prior known type. Rotatable plug 6 is so assembled to housing 7 that keyway 5 of the plug is substantially along the lower portion of the vertical diametrical region of the housing when the locking hardware is locked. When the key is fully inserted in the keyway, shoulder 11 at the forward end of the key lower face is against the front end of the body proper of cylindrical housing 7.

Extending radially outward within housing 7 but not through the outer wall thereof, a plurality, usually five or six but not limited to such number, of spaced vertical pin tumbler drive chambers 12 is provided from bore 10. Within each drive chamber, a pin tumbler consisting of a coil biasing spring 13, an upper pin 14 and a bottom pin 15, is housed of which the spring is braced between the closed end of the drive chamber and the upper pin to bias both pins in the direction toward the bore 10 to extend the pins from the drive chambers as far as they can freely move unless obstructed. For master keyed systems, these drive chambers contain additional pins, often called "wafers" (not shown).

In rotatable plug 6 a like-numbered plurality of radial bores 16, each individual bore 16 registerable with an individual drive chamber 12, extends from the normally uppermost portion of the cylindrical surface of the plug to ridge 8 of keyway 5, so that when plug 6 is properly assembled, absent the proper key, with the lateral center line of keyway 5 vertical pins 14 and 15 of each pin tumbler may be received in its associated bore 16. It will be noted that under the bias of its associated spring 13, absent the proper key in the keyway, each group of pins 14 and 15 is biased in such direction that the lower and usually half-round vertically or semi-spherical face of each bottom pin 15 extends into plug 6 to a point which assures that the key has free horizontal movement, bottom pins 15 being restricted from further downward movement by ridge 8. Upper pins 14 are of such length, and they may and often do, differ from each other in their respective lengths, that when the proper key is not inserted, or not fully inserted, in keyway 5 they extend from their respective drive chambers 12 into the associated radial bore 16 in the plug, preventing rotation of the plug and thus operation of the locking hardware.

Only when the pins of all the pin tumblers are positioned with the lower faces of their upper pins 14 and the upper faces of bottom pins 15 in alignment at the shear line, that is, at the cylindrical surface of rotatable

plug 6, is the latter free to rotate. The customary way of positioning the pin tumblers at the shear line is by fully inserting the proper key 1 into keyway 5, the key having as stated a plurality of spaced variable depth key cuts 4 in its upper edge 3, which serve to lift bottom pins 15, and hence also upper pins 14, against the pressure of springs 13 from the keyway ridge 8 against which the lower faces of lower pins 15 rest, the required amount so that the upper pins 14 no longer extend into the rotatable plug while the lower pins remain wholly within the plug supported from the bottom by the inserted key. Obviously the key cut depths vary to accommodate lower pins of different lengths. However, it is well known that the pins may be correctly aligned at the shear line without the full insertion of the proper key, indeed without the insertion of any key, by various means, primarily with small tools called "picks," which will manipulate the tumbler pins to the required height, individually or collectively. Generally these picks are insertable into the keyway, and in succession the pins may be manipulated one at a time or in concert and held at the shear line until rotation of the plug is effected. Lock picking may be perfectly proper, as where locksmiths are called upon to open pin tumbler locks when the key is lost, misplaced or unavailable; or it may be illegal, as by thieves, burglars, or other unauthorized persons seeking access to and possession of what is safeguarded by the lock. It is well known that, given the time and opportunity, any prior art pin tumbler lock may be picked, even though the more or less standardized multi-pin tumbler lock, usually having five or six pin tumblers, provides adequate security for general purposes.

What has thus far been described with respect to FIGURE 1 is prior known but was a necessary preliminary for a full understanding of my invention of which the first illustrative embodiment, rendering the lock pick-proof, is shown at the right end region of FIGURE 1. Registering with drive chamber 12L, the last one of the drive chambers in lock body 7, I provide a ballrace 17 of limited arcuate extent for a ball 18 of appropriate size, the depth of the raceway being such that the uppermost region of preferably steel ball 18 therewithin is at the cylindrical surface of rotatable plug 6. I prefer to use the last drive chamber 12L as by so doing the need for a longer key is eliminated; except for this consideration of key length, any drive chamber position may be utilized with equal effectiveness.

Drive chamber 12L houses a sleeve 22 which is a sliding fit therein, and a pin 23 having an enlarged head 24 against which coil spring 13L between pin head 24 and the closed top end of drive chamber 12L is biased tending to move head 24 against the upper face of sleeve 22 and, on their contact both pin 23 and sleeve 22 in the direction to extend the lower end regions of both from chamber 12L. Pin 23 is a sliding fit in sleeve 22 and of such length that with spring 13L pressing pin head 24 against the upper annular face of sleeve 22, pin 23 extends from the sleeve a distance somewhat less than half the radius of ball 18.

The width of raceway 17 is substantially equal to the diameter of drive chamber 12L with which it registers and such that ball 18 is freely rollable circumferentially in the raceway. With keyway 5 in its normal locked position and absent the key therein, raceway 17 starts from the left cylindrical half of bore 16L, which thus forms shoulder 19, in the peripheral region of plug 6 and extends so that an initial counterclockwise movement of the normally clockwise rotatable plug can be had (initially clockwise when the normal rotation of the plug is counterclockwise), an arcuate distance determined by, and less than, the degree of rotation required to actuate the locking hardware. In the sections of FIGURES 3, 3A and 3B, showing different rotatable positions of this embodiment of my pick-proof mechanism, this arcuate length of raceway is shown as about equal to twice the

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diameter of ball 18. The raceway terminates in a shoulder 20 having a step 21 of about equal to the radial width of sleeve 22 at a height above the bottom of the raceway somewhat in excess of half the diameter of ball 18. With keyway 5 in its normal locked position (FIGURE 3), the bottom region of sleeve 22 extends into the raceway being stopped from further movement thereinto by the contact of a portion of its bottom face with the surface of the ball, the latter being blocked from further rolling in the raceway by step 21 of shoulder 20 against which the ball is pressed by the pins 23 and sleeve 22 under the bias of spring 13L.

The operation of the first pick-proof mechanism embodiment of my invention (FIGURES 1, 3, 3A and 3B) which requires clockwise rotation of plug 6 to open its locking hardware, is as follows: In the normal locked position of the pin tumbler lock (FIGURES 2 and 3), ball 18 is to the right of drive chamber 12L and both sleeve 22 and pin 23 extend into raceway 17 (FIGURE 3). Both the sleeve and the pin are thus in the way of any movement of shoulder 19 to the right of the latter's position as shown in FIGURE 3 which would be involved on attempting clockwise rotation of the plug, whether the proper key is or is not in the keyway. It must be recalled that at this time absent the key the regular pin tumblers of the tumbler pin lock are so positioned, unless they have been correctly picked, as likewise to prevent rotation of the plug in any direction. With the proper key fully inserted in keyway 5, the pin tumblers would allow rotation of the plug; however, in this extending position sleeve 22 and pin 23 still contact shoulder 19 and hence prevent clockwise rotation of plug 6. But if the plug be now rotated counterclockwise, ball 18 is forced by step 21 of shoulder 20 successively under sleeve 22 and the bottom of pin 23, raising both against the bias of spring 13L so that the bottom face of each is at the shear line, and the plug may now be rotated in such direction until ball 18 passes to the left thereof when pin 23 and sleeve 22, under the bias of spring 13L, are restored to their projecting position, the adjacent portion of the bottom of the sleeve now, however, coming to rest atop step 21 and the cylindrical surface of pin 23 striking step 21 while the cylindrical surface of sleeve 22 strikes shoulder 20, to prevent further counterclockwise rotation of the plug, as is shown in FIGURE 3A. If now the plug is rotated clockwise, the diameter of pin 23 being slightly greater than the distance d (FIGURES 3A and 3B), the arcuate length from shoulder 19 along the cylindrical surface of the plug from shoulder 19 to the top point of ball 18 when the ball is against this shoulder, continuous rotation of the plug clockwise tends to maintain the ball against this shoulder, the bottoms of pin 23 and sleeve 22 are maintained at the shear line, so that shoulder 19 passes under the sleeve and pin. Thereafter, for the proper direction of plug rotation necessary to open the locking hardware, here clockwise, the continuous surface of the plug maintains the pin and sleeve at the shear line. Such further rotation in the opening direction is possible even though the ball, after it passes beyond the highest position within the raceway, obviously rolls away from shoulder 19 to shoulder 20 in that the downward movement to the extending position of both pin 23 and sleeve 22, as stated, is prevented by the solid unbroken cylindrical surface of the plug now thereunder.

Now assume the regular pin tumblers of a lock incorporating my pick-proof mechanism have been picked, or otherwise manipulated, to the shear line, and the attempt to rotate the plug clockwise fails due to the condition shown in FIGURE 3. Even with a full understanding of my pick-proof mechanism, the picker cannot determine or know if the plug rotation is impeded by shoulder 19 and pin 23 with sleeve 22 thereagainst of my pick-proof mechanism, or by the regular tumbler pins, or by his attempted plug rotation being in the wrong direction, since many plugs of pin tumbler locks now in use rotate

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to unlock in but one direction. Furthermore, my pick-proof mechanism which relocks can be for either clockwise or counterclockwise plug rotation. Let us further assume that the picker is persevering and lucky, and he does "successfully" pick the regular pin tumblers and even rotate the plug in the correct initial direction in accordance with full understanding of my pick-proof mechanism. As a prerequisite to opening the locking hardware, the picker must next rotate the plug under the regular upper pins—this is an absolute *must*. However, the distance between the present position of the plug radial bores 16 for the regular pin tumblers of the lock and the upper pins after the initial rotation of the plug, FIGURE 3A, is too short for "spinning" the plug which requires great speed. Favoring my mechanism in addition, is my special upper pin structure, pin 23 and sleeve 22, which permits pin 23 thereof to drop into raceway 17 long before a one-piece upper pin of the regular pin tumbler of the prior art could drop into its cooperating radial bore 16 in the plug. The final logical alternative of the picker would thus be to hold what he has namely, the lower pins with their tops at the shear line, which is literally impossible without the proper key, and slowly rotate the plug under the upper pins. However, any dwell, stoppage, or hesitation while rotating the plug in the vicinity of the position in which the plug is normally locked to the cylinder body, that is, with the keyway of the plug upright vertically, results in the condition shown in FIGURE 3; in effect relocking the unit and requiring renewed picking, etc. Such repicking will be futile for every time it is done or when there is any dwell or hesitation the condition shown in FIGURE 3 obtains. It will, furthermore, be noted that because pin 23 is of a diameter smaller than the standard diameter of .115" for tumbler pins, spinning of the rotatable plug under such upper pin 23 is prevented. Since pin 23 and sleeve 22 of my pick-proof mechanism are both biased by spring 13L, common to both, there is independent spring action when either or both have the opportunity to seat themselves, as in the case of attempted spinning. With the customary tumbler pins of the prior art, spinning is possible, because to enter the cooperating radial bore in the plug, the entire pin must be over the opening of the radial bore in registration therewith before the downward bias of the spring on such upper pin is apparent, so that if the plug is rotated or spun fast enough the bore opening is gone before the regular upper pin can seat itself. Not so with my upper pin 23 which can readily seat itself even though sleeve 22 is not in exact registration with the opening of the radial bore; seating of pin 23 being possible due to its smaller diameter than sleeve 22 in which pin 23 is a sliding fit and which is of the standard diameter of the customary prior art upper pin.

To recapitulate: The pin tumbler lock incorporating the first illustrative embodiment of my pick-proof mechanism, is unlocked using the proper key by an initial rotation of the plug counterclockwise for an arcuate distance of about a quarter inch (or through an angle of about 45°) from the normal vertical position of the keyway of the lock in its locked position, followed by a clockwise rotation of the plug without any hesitation or dwell for such distance as is required until the locking hardware is operated to its open position.

A modification of this first embodiment is shown in FIGURE 4, this modified pick-proof mechanism likewise not being accessible through the keyway of the lock. In this modification, a single upper pin 25, biased by spring 13L in a drive chamber 12L, is utilized in combination with ball 18 in raceway 17'; the latter being quite similar to raceway 17 of the first embodiment but for its end faces 17L and 17R. In this modified embodiment, raceway left end 17L has an upper stop 26 above a step 27, which step is only wide enough to receive an adjacent portion of pin 25 in the locked position (keyway 5 vertical) of the rotatable plug. In such position, pin 25 pressed

by drive spring 13L, pushes ball 18 to the right thereof between the remote portion of the bottom region of pin 25 and right stepped end 17R of the raceway. Raceway right stepped end 17R has an upper stop 28 above step 29 which is of such dimension as to accommodate thereon the entire bottom face of pin 25 when rotatable plug 6 is rotated counterclockwise, to limit counterclockwise rotation. Both steps 27 and 29 are at a height from the bottom of the raceway which is slightly in excess of half the diameter of ball 18 so that on rotation of the plug in either direction a rising portion of the curvature of the ball is against a portion of the bottom of pin 25. The ball can thus on rotation of the plug raise pin 25 against the bias of spring 13L until the pin is at the shear line. Should the picker of the regular pin tumblers of the lock, after having so picked those pins, turn the plug in the wrong direction for opening the locking hardware, that is, turn plug 6 of the FIGURE 4 modification slightly counterclockwise, ball 18 will in its initial movement retract pin 25 against its biasing spring 13L, but after the high portion of the ball passes to the left of the center of pin 25, the latter will be restored by its spring to a projecting position onto step 29 and against stop 28 so that all attempts further to rotate the plug counterclockwise are prevented by pin 25 engaging the upper portion 28 of raceway stepped end 17R. It will be noted that the width of step or shelf 29 is greater than that of step or shelf 27; if the width of these steps were to be equal, the initial rotation of the plug could readily be in either direction for the ball could be positioned in the raceway, when the keyway is positioned vertically, to either side of pin 25 and raise the latter in its chamber 12L no matter in which direction the plug was rotated. With the width of shelves 27 and 29 as shown in FIGURE 4, initial rotation of the plug of the modified embodiment clockwise is not possible. Not until counter-clockwise rotation of the plug has restored pin 25 into its drive chamber 12L, is clockwise rotation of the modified embodiment of FIGURE 4 possible.

In a second embodiment of my pick-proof mechanism, of which a transverse section is shown in FIGURE 5, which can easily be incorporated with any one or more of the regular pin tumbler mechanism, I use three balls 18 being about $\frac{1}{8}$ " in diameter and one ball 31 of approximately 0.115" diameter, the third and smaller ball 31 being a sliding fit in radial bore 30 in plug 6 and functioning as the bottom pin of the particular pin tumbler mechanism. Bore 30 differs from radial bores 16 and 16L in that it does extend to ridge 8 of the keyway. In this embodiment, drive chamber 12 houses drive spring 13 bearing against top flange 24 of my inventive two-part tumbler pin comprising flanged pin 23 and sleeve 22 above described. The body of pin 23 is a sliding fit in sleeve 22 which in turn is a sliding fit in 30, the bottom of both bearing against ball 31 in such bore. One ball of the pair of balls 18 is disposed to either side of bore 30 in raceway 32. Bore 30 has its diametrically opposite sides open parallel to the bore axis at least partially to raceway 32 to permit limited surface portions of balls 18 to extend into bore 30 when bottom ball 31 rests on ridge 8, that is, when the tip of the key is not supporting ball 31. These parallel openings are sufficiently narrow, however, that ball 31 cannot laterally roll out of bore 30. Raceway 32 is bounded at its respective ends by linear inclined surfaces 33L and 33R, the lower ends of these inclined surfaces or ramps being spaced radially above ridge 8. Absent the proper key, lower ball 31 rests on ridge 8 and the three balls, 18, 18 and 31 remain separated from each other in the locked position of the plug with its locking hardware, as shown in the full line positions of the respective balls in FIGURE 5. In this condition, the position of balls 18 with their uppermost portions at the shear line is without effect on the locking hardware because the balls 18 will roll, when rotation of the plug

is attempted, down one of the ramps, 33L where the attempted rotation is clockwise and 33R if the attempted rotation is counterclockwise. In either such event, sleeve 22 and pin 23 are unimpeded and pushed by spring 23 beyond the shear line and into the plug stopping further rotation of the plug by pin 23 and sleeve 22 striking against the peripheral end of ramp 33L on attempted clockwise rotation and against that of ramp 33R on attempted counterclockwise rotation when such ramps in the limited movement of the plug on such attempted rotation reach a general vertical position, respectively. However, with the key inserted, ball 31 is raised to the dotted position (FIGURE 5) 31' and is there held by the key so that the balls 18 are held at the shear line, and the plug can be rotated. That is, balls 18 are maintained in place by the lower ball at position 31' and neither of them leaves the shear line to expose the latter for an arcuate length sufficient to permit pin 23 or sleeve 22 to enter between left ball 18 and ramp 33L or between right ball 18 and ramp 33R. It will be noted that lower ball 31 of this embodiment acts wholly independently of pin 23 and sleeve 22 and does not rest in a key cut, as do the regular pin tumblers, but on the contrary is lifted and maintained lifted by a tip of the key in position 31' at which, while it engages both balls 18, it still does not engage pin 23 or sleeve 22. In this position, balls 18 are also at the shear line and against longitudinal bore 10, so that lower ball 31 is not movable further upwardly in radial bore 30.

In FIGURE 6, I show a third embodiment of my invention pick-proof mechanism, likewise in simplified section, with FIGURES 6A and 6B showing side and a front view of a detail thereof. In this embodiment I provide an individual narrow arcuate channel 40 in the peripheral region of the plug extending from each radial bore 16 of which the pin tumbler is equipped with this embodiment in plug 6 to keyway 5 thereof. The successive channels 40, which may be formed by milling or in casting, if a plurality thereof are used, are in diametrically opposite halves of the plug; thus in the five pin tumbler lock the channels for each the first, third and fifth bores from flange 9 of the plug may be in the left half of the plug, as shown in FIGURE 6, which is a section through the first bore 16 looking toward the remote end of the plug, while those for each the second and fourth bores are in the right half of the plug, for example. A flat metal plate member 41, of substantially semi-annular shape, FIGURES 6A and 6B, is slidably located in each channel 40 and has a bevel 42 at its lower end, the bevel facing the front end of the plug so that on insertion of the key in keyway 5, plate member 41 offers minimum resistance to key insertion. Obviously, plate members 41 which are for location in channels 40 on the right half of the plug are curved to the left, while those for the left half of the plug are curved to the right, the latter being shown in FIGURE 6A. The inner diameter of semi-annular members 41 is such as to permit smooth sliding of member 41 on the bottom of channels 40, while the outer diameter thereof is such as not to extend beyond the cylindrical surface of the rotatable plug, the radial width 44 between such inner and outer diameters being a predetermined amount, determined to a large extent by the strength the member needs to hold upper pin 23 of my pick-proof mechanism of this embodiment; for example, for incorporation of this embodiment with pin tumbler prior art locks, I have found $\frac{1}{16}$ " quite appropriate. The upper semi-circular cut-out portion 43 of member 41 is of a diameter such that sleeve 22 and pin 23 can readily pass therethrough into radial bore 16, as can bottom pin 15. With no key in keyway 5, that is, when the tumbler pins will perhaps be picked, sleeve 22 and upper pin 23, or at least pin 23 as a minimum, will be pressed by spring 13 downwardly a distance greater or less than radial width 44 of members 41, since absent

the proper key in the keyway, members 41 by gravity slide downwardly with their lower ends 42 extending somewhat into the keyway and hence their upper end withdrawn from radial bores 16 proper, until the tips of the lower end rest against the other, and solid, side of the keyway opposite to that in which the particular channel 40 is formed.

It must here be recalled that the essence of picking is to manipulate the lower pins to the shear line, and that no rotation of the rotatable plug can be effected as long as any upper pin projects to any extent from its drive chamber. The latter is also true of my inventive two-part upper pin combination of pin and sleeve, in which just so long as any portion of the pin or sleeve thereof extends into the plug, productive picking is not possible. If in this embodiment, the pin thereof extends any portion of the member width 44 into the plug, while plug movement to a limited rotation is obtained, such rotation stops when bevelled end 42 of member 41 strikes the far side of the keyway. But in this latter condition, the upper pins of the regular pin tumblers are no longer aligned with their associated radial bores 16, and further manipulation of these upper pins projecting to any extent from the lock body 7 is no longer possible. The upper pins, in view of the partially rotated plug including its keyway, are thus made inaccessible and so remain unless the plug is rotated back to restore the keyway to its vertical position at which time all regular pins are restored to their locking position. To negate the effect of one or more members 41, each associated with a different pin tumbler of the lock, the picker would have to provide a tool at the base of the keyway for the entire length of the keyway and of the proper width; thus he would be further restricting his working area which is already unduly small. In this connection, it will be recalled that keyways are made serpentine as a matter of basic security to restrict the working room of pickers even when the keyway is totally otherwise unobstructed. That the picker might thus fill the keyway in no way assures the picker's success in so manipulating the lock to ultimately rotate the plug to unlock the locking hardware. In a pin tumbler lock provided with one or more embodiments of this my inventive pick-proof mechanism, the picker must contend not only with more than one tumbler but also with gravity in respect to both the pins and the arcuate members 41. It must further be noted that this embodiment of my invention, in which semi-annular members 41 are accessible through the keyway 5, may be utilized independently of, as well as in conjunction with, the first and second above described embodiments of my invention in which none of the elements of the pick-proof mechanism are accessible through the keyway.

In still a fourth embodiment of my pick-proof mechanism, shown in FIGURE 7, the pin member of the mechanism is not accessible through the keyway. As shown in FIGURE 7, it will readily be noted that counterclockwise rotation of the plug will unlock the locking hardware. Pin 45, essentially a standard lower tumbler pin 15, is slidable in the last drive chamber 12L under the tension of spring 13L, and tends to project into radial bore 46 in plug 6, bore 46 registering with drive chamber 12L when the plug and its keyway are in the locking position. Radial bore 46 does not, however, extend to keyway 5. Counterclockwise as shown in FIGURE 7 an arcuate channel 47 extends from the bore 46 to the bottom end of keyway 5 in the cylindrical surface region of the plug, and a plate half-round member 48 is slidably movable in channel 47. The outer diameter of half-round 48 is such that with the inner cylindrical face of the half-round sliding along the bottom of channel 47, the outer cylindrical surface of the half-round is aligned with the longitudinal bore 10 in housing 7 in which plug 6 is rotatable. The arcuate length of half-round 48 is such that, absent the proper key in the keyway, the lower end 49 of the half-round, which is bevelled

facing the direction of key insertion, extends into the keyway while its upper end 50, which is likewise bevelled but facing the rounded bottom of pin 45, is displaced from bore 46 when pin 45 extends into bore 46 under the bias of spring 13L as shown in FIGURE 7, thus preventing counterclockwise rotation of the plug even though the regular pin tumblers of the lock have all been picked and are at the shear line. It will be noted that were the proper key fully inserted into the keyway, half-round 48 due to its arcuate length would have been pushed clockwise and upwardly in its channel 47 by the key, thus causing its upper bevelled end or ramp 50 to enter bore 46 below pin 45 and push the pin upward, so that the bottom of the pin would be resting on ramp or bevel 50. Counterclockwise rotation of the plug is still impeded by the right shoulder of bore 46. With or without the insertion of the proper key in the keyway, the embodiment of FIGURE 7 permits of a limited clockwise rotation of the plug, providing the regular tumbler pins of the lock are at the shear line. On start of this clockwise rotation, pin 45 rides to the top of upper bevelled end or ramp 50 of half-round 48, thereupon riding upon the full outer diameter cylindrical surface 51 of the half-round, to drop along inclined face or ramp 52 into the recessed portion 53 ultimately to strike against shoulder 54. During such clockwise plug rotation the half-round 48 moves counterclockwise in channel 47 until its lower bevelled end or ramp 49 strikes the bottom of the keyway face opposite the open end of channel 47. The half-round can move no further and, since pin 45 now extends into recess 53 of the half-round and is against shoulder 54, further counterclockwise movement of the half-round is no longer possible thus stopping the clockwise rotation of the plug. Now, with pin 45 in recess 53 the picker can only reverse his course and rotate the plug counterclockwise. Bearing in mind that the key is absent and that he has the regular tumbler pins to contend with, he must maintain the regular lower pins at the shear line as the keyway, on rotation of the plug, returns to the vertical. In this counterclockwise rotation, pin 45 climbs incline 52 out of the recess 53 to the outer diameter cylindrical surface portion 51 of the half-round. Such climbing of incline 52 causes the half-round to move in channel 47 until the tip end of ramp 50 strikes against the right side of bore 46. When the key is present in the keyway, the movement here can be smooth and consistent, permitting the plug to spin over the void left by bevel 50 and to continue its counterclockwise rotation to open the locking hardware. When, as in picking, the key is absent, as the plug approaches the generally vertical keyway position, any dwell or hesitation will endanger the picked position of the regular tumbler pins, and pin 45 under the bias of its spring 13L will force half-round 48, due to bevel 50, away from the right side of bore 46, and firmly seat itself thus requiring the picker to repeat his operation from its very beginning, etc., etc.

In this embodiment channel 55 to the right of pin 45 with keyway 5 in the upright vertical locking position having shoulder 56 is provided solely as a stop to limit rotation of the plug; if full cycle plug rotation were permitted, pin 45 conceivably could bind in the keyway if the plug were rotated more than 180° counterclockwise. In this embodiment, unlocking of the locking hardware is obviously had just before pin 45 reaches shoulder 56. With the key present in the keyway, it will furthermore be noted that the initial clockwise rotation of the plug is limited to about 50° to 60° due to the clockwise shifting of half-round 48 in its channel by the inserted key, whereas if the key is not present, as in picking, such initial clockwise rotation is about 70° due to the half-round 48 being free to slide in the channel for the additional width of the keyway. In recapitulation: pin tumbler locks provided with this embodiment of my pick-proof mechanism are to have their plug first rotated clockwise until the bottom of pin 45 is to the left of half-round ramp 52

whereupon their rotation is to be smoothly and consistently reversed to counterclockwise until the locking hardware is opened. This embodiment of my pick-proof mechanism insures that the regular upper tumbler pins are exposed to reseal themselves (and thus prevent further rotation of the plug) in their radial bores 16 in the plug under the least favorable conditions to those, e.g., pickers, who would rotate the plug without the proper key. Even as to the regular tumbler pins, stop 54 on half-round 48 provides a maximum rotation of 70°, which is hardly enough for effectively spinning them. If in this embodiment, there is any dwell near the vertical position of the keyway, either the pick-proof mechanism will seat itself or the regular pin tumblers will scramble and relock the plug to the lock body.

Referring now to FIGURE 8, which is a section along VIII—VIII of FIGURE 1, through a modified tumbler pin of the lock, the upper pin thereof is the two-pin arrangement, consisting of pin 23 with a head end flange 24 and sleeve 22 about the body portion of pin 23, which I have used rather extensively in the various embodiments of my pick-proof mechanism of the instant invention. Drive spring 13 presses on flange head 24 of pin 23 thereby tending to extend both pin 23 and, when flange head 24 strikes the top face of the sleeve, sleeve 22 into the cooperating radial bore 16 in the plug to lock the plug against rotation in any direction. In FIGURE 8, the bottom pin 15 has been moved by the inserted key, not shown, to facilitate understanding of the figure, to the shear line; that is, the upper face of bottom pin 15 and the lower faces of both pin 23 and sleeve 22 are aligned with the cylindrical surface of the rotatable plug 6, which can be rotated with the pins (and sleeve) so positioned. With the body of upper pin 23 slidable within sleeve 22 which in turn is slidable in the standard diametered drive chamber 12 of the pin tumbler locks, the advantage of a quicker locking of the plug by the more facile entry thereinto of the smaller in diameter pin body 23 as compared to the standard upper pins for tumbler pin locks, is readily noted.

It is to be expressly understood that the invention has herein been described in embodiments which are illustrative only and are by no means to be interpreted as limitative; the invention being limited only as required by the prior art. Various modifications may suggest themselves to the skilled worker in the art within the scope of my invention as defined in the claims.

What I claim is:

1. A pick-proof mechanism for pin tumbler locks having locking hardware selectively actuatable to its locking and unlocking positions by rotation of a plug in a cylinder, the plug being connected to the locking hardware, on insertion of a proper key into the keyway of the plug to move the pin tumblers of the lock to a shear line, comprising a radial chamber in the cylinder open at its end toward the plug and closed at its other end, at least one arcuate peripheral groove in the cylindrical surface region of the plug of which at least a portion registers with the open end of the chamber, pin means slidable in the chamber and spring biased to extend the pin means a limited distance into the groove, and means comprising at least one spherical ball wholly within and movable in the groove selectively to a first position permitting the pin means to maintain its extending-into-the-groove position thereby limiting plug rotation and to a second position to restore the pin means against its spring bias wholly into the chamber thereby permitting plug rotation, the tumblers of the lock being at the shear line in both the first and second positions of the movable means.

2. The pick-proof mechanism according to claim 1 in which the pin means consists of a pin having an enlarged head and a sleeve in which the body of the pin is a sliding fit, the sleeve being a sliding fit in the radial chamber, and a coil spring braced against the closed end of the chamber and acting against the head of the pin

to engage the sleeve and on such engagement also acting against the sleeve.

3. The pick-proof mechanism according to claim 1 in which the movable means in the arcuate groove of the plug is a single ball and the length of the groove is substantially twice the diameter of the ball.

4. The pick-proof means according to claim 1 in which the radial chamber in which the pin means is slidable is inaccessible through the keyway of the plug.

5. The pick-proof mechanism in accordance with claim 1 the arcuate groove in the plug in which the movable means is positioned is inaccessible through the keyway of the plug.

6. The pick-proof mechanism according to claim 1 in which both the radial chamber and the arcuate groove are inaccessible through the keyway of the plug.

7. The pick-proof mechanism according to claim 1 in which the movable means comprises two balls of which one ball is to either side of the pin means portion extendable into the groove, and a third which by insertion of the key into the keyway is insertable between the two balls in the groove.

8. The pick-proof mechanism according to claim 2 in which the movable means in the arcuate groove is a spherical metal ball, the arcuate groove is inaccessible through the keyway of the plug and extends from a linear shoulder registerable with one lateral side of the cylinder chamber for an arcuate distance equal to about twice the diameter of the ball to a stepped shoulder of which the step is at a height from the bottom of the arcuate groove slightly greater than half the diameter of the ball and of an arcuate length equal to the radial width of the sleeve.

9. The pick-proof mechanism according to claim 1 in which the movable means in the arcuate groove is a spherical metal ball, the arcuate groove is inaccessible through the keyway of the plug and extends from a first stepped shoulder registerable with the lateral side of the cylinder chamber, the step thereof being of an arcuate length less than half the arcuate length of the pin means, to a second stepped shoulder registerable with the other lateral side of the cylinder chamber, the step of the second shoulder being of an arcuate length equal to the arcuate length of the pin means, each step being at a height from the bottom of the arcuate groove slightly greater than half the diameter of the ball, and the arcuate distance between the lower portions of the first and second shoulders being equal to the distance such that with the ball against the lower portion of the second shoulder its surface is against the edge of the pin means on the step of the first shoulder and overhanging such step of the first shoulder.

10. The pick-proof mechanism according to claim 2 in which the movable means in the groove comprises a pair of balls of which one ball is to either side of the portion of the body of the pin and sleeve extending into the groove, a radial bore in the plug extends from the peripheral arcuate groove to the top of the keyway aligned with the axis of the keyway, the arcuate groove terminates at each end in a downwardly inclined shoulder, a third ball in the radial bore of the plug and positioned in the absence of the proper key in the keyway at the junction of the bore and the keyway while on insertion of such key is positioned upwardly thereof, the plug radial bore having lateral openings into the groove permitting a limited portion of each ball of the pair to project into the radial bore to be engaged by the third ball in its upwardly moved position, the inclination of the shoulders and their spacing being such that with the third ball at its lower position the pair of balls are engaged by adjacent regions of the pin and sleeve extending into the groove while at its upper position the third ball engages each of the pair of balls and holds them at the shear line.

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