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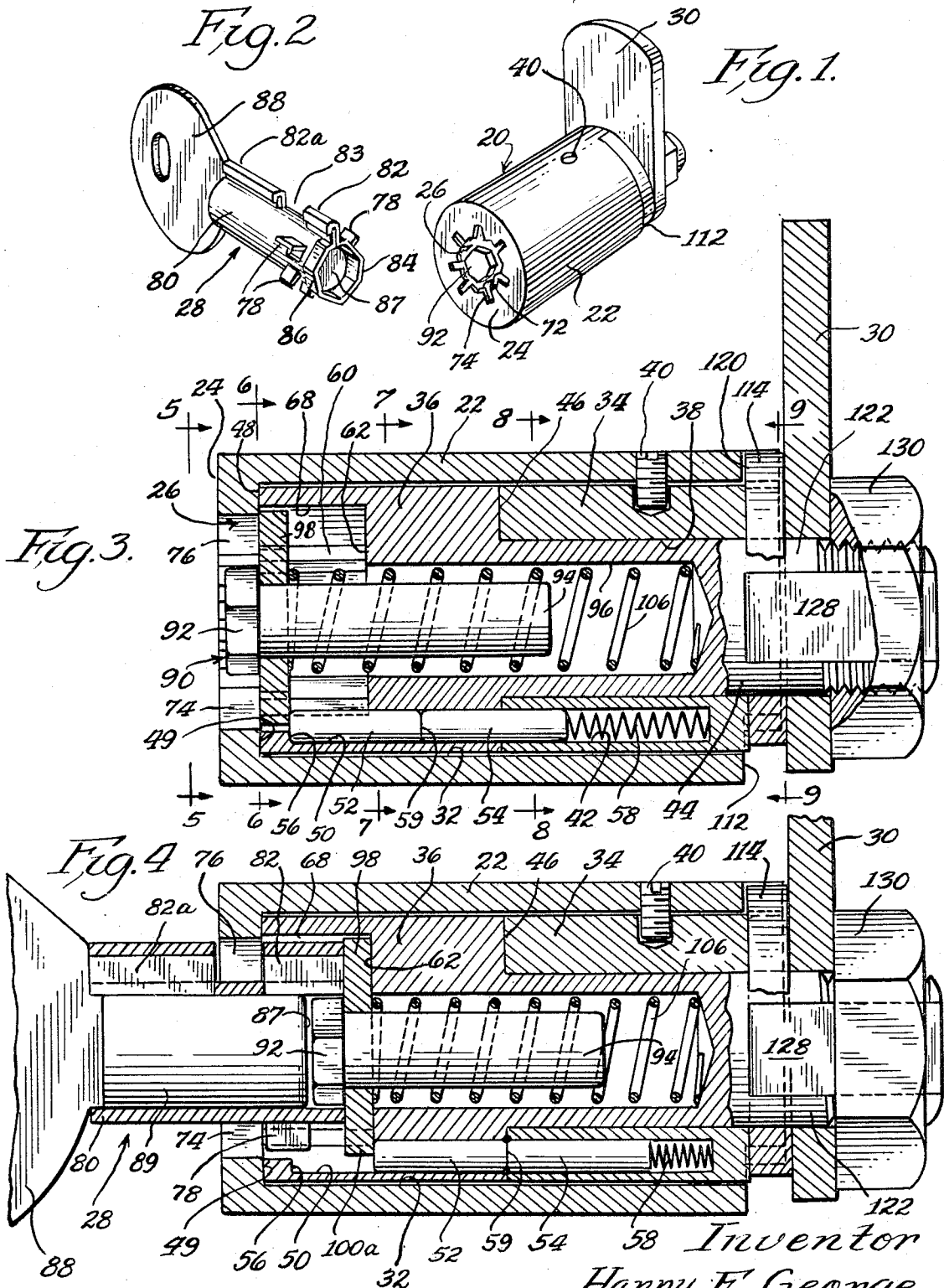
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3,524,335

AXIAL TUMBLER TYPE LOCK AND KEY THEREFOR

Filed Feb. 6, 1968

3 Sheets-Sheet 1



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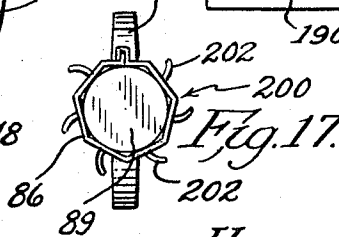
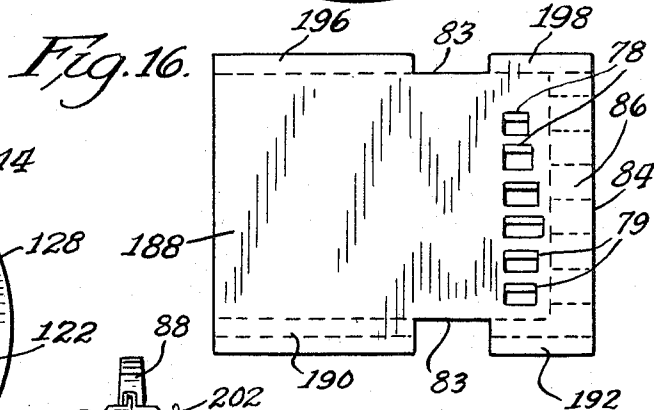
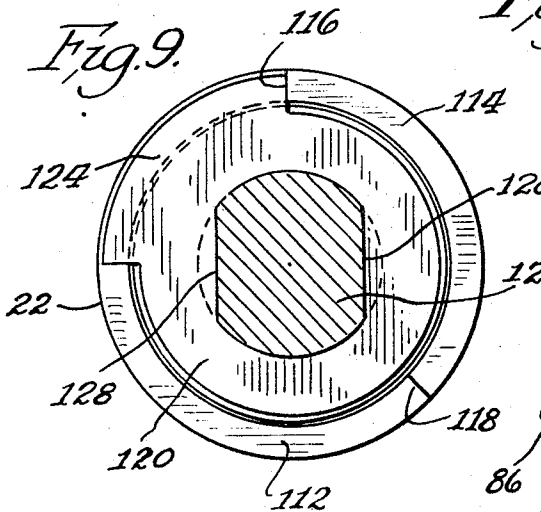
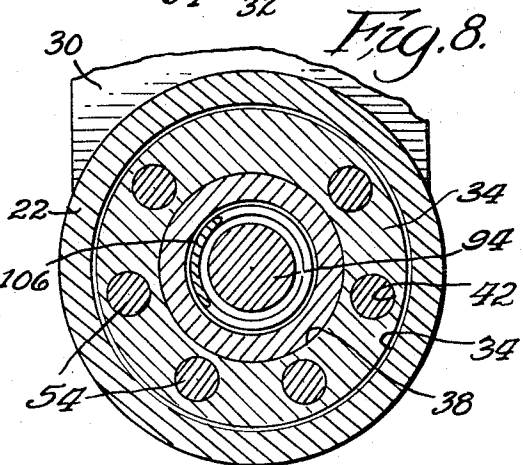
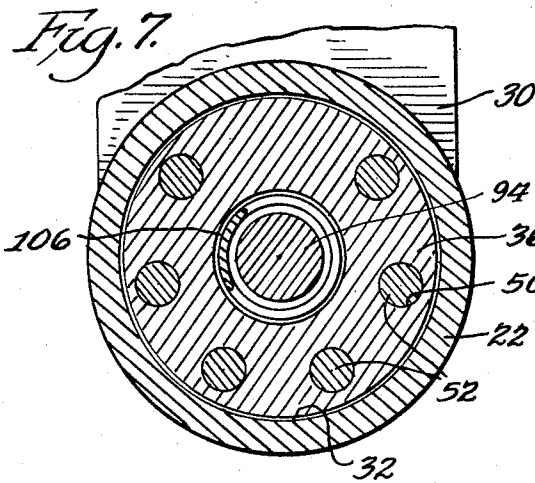
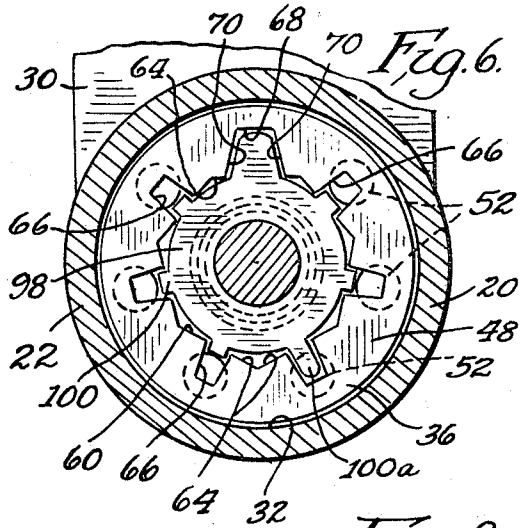
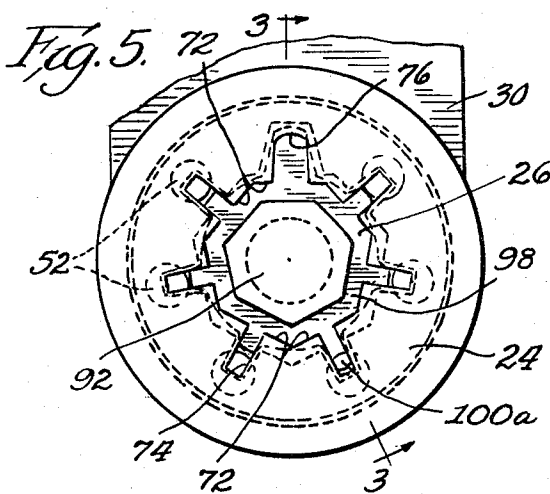
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AXIAL TUMBLER TYPE LOCK AND KEY THEREFOR

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3 Sheets-Sheet 2



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AXIAL TUMBLER TYPE LOCK AND KEY THEREFOR

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19 Claims

ABSTRACT OF THE DISCLOSURE

A lock mechanism of the axial tumbler type including a shell having a polygon-shaped key entrance in one end thereof, a locking barrel fixedly disposed within the shell, a locking cylinder rotatably supported within the shell and having an actuating shaft extending outwardly of the shell, tumbler pins slidably supported by the locking cylinder and barrel for axial movement from first locking positions preventing rotation of the actuating shaft to second positions allowing rotation of the actuating shaft, a key ejector disposed within the shell to eject an operating key when the lock is in a locked position, a dust cover substantially closing the key entrance when the key is removed, and a key having a polygon-shaped forward end and outwardly extending bitings adapted to effect movement of the tumbler pins to their second positions upon entry of the key into the shell.

BACKGROUND OF THE INVENTION

The present invention relates to axial tumbler type locks, and more particularly to such locks having key ejector means and being particularly adapted to prevent unauthorized actuation thereof. The present invention also relates to a novel key for use with such an axial type tumbler lock, which key substantially eliminates the possibility of duplication through conventional key duplicating machinery, and a method for making the key.

Axial tumbler type locks generally employ axially aligned relatively rotatable locking cylinder and barrel members which slidably support a plurality of tumbler pins. The tumbler pins are axially movable upon engagement by a key from first locking positions to positions allowing rotation of the locking cylinder relative to the barrel whereby an actuating lever associated with the locking cylinder may be rotated. Axial movement of the tumbler pins requires a key adapted to engage the tumblers for movement thereof to positions allowing the rotation of the locking cylinder and actuating shaft.

Such axial type tumbler locks as generally described above fail to adequately preclude tampering or unauthorized actuation. The known prior art lock devices of this type lend themselves to unauthorized actuation by keys made from conventional key duplicating machinery, which keys are readily available to unauthorized persons. Further, the known prior art tumbler locks fail to provide means for ejecting the key when the lock mechanism is in an inoperative locked position, thereby allowing unauthorized persons to actuate the lock mechanism.

Attempts have been made to reduce the ease with which the prior art tumbler type locks can be "picked" by unauthorized persons. Such attempts at preventing unauthorized use or actuation have generally included means to prevent access to ends of the axially movable tumbler pins, thereby requiring a key to be initially inserted a specific distance, rotated slightly, and then further inserted to engage the tumblers for movement to positions whereby the lock may be actuated. While such methods have proven partially effective, they do not provide the lock manufacturer with adequate means to vary the individual lock and key structural combinations in a man-

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ner to substantially preclude picking by unauthorized persons. For example, a person once having a key adapted to unlock one of the known tamper-proof axial tumbler type locks may duplicate the key and, with knowledge of the key operating action, readily actuate all similar lock mechanisms.

SUMMARY OF THE INVENTION

One of the primary objects of the present invention is to provide an axial tumbler type lock which overcomes the above-noted disadvantages in the prior art lock mechanisms through including novel means to substantially eliminate the possibility of unauthorized unlocking and actuation without a novel key specifically adapted to actuate the particular lock mechanism.

Another object of the present invention is to provide an axial tumbler type lock mechanism employing a plurality of circumferentially spaced tumbler pins axially movable to positions wherein a movable element of the lock may be rotated, the lock assembly having a novel key entrance requiring a key having outwardly directed projections thereon to effect axial movement of the tumbler pins to their unlocking positions upon entry of the key into the lock mechanism.

Another object of the present invention is to provide an axial tumbler type lock mechanism having a novel polygonal-shaped key entrance configuration, which entrance requires a key having the exact predetermined polygonal configuration of the key entrance to effect unlocking and actuation of the lock mechanism.

Another object of the present invention is to provide an axial tumbler type lock assembly having novel means for ejecting the key if the operator fails to remove the key after unlocking and actuating the lock mechanism.

Another object of the present invention is to provide an axial tumbler type lock mechanism as above-described including a dust cover associated with the key ejector means and adapted to preclude the introduction of foreign matter into the lock mechanism when the key is removed from the lock assembly.

A further object of the present invention is to provide an axial tumbler type lock as above-described wherein the dust cover is inwardly movable upon the entry of a key and includes means thereon operative to engage selected tumbler pins and move the selected tumbler pins to unlocking positions upon inward movement of the key.

Another object of the present invention is to provide an axial tumbler type lock mechanism having novel means for urging the axially movable tumbler pins toward their forward locking positions.

Still another object of the present invention is to provide a novel key for use with an axial tumbler type lock assembly, which key precludes duplication by conventional key duplicating apparatus.

Another object of the present invention is to provide a novel key for use with selected axial tumbler type lock assemblies, which key is made by forming outwardly extending projections in a flat sheet metal plate, thereafter forming the plate into a generally tubular body with the projections disposed outwardly therefrom, and forming a generally polygonal-shaped wall portion on the forward end of the key to define a hollow polygonal end to be received into the key entrance.

Another object of the present invention is to provide a novel key for use with selected axial tumbler type lock assemblies as described, which key is particularly suited for computerized manufacturing techniques.

In a preferred embodiment of an axial tumbler type lock mechanism and key in accordance with the present invention, a generally cylindrical shell having an axially

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disposed polygon-shaped key entrance is adapted to support a fixed position locking barrel and a rotatable locking cylinder having an actuating shaft extending outwardly from the shell. The locking cylinder and barrel slidably support a plurality of tumbler pins axially movable from first positions preventing rotation of the locking cylinder and actuating shaft to second unlocking positions allowing rotation of the locking cylinder. The forward ends of the tumbler pins are selectively engageable by outwardly projecting bitings on the key upon entry thereof into the key entrance. A movable polygon-shaped key receiving head is urged to a position within the polygon-shaped key entrance in the shell to define an annular polygon-shaped space between the head and the shell. A movable dust cover and key engaging plate is disposed rearwardly of the key receiving head and serves to preclude the entry of foreign matter into the lock mechanism when in a locked position. The annular polygon-shaped key entrance space requires a key having a hollow forward end defined by a similarly shaped polygonal wall to effect unlocking of the lock mechanism, the forwardmost end surface of the key serving to engage the dust cover when received over the head and move the dust cover rearwardly. Preferably, the dust cover includes at least one spur thereon to engage a corresponding tumbler pin for movement thereof to its unlocking position, thereby making the corresponding key biting a dummy actuator. The tumbler pins and key engaging plate are urged forwardly to eject the key when the lock mechanism is in a locked state.

Further objects and advantages of my invention, together with the organization and manner of operation thereof, may best be understood by reference to the following description of preferred embodiments of the invention when taken in conjunction with the accompanying drawings, in which like reference numerals designate like parts throughout the several views.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an enlarged prospective view of an axial tumbler type lock mechanism in accordance with a preferred embodiment of the present invention, illustrating the polygonal-shaped key entrance;

FIG. 2 is an enlarged perspective view of a key for use with the tumbler type lock of FIG. 1;

FIG. 3 is an enlarged longitudinal sectional view of the tumbler lock illustrated in FIG. 1, taken generally along the line 3—3 of FIG. 5;

FIG. 4 is an enlarged longitudinal sectional view similar to FIG. 3 but showing the key inserted to establish an unlocking position;

FIG. 5 is a front elevational view looking in the direction of the arrows 5—5 of FIG. 3;

FIG. 6 is a transverse sectional view taken substantially along the line 6—6 of FIG. 3 looking in the direction of the arrows;

FIG. 7 is a transverse sectional view taken substantially along the line 7—7 of FIG. 3 looking in the direction of the arrows;

FIG. 8 is a transverse sectional view taken along the line 8—8 of FIG. 3 looking in the direction of the arrows;

FIG. 9 is a transverse sectional view taken along the line 9—9 of FIG. 3 and looking in the direction of the arrows;

FIG. 10 is an enlarged longitudinal sectional view generally similar to FIG. 3 but illustrating a modified locking barrel which eliminates the shell;

FIG. 11 is an enlarged front elevational view of the lock mechanism shown in FIG. 10 with the key removed;

FIG. 12 is an enlarged longitudinal sectional view taken along line 12—12 of FIG. 13 and illustrating an alternative embodiment of a locking barrel having novel means for urging the tumbler pins axially outwardly;

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FIG. 13 is an end elevational view of the spring cap of FIG. 12, looking in the direction of arrows 13—13;

FIG. 14 is a sectional view taken substantially along the line 14—14 of FIG. 13, looking in the direction of the arrows and with the spring cap removed from the locking barrel;

FIG. 15 is an end view of the locking barrel of FIG. 12, taken along the line 15—15 of FIG. 12 and with the spring cap removed;

FIG. 16 is a plan view of a sheet metal plate from which the key is made, showing the outwardly projecting bitings formed therein; and

FIG. 17 is a front elevational view of an alternative embodiment of a key having outwardly projecting generally arcuate bitings thereon.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, and in particular to FIGS. 1 and 2, an axial tumbler type lock mechanism constructed in accordance with a preferred embodiment of the present invention is indicated generally at reference numeral 20. The lock mechanism 20 includes casing means comprising a generally cylindrical hollow shell 22 having a forward key end 24 defined by an end wall lying in a plane normal to the longitudinal axis of the shell. The shell 22 preferably comprises a metallic sleeve stamped out of a suitable material such as brass, with the forward key end 24 preferably being formed integral with the cylindrical body 22 and the end of the shell opposite the key end 24 being open ended. The key end 24 has a key receiving entrance 26 therein having a generally polygonal shape as will be more fully described hereinbelow. The key entrance 26 serves to receive the forward end of a key, indicated generally at reference numeral 28, the key being operable to actuate lock mechanism disposed within the shell 22 to effect rotational movement of an actuating member 30. The actuating member 30 may be suitably connected to linkage or switch means (not shown) as desired, the linkage or switch means thereby being under the control of lock 20.

Referring to FIGS. 3 and 4, taken in conjunction with FIGS. 5-9, the hollow cylindrical shell 22 has a cylindrical longitudinally extending bore 32 which receives and supports a cylindrical locking barrel 34 and a cylindrical locking cylinder 36. The cylindrical locking barrel 34 has a longitudinally extending axial bore 38 therethrough and is retained in fixed position within the bore 32 of shell 22 through suitable means, such as a set screw 40. The locking barrel 34 includes a plurality of parallel longitudinally extending cylindrical bores 42 circumferentially spaced about the axis of the barrel, preferably on a common center circle coaxial with the barrel axis. FIG. 8 illustrates six such bores 42 generally equidistantly spaced on a common center circle, the uppermost pair of bores being spaced by approximately twice the arcuate distance as between the remaining bores. The bores 42 of locking barrel 34 serve to slidably support tumbler pins as described below.

The locking cylinder 36 has an axially extending cylindrical actuating shaft 44 preferably formed integral therewith. The actuating shaft 44 is slidably rotatably received within the axial bore 38 of locking barrel 34 so as to be rotatable therein. The outer diameter of the locking cylinder 36 is such as to allow rotation thereof within the bore 32 of shell 22. The locking cylinder 36 includes an annular shoulder portion 46 disposed in a plane normal to the longitudinal axis of the locking cylinder, which shoulder abuts a corresponding end surface on the locking barrel 34 in sliding relation and establishes an interfacial contact plane therebetween. A forward end surface 48 on the locking cylinder 36 abuts an inner surface 49 of shell key end 24 in sliding relation, the locking cylinder being maintained in fixed axial relation within the shell through the fixed position locking barrel 34.

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The locking cylinder 36 further includes a plurality of longitudinally extending parallel bores 50, there being six such bores circumferentially spaced about the axis of locking cylinder 36 in identical position to the bores 42 in the locking barrel 34. The bores 50 have longitudinal lengths extending from the shoulder surface 46 of locking cylinder 36 to end wall portion 56 spaced axially rearwardly from the forward end surface 48 of the locking cylinder. With the bores 50 of the locking cylinder 36 and the bores 42 of the locking barrel 34 being identically disposed about the axes of the cylinder and barrel as described, the locking cylinder may be oriented relative to the fixed locking barrel such that the respective bores are axially aligned. The relative positions of the locking cylinder 36 and locking barrel 34 to establish such axial alignment of the bores 50 and 42 define a locking position for the lock mechanism 20, as will become more apparent hereinbelow.

The axially aligned bores 42 and 50 of the locking barrel 34 and locking cylinder 36, respectively, receive and slidably support tumbler pin means. The tumbler pin means comprises pairs of axially movable tumbler pins, one pair of tumbler pins being disposed within each set of axially aligned bores 42 and 50. Each pair of tumbler pins comprises a forward tumbler pin, termed the driver pin 52 which is always disposed within the corresponding bore 50 in locking cylinder 36, and a rear pin termed the locking pin 54 which is normally partially disposed within the bore 42 of the locking barrel 34 and the bore 50 of the locking cylinder to thereby prevent rotation of the locking cylinder. The forward driver pin 52 and rear locking pin 54 of each pair of tumbler pins are of predetermined axial lengths and are normally urged to a forward locking position wherein the driver pin abuts the shoulder 56 defining the forward end of the bore 50 through spring means, such as a coil compression spring 58. Each pair of tumbler pins 52 and 54 is maintained in end-to-end abutting relation through the corresponding compression spring 58, with the abutting end surfaces defining a parting plane 59 therebetween. Unlocking of the lock mechanism 20 is effected when the tumbler pins are moved rearwardly such that the respective parting planes 59 are coincident with the interfacial plane 46 between the locking cylinder 36 and locking barrel 34.

Referring to FIG. 6, taken in conjunction with FIG. 3, the forward end of the locking cylinder 36 adjacent the end surface 48 is provided with a recess 60 which intersects the forward end surface 48 and extends longitudinally rearwardly within the locking cylinder a predetermined depth. The inner end of the recess 60 is defined by a surface 62 providing a shoulder disposed in a plane normal to the longitudinal axis of the locking cylinder. The cross-sectional configurations of the recess 60 is preferably polygonal in shape, FIG. 6 illustrating the polygonal-shaped recess as being a seven-sided septagon defined by intersecting planar surfaces 64. One surface 64 of the septagon forms the uppermost surface of the polygonal-shaped recess and is disposed in normal relation to a vertical longitudinal plane through the locking cylinder. While the recess 60 is described and illustrated as having a septagon-shaped cross section, it will be understood that my invention contemplates the provision of any polygonal shape which fulfills my inventive concept as will become more apparent hereinbelow. Six of the seven planar surfaces 64 defining the septagon-shaped recess 60 have radially extending slots 66 disposed generally intermediate the widths of the respective planar surfaces as considered in FIG. 6. Each of the radially extending slots 66 extends longitudinally within the locking cylinder 36 a distance equal to the depth of the septagon-shaped recess 60 and has a radial extent sufficient to intersect its associated tumbler pin bore 52 throughout the length of the bore extending between the shoulder 56 of the locking cylinder and the rear end surface 62 of the recess. The portion of each slot 66 disposed forwardly of the corresponding

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tumbler pin bore 50 extends radially at least to the axis of the bore so as to overlie the forward end of the corresponding driver pin 52.

The above-noted uppermost planar surface 64 of the septagon-shaped recess 60 has a generally upwardly and radially outwardly extending slot 68 therein disposed intermediate the width of the planar surface. The slot 68 is slightly larger than the slots 66 and has generally outwardly directed side surfaces 70 which serve as reaction surfaces during actuation of the lock mechanism 20 to an unlocking position. The slot 68 extends from the forward end surface 48 of the locking cylinder 36 to the rear surface 62 of the recess 60.

As noted above, the key end 24 of the cylindrical shell 22 includes a polygon-shaped key entrance 26. With reference to FIG. 5, the polygon-shaped key entrance 26 is illustrated as having a septagon-shaped cross-sectional configuration defined by edge surfaces 72. The edge surfaces 72 defining the septagon-shaped key entrance 26 are oriented in similar fashion to the surfaces 64 defining the septagon-shaped recess 60 in the locking cylinder 36. Six of the seven edge surfaces 72 have slots 74 extending radially therefrom, with each of the slots having a radial extent sufficient to overlie approximately one-half the diameter of a corresponding driver pin 52 when considered in FIG. 5. A slightly larger radially extending slot 76 is provided extending upwardly from the uppermost edge surfaces 72 of the septagon-shaped key entrance 26 to overlie the slot 68 in recess 60 of the locking cylinder. The septagon-shaped key entrance 26 in the key end 24 of shell 22 and the corresponding radially extending slots 74 and 76 are slightly smaller in area than the septagon-shaped recess 60 and the corresponding slots 66 and 68 in the locking cylinder 36. For example, a circle drawn within the septagon-shaped key entrance 26 which touches the midpoints of the edge surfaces 72 will have a smaller diameter than a similarly drawn circle within the septagon-shaped recess 60 which touches the midpoints of the surfaces 64 thereof.

With the above-described septagon-shaped key entrance 26 and corresponding radial slots 74 in the key end 24 of shell 22, and the septagon-shaped recess 60 and corresponding radial slots 66 in the locking cylinder 36, it can be seen that access to the forward ends of the driver pins 52 abutting the shoulders 56 of the tumbler pin bores 50 in the locking cylinder may be obtained through the respective radial slots 74 and 66.

Referring to FIG. 2, taken in conjunction with FIGS. 4-6, the key 28 includes means for engaging the driver pins 52 of the tumbler pin means upon insertion of the key into the key entrance 26 of the shell 22 and the recess 60 of the locking cylinder 36 to effect movement of the tumbler pins to unlocking positions. Such driver pin engaging means comprises a plurality of radially outwardly projecting bitings 78 disposed in circumferentially spaced relation about the peripheral surface of a generally cylindrical body portion 80 of the key. The bitings 78 are spaced about the peripheral surface of the cylindrical body portion 80 of the key such that they will be received within the radial slots 74 and 66 in the key entrance 26 and recess 60, respectively, during entry of the key into the lock mechanism. Longitudinally extending radially outwardly directed fin portions 82 and 82a are provided along the uppermost surface element of the outer peripheral surface of the key 28, as considered in FIG. 2, which fin portions are separated by a space 83. The forward fin portion 82 extends from a forward edge surface 84 of the key to a position generally coincident with the rearward edge portions of the bitings 78. The fin portion 82 is slightly larger than the bitings 78 and is received within the corresponding enlarged slots 76 and 68 of the key entrance 26 and recess 60, respectively, upon insertion of the key into the lock. The fin 82 serves as a driver means for engaging the reaction surfaces 70 during rota-

tional movement of the locking cylinder 36 when actuating the lock mechanism.

The key 28 includes a hollow forward end portion 86 which extends from the forward edge surface 84 rearwardly to a position slightly forward of tumbler pin engaging edges 79 of the bitings 78. The end portion 86 of the key is defined by a polygonal-shaped wall, such polygon being illustrated as being a septagon corresponding in configuration to the annular septagon-shaped key entrance 26 in the key end 24 of lock shell 22. Accordingly, the radially outwardly projecting driver fin 82 is disposed generally midway along the width of a horizontal surface defining one side portion of the septagon-shaped key end. The hollow recess defined by the septagon-shaped end portion 86 of the key extends rearwardly to the forward end 87 of a cylindrical shank portion 89 of the key as will be more fully described hereinbelow. The key 28 includes a flat portion 88 formed integral with or otherwise suitably secured to the shank 89 of the key to facilitate turning of the key by the operator's fingers in a conventional manner.

Referring again to FIGS. 3-6, the lock mechanism 20 includes means, indicated generally at 90, disposed within the shell 22 generally adjacent the key entrance 26 to prevent unlocking and actuation of the lock mechanism with a key not having the particular above-described polygonal hollow end configuration. In the embodiment illustrated in FIGS. 3-6, such means includes an outwardly spring biased axially movable key receiving head 92 formed integral with or otherwise suitably secured to a longitudinally extending shaft 94 which extends rearwardly within an axial bore 96 within the locking cylinder 36. The head 92 has a polygonal cross-sectional configuration when viewed in FIG. 5 similar to the polygonal configuration defined by the edge surfaces 72 of the polygon-shaped key entrance 26. For purposes of illustration, the polygonal-shaped key entrance 26 has been described as being a septagon. Correspondingly, the cross-sectional configuration of the head 92 is of a septagon shape with the respective sides of the septagon being oriented in parallel relation with the edge surfaces 72 of the key entrance 26 to define a continuous septagon-shaped space between the head 92 and the edge surfaces 72 of the key entrance. The septagon-shaped head 92 is of a size such that when it is disposed within the key entrance 26, the continuous septagon-shaped space between the head and the edge surfaces 72 of the key entrance 26 precludes the introduction of a key over the head 92 other than a key having a hollow forward end defined by a thin septagon-shaped wall. For example, a cylindrical annular wall having an inner diameter sufficient to fit over the head 92 could not be inserted into the septagon-shaped key entrance 26. The forward hollow end portion 86 of the key 28 (FIG. 2) is therefore preferably formed of a thin walled metal sheet material formed into a septagon shape adapted to be received over the head 92 and within the edge surfaces 72 defining the septagon-shaped key entrance 26.

The shaft 94 fixedly supports a plate member 98 thereon adjacent the head 92. Noting FIGS. 5 and 6, the plate member 98 comprises a generally annular member having an outer diameter adapted to be slidably received within the septagon-shaped recess 60 in locking cylinder 36. The outer diameter of the plate member 98 is greater than the longest dimension across the septagon-shaped area of key entrance 26 in shell 22 when considering FIG. 5, such that the plate member substantially covers the septagon-shaped key entrance 26. Preferably, the plate member 98 has a radially projecting spur 100 corresponding to and projecting radially into each of the radial slots 66 in the recess 60. The radial extent of each of the spurs 100 is such that upon rearward movement of the plate member 98, from left to right when considered in FIG. 3, the spurs 100 will not en-

gage the driver pins 52. The spurs 100 are of a circumferential width sufficient to cover a portion of the corresponding radial slots 74 in the key entrance 26 of shell 22. The plate member 98 also has a radial projection 102 thereon which is received within the radial slot 68 of the recess 60. The radial projection 102 is of a size sufficient to cover the radial slot 76 in the key entrance 26 of shell 22 when plate 98 is in a forward position abutting the rear surface 49 of key end 24. With the plate member 98 having spurs 100 and 102 thereon as described, the plate member serves as a dust cover substantially covering the key entrance 26 in shell 22 to preclude the entry of foreign matter into the lock mechanism when in an inoperative locked position.

The plate member 98 is urged forwardly against the rear surface 49 of key end 24 of the shell 22 by a compression spring 106 disposed about the shaft 94 within the bore 96 and abutting the rear surface of the plate member. With the plate member 98 urged against the surface 49 of shell 22, the key receiving head 92 will correspondingly be urged to a position within the key entrance 26.

The above-described plate member 98 disposed on shaft 94 serves, in cooperation with the coil compression spring 106, as a key ejector means within the lock mechanism 20 for ejecting the key 28 when the lock is in locked or inoperative position. In addition, the compression springs 58 urge the tumbler pins outwardly against the biting 78 of the key 28 when inserted within the key entrance 26 and recess 60 to further assist in ejecting the key. For example, with the plate member 98 and tumbler pins being urged toward the key end 24 of shell 20 when in an inoperative locked position, it can be seen that the plate member and tumbler pins will eject the key 28 if the operator inadvertently neglects to totally remove the key from the lock mechanism when in its locked position.

Referring again to FIG. 2, taken in conjunction with FIG. 4, the key 28 includes means to retain the key within the recess 60 of locking cylinder 36 when in an inserted unlocking position. Such retaining means comprises the forward radial fin portion 82. Noting FIG. 4, when the key 28 is inserted into the key entrance 26 over the key receiving head 92 to abut the plate member 98 and effect rearward movement of the plate member to bottom against the rear surface 62 of recess 60, the rear upstanding edge of fin portion 82 adjacent the gap 83 will be disposed inwardly from the inner surface 49 of the shell key end 24. With the fin portion 82 disposed inwardly from the surface 49 through the slot 76 of key end 24 and the tubular pins thereby moved to their unlocking positions, the key may be rotated with the fin 82 preventing rearward movement of the key through engagement with the inner surface 49 of the shell 22. To allow rotation of the key 28 when inserted as above described, the space 83 between the forward and rear fin portions 82 and 82a is made slightly greater than the thickness of the key end 26.

For purposes of increasing the combinations of element positions required to actuate the lock mechanism 20, the tumbler pin engaging forward edges 79 of the bitings 78 may be staggered at varied distances from the front end surface 84 of the key. Correspondingly, the associated tumbler pins 52 and 54 for each of the bitings 78 are made to predetermined lengths such that upon entry of a key into the key entrance 26 and recess 60, the bitings will effect movement of the parting planes 59 between the driver and locking pins to positions coplanar with the interfacial plane 46 between the locking cylinder 36 and locking barrel 34.

To further increase the number of key and lock combinations effective to actuate lock mechanism 20, a selected one or more of the spurs 100 on the dust cover or plate member 98 may be radially extended to overlie the outer end of the associated driver pin 52. An ex-

ample of such a radially extended spur is shown at 100a in FIG. 6. With at least one spur 100a extended to engage the outer end of its associated driver pin 52, rearward movement of the plate member 98 through engagement with the forward end surface 84 of the key will cause the radially extended spur 100a to move its associated tumbler pin pair rearwardly, thereby establishing the corresponding key biting 78 as a dummy. It will be understood that the lengths of the driver pin 52 and locking pin 54 associated with the extended spur 100a must be such that when the plate member 98 is in its rearwardmost position as shown in FIG. 4, the parting plane between the associated driver and locking pins will be disposed in coplanar relation with the interfacial plane between the locking cylinder 36 and locking barrel 34.

Referring now to FIGS. 3 and 9, the locking barrel 34 extends rearwardly such that its rear end surface is generally coplanar with an end surface 112 of the shell 22. An arcuate circumferential segment of the shell is preferably extended axially rearward of the end surface 112 and includes end portions 116 and 118 which serve as stops to limit rotation of a limiting plate 120 in a conventional manner. The limiting plate 120 has an arcuate segment 124 thereon and is disposed in generally fixed rotational relation on an outwardly extending end portion 122 of the actuating shaft 44 through a suitable pair of parallel flats 128 provided on the actuating shaft. The actuating lever 30 is similarly provided with a suitable aperture therethrough to receive the end 122 of shaft 44 for rotation therewith. A locking nut 130 is disposed upon a threaded end portion of the actuating shaft 44 to secure the actuating lever 30 and limiting plate 120 thereon. The arcuate segment 124 of limiting plate 120 may be selected such that, in cooperation with the stops 116 and 118 of the extending segmental portion 114 of shell 22, the desired amount of rotation of the actuating shaft 44 during actuation of the lock mechanism is obtained.

FIG. 10 illustrates an axial tumbler type lock mechanism, indicated generally at reference numeral 134, constructed in accordance with an alternative embodiment of the present invention. The lock mechanism 134 is generally similar to that illustrated in FIGS. 1 and 3-9 except that rather than having casing means comprising a separable shell 22 as above described, the casing means of the lock mechanism of FIG. 10 comprises a modified locking barrel having a shell portion formed integral therewith. The modified locking barrel cooperates with a frontal key entrance plate to enclose and retain the locking mechanism components. The lock mechanism 134 includes a cylindrical annular locking barrel 136 having a plurality of circumferentially spaced parallel tumbler pin bores 42 therein adapted to slidably receive locking tumbler pins 54 in similar fashion to the locking barrel 34 above described. The locking barrel 136 has a forwardly extending annular shell or sleeve portion 138 formed integral with the barrel. The sleeve portion 138 includes an axial cylindrical bore 140 to receive a locking cylinder 36 in sliding rotational relation therein. The forwardly extending shell or sleeve portion 138 of the barrel 136 includes an annular shouldered recess 142 which serves to seat a key entrance plate 144 having a generally diametrical outer peripheral surface.

The key entrance plate 144 has an axial thickness equal to the thickness of the above-described key end 24 of shell 22 and is suitably staked at 146 (FIG. 11) within the shouldered recess 142 of the cylinder barrel 136. The key entrance plate 144 has a polygonal-shaped key entrance 26 substantially identical to the key entrance 26 in the key end 24 of the above-described lock shell 22.

The locking barrel 136 has a cylindrical outer peripheral surface suitably received within a cylindrical bore 147 in a support frame 148 which may comprise a portion of a device with which the lock mechanism 136 is used. Any suitable means, such as a snap ring 150, may be utilized in cooperation with the locking barrel 136 and the sup-

port frame 148 to retain the locking barrel in fixed axial position within the support frame, it being desirable that the snap ring 150 include means to prevent rotation of the barrel 136 within the support frame.

The lock mechanism 136 also includes means to resist entry of a key other than one having a polygonal-shaped hollow forward end portion as above described into the lock for actuation thereof. Such means includes a key receiving head 92 formed integral with or otherwise suitably secured to the shaft 94, and a coil compression spring 106. If desired, the key receiving head 92 may be provided with a generally axially disposed cone 152 which extends outwardly from the head 92. The cone is received within a mating conical recess 154 in the forward end surface 87 of the cylindrical shaft 89 of key 28. The conical projection 152 provides additional means to prevent actuation of the lock mechanism 134 with a key other than one having the proper cooperating relation with the lock mechanism.

FIGS. 12-15 illustrate an embodiment of a locking barrel, indicated generally at 159, having alternative means disposed on the rear end thereof for urging the tumbler pins to forward locking positions. The locking barrel 159 and associated tumbler pin spring means may be readily utilized with the above-described lock mechanism 20 or, upon slight modification, with the lock mechanism 134 of FIG. 10. The locking barrel 159 includes an annular cylindrical sleeve 160 having an axial bore 162 therethrough adapted to receive and support the above-described actuating shaft 44 in rotatable relation. The annular sleeve 160 has a rear end surface 164 having inner and outer annular shouldered recess 166 and 168, respectively, which receive inner and outer leg portions 170 and 172, respectively, of an annular U-shaped spring cap 174.

The annular U-shaped spring cap 174 has a plurality of spring fingers 176 formed from a planar end portion 178 disposed between the inner and outer leg portions 170 and 172, respectively, of the spring cap. The spring fingers 176 are generally arcuate when considered in FIG. 13 and are formed downwardly between the inner and outer legs 170 and 172 of the spring cap to allow resilient movement thereof toward the planar end portion 178.

The annular sleeve 160 of locking barrel 159 includes a plurality of tumbler pin bores 180 circumferentially spaced thereabout in similar fashion to the tumbler pin bores 42 of the above-described locking barrel 34. The tumbler pin bores 180 in the annular sleeve 160 slidably receive tumbler pins 182 which comprise the locking pins for the lock mechanism with which the locking barrel 159 is used. The spring cap 174 includes a spring finger 176 corresponding to each of the tumbler pins 182 such that upon assembly of the spring cap with the locking barrel 159, the rearward end of each of the tumbler pins 182 will be engaged by a corresponding spring finger 176 and urged outwardly from the barrel.

Referring to FIG. 2, taken in conjunction with FIG. 16, the key 28 is preferably made from flat sheet metal stock, the method of manufacture of the key readily lending itself to the use of computerized manufacturing techniques. The cylindrical portion 80 of key 28 and the forward polygon-shaped end portion 86 are formed from a generally flat sheet metal blank 188 in the following manner. The blank 188 is first formed as by conventional cutting or stamping such that it has an outer configuration including extending side edge portions 190 and 192, which are separated by the space or gap 83 having a longitudinal length slightly greater than the thickness of the key end 24 of lock shell 22, or the key plate 144 of lock mechanism 134. The side edges of the blank 188 opposite the extending edge portions 190 and 192 are similarly slightly extended at 196 and 198, which extensions are similarly spaced at 83 as are the side extensions 190 and 192. Having formed the blank 188 to include the

side extensions 194, 192, 196 and 198, a plurality of generally upwardly extending bitings 78 may be formed from the blank, the bitings being spaced in transverse relation to the longitudinal axis of plate 188. The bitings are formed from the planar blank through any suitable means such as punch and die means. While FIG. 16 illustrates the bitings 78 as having forward edge portions 79 disposed generally equidistantly rearwardly of the forward edge 84 of the blank, it will be understood that the forward edge portions 79 may be selectively varied in spatial relation from the forward edge 84 to vary the combinations possible with the key 28 in combination with the lock mechanisms 20 or 134.

After forming the upstanding bitings 78 in the key blank 188, the blank may be formed about the above-described shank 89 with the extending edge portions 190, 192, 196 and 198 being formed in conventional overlapping folded relation to establish the radial fins 82 and 82a as shown in FIG. 2. Simultaneously, the forward end portion 86 of the key blank 188 may be formed about a die member to establish the desired polygonal shape, FIG. 2 showing the end 86 formed as a septagon. As the key blank 188 is formed about the cylindrical shank 89, the bitings 78 will be accordingly formed outwardly in generally radial relation to the axis of the shank 89. While the edge portions 190, 192, 196 and 198 have been described as being secured in folded fixed relation, it will be understood that the rearward fin portion 82a of FIG. 2 may be eliminated, with the corresponding edge portions of the key blank being welded or otherwise suitably secured. The folded and secured edge portions 192 and 198 form the upstanding fin 82 which comprises the driving means when engaged within the key mechanism to effect rotational movement thereof.

FIG. 17 illustrates an alternative embodiment of a key indicated generally at 200 made in accordance with the above method described for key 28. The key member 200 is generally similar to the above-described key 28 and includes a generally cylindrical shank portion 89 secured to an appropriate thumb flat 88. In the key illustrated in front element in FIG. 17, a plurality of outwardly projecting tumbler pin engaging bitings 202 are formed from a generally cylindrical sheet metal body made from a flat blank similar to blank 188 of FIG. 16. The outwardly projecting bitings 202 are disposed rearwardly of a septagon-shaped forward end portion 86 as are the bitings 78 of key 28, and are preferably of generally arcuate shape when considered in FIG. 17, thereby further increasing the difficulty of duplicating the key and precluding unauthorized actuation of the lock mechanism. It will be understood that with the generally arcuate bitings 202 disposed in circumferential spaced relation about the peripheral surface of the key 200, slots corresponding to slots 74 in key entrance 26 (FIG. 5) and slots 66 of locking cylinder 36 (FIG. 6) will also require a similar arcuate configuration, when considered in front elevational view, to readily receive the arcuate-shaped bitings 202 of the key 200.

Having described preferred embodiments of lock and key mechanisms in accordance with the present invention, their operation will now be briefly described. Considering the locking mechanism 20 as illustrated in normal locked position in FIG. 3, it can be seen that the locking tumbler pins 54 are disposed partially in the locking barrel 38 and partially in the locking cylinder 36, thereby preventing rotation of the locking cylinder relative to the locking barrel. To effect movement of the driver pins 52 and locking pins 54 to positions wherein the parting planes 59 therebetween are disposed in coplanar relation with the interfacial plane 46 between the locking cylinder and locking barrel, a key 28 having outwardly projecting bitings corresponding to slots 74 in the key entrance 24 of shell 22 and a forward hollow polygonal shape defined by a wall having a configuration identical to that of key entrance 26 must be used to actuate the key. Inserting

the key 28 to a position wherein the hollow polygonal-shaped forward end 86 thereof receives the key engaging head 92 with the forward edge 84 of the key abutting the plate member 98, allows the key to be moved inwardly until the plate member abuts the rear surface 62 of recess 60. Upon engagement of the outwardly projecting bitings 78 with the forward ends of the tumbler pins 52, inward movement of the key effects movement of the parting planes 59 between the respective pairs of tumbler pins to positions wherein they are coplanar with the interfacial plane 46 to thereby allow rotation of the actuating shaft 44 and a corresponding movement of the actuating lever 30 as desired.

As was above described, at least one of the radially projecting spurs 100a on the dust cover plate 98 may be made of a length sufficient to engage the end of the corresponding driver pin 52 such that upon inward movement of the key, the corresponding biting 78 performs no function, the tumbler pins being moved rearwardly by the spur 100a.

Should the operator of either of the described locks 20 or 134 effect unlocking and actuation thereof and thereafter rotate the key to an inoperative position whereby to lock the lock mechanism, and inadvertently forget to remove the key from the lock recess 60, the compression springs 58 disposed rearwardly of the locking pins 54 and the outwardly biased plate member 98 will urge the key 28 outwardly and eject the key from the key entrance 26 of the lock mechanism. When the lock mechanism is in its locked position with the key removed therefrom, the dust cover plate 98 serves to substantially cover the key entrance 26 to prevent the entry of foreign particles or matter into the lock mechanism.

As above noted, one of the inventive features of the subject lock mechanism is to provide a lock wherein many selective combinations of elements may be assembled whereby a standard key will be ineffective to actuate the lock. To this end, it will be understood that the respective lengths of the driver and tumbler pins 52 and 54, respectively, may be varied in combination with varied spacing of the forward tumbler pin engaging edges 79 of the bitings 78 from the forward edge 84 of the key 28 such that each of the tumbler pin sets require a different axial movement to effect actuation of the lock.

The specific key required to actuate either of the above-described lock mechanisms 20 or 134 is of a configuration and structure to substantially reduce the possibility of key duplication by unauthorized persons. The specific structural combinations of key elements prevent their reproduction by conventionally known key reproducing machinery. As above noted, the described septagon-shaped key entrance and corresponding hollow septagon-shaped forward end of the key are given by way of example only, and any polygonal configuration may be selected as best precludes key duplication and prevents unauthorized actuation of the lock mechanism. The above-described method of manufacturing the keys 28 and 200 lends itself to computerized manufacturing processes. Such computerized manufacturing processes are readily adaptable to changing the parameters of biting position and polygonal forward end configurations as desired.

While particular embodiments of my lock mechanism and key have been shown and described, as well as a preferred method of manufacturing the key, it will be obvious to those skilled in the art that changes and modifications may be made therein without departing from the invention in its broader aspects.

I claim:

1. A tumbler lock comprising, in combination, casing means having a key receiving entrance therein, a locking barrel fixedly supported within said casing, a locking cylinder rotatably supported within said casing and having an actuating shaft, said locking cylinder having a portion extending between said key receiving entrance and said locking barrel and defining an interfacial plane

with said locking barrel, tumbler pin means including a plurality of tumbler pins slidably supported for longitudinal movement by and within said locking barrel and cylinder in circumferentially spaced relation about the axes thereof, and tumbler pins being normally urged to first locking positions preventing rotation of said locking cylinder and being movable to second unlocking positions allowing rotation of said locking cylinder, said locking cylinder having a longitudinally extending recess therein adjacent said key receiving entrance, said recess including a plurality of outwardly directed slots extending rearwardly from said key receiving entrance into said locking cylinder with each slot communicating with one of the tumbler pins supported by said locking cylinder and an additional outwardly directed slot providing a reaction surface, a key adapted to be introduced into said key receiving entrance and said recess, said key having a plurality of outwardly extending bitings thereon each corresponding to one of said slots in said locking cylinder and being adapted to be received within the corresponding slots to effect selective movement of said tumbler pins, from said first to said second positions, said key further having a driver fin operable to engage said reaction surface and effect rotation of said locking cylinder when said tumbler pins are in said second positions, and key ejector means within said casing and adapted to eject said key from said casing when the tumbler lock is in a locked position.

2. A tumbler lock as defined in claim 1 wherein said key ejector means includes a plate member adapted to substantially cover said key receiving entrance and preclude the entry of foreign matter into said recess when said tumbler pins are in said first position.

3. A tumbler lock comprising casing means having a key receiving entrance therein, a locking barrel fixedly supported within said casing, a locking cylinder rotatably supported within said casing and having an actuating shaft, said locking cylinder being disposed adjacent said barrel to define an interfacial plane therebetween, tumbler pin means including a plurality of tumbler pins slidably supported for longitudinal movement by and within said locking barrel and cylinder in circumferentially spaced relation about the axes thereof, said tumbler pins being normally urged to first locking positions preventing rotation of said locking cylinder and being movable to second unlocking positions allowing rotation of said locking cylinder, said locking cylinder having a recess therein generally adjacent said key receiving entrance for providing access to said tumbler pins for movement thereof, a key adapted to be introduced into said key receiving entrance and said recess, said key being operative to effect movement of said tumbler pins from said first to said second positions, said key being further operable to effect rotation of said locking cylinder when said tumbler pins are in said second positions, and key ejector means within said casing and adapted to eject said key from said casing when the tumbler lock is in a locked position, said key ejector means including a plate member having means operative to effect axial movement of at least one of said tumbler pins to its second position upon the introduction of said key into said recess.

4. A tumbler lock comprising, in combination, casing means having a key receiving entrance therein having a polygonal configuration, a locking barrel fixedly supported within said casing, a locking cylinder rotatably supported within said casing and having an actuating shaft, said locking cylinder being disposed adjacent said barrel to define an interfacial plane therebetween, tumbler pin means slidably supported for longitudinal movement by and within said locking barrel and cylinder, said tumbler pin means being normally urged to a first locking position preventing rotation of said locking cylinder and being movable to a second unlocking position allowing rotation of said locking cylinder, said locking cylinder having a

recess therein generally adjacent said key receiving entrance for providing access to said tumbler pin means for movement thereof, a key adapted to be introduced into said key receiving entrance and said recess, said key being operative to effect selective movement of said tumbler pin means from said first to said second positions and being operable to effect rotation of said locking cylinder when said tumbler pin means are in said second position, key ejector means within said casing and adapted to eject said key from said casing when the tumbler lock is in a locked position, and a key receiving head supported by said key ejector means, said key receiving head having a similarly shaped polygonal configuration and being normally urged to a position within said key receiving entrance, said key receiving entrance and said key receiving head cooperating to define a continuous polygonal space therebetween, said key having a hollow forward end portion defined by a polygonal-shaped thin wall corresponding in shape to said continuous polygonal space so as to be received over said key receiving head within said key receiving entrance.

5. A tumbler lock as defined in claim 3 wherein said tumbler pin means includes a plurality of tumbler pins circumferentially spaced about the axes of said locking cylinder and barrel, said locking cylinder recess including an outwardly directed slot communicating with each of said tumbler pins within said locking cylinder, and wherein said plate member includes a plurality of projections thereon adapted to be received within said outwardly directed slots within said locking cylinder, at least one of said projections being of an outward extent sufficient to engage the corresponding tumbler pin to effect movement thereof to said second position upon introduction of said key into said recess.

6. A tumbler lock as defined in claim 5 wherein said locking cylinder recess includes a reaction surface, and said key includes an outwardly extending driver fin adapted to engage said reaction surface upon entry of said key into said recess whereby rotation of said key effects rotation of said locking cylinder when said tumbler pin means are in said second position.

7. A tumbler lock as defined in claim 5 wherein said plate member comprises a dust cover plate adapted to substantially cover said key receiving entrance and preclude the entry of foreign matter into said recess when said tumbler pin means are in said first position.

8. A tumbler lock as defined in claim 4 wherein said key receiving entrance and said key receiving head have similar shaped septagonal configurations, said key receiving entrance and said key receiving head cooperating to define a continuous septagon space therebetween.

9. A key for use with a tumbler lock having a locking cylinder slidably supporting a plurality of longitudinally movable tumbler pins therein normally urged to first locking positions and movable to second unlocking positions, the locking cylinder having a recess therein providing access to the tumbler pins and having a reaction surface therein, and a key receiving entrance defined by a continuous polygonal-shaped space having generally outwardly directed slots therein communicating with the tumbler pins and the reaction surface, comprising, a body having a generally cylindrical portion and a forward hollow end portion defined by a polygonal-shaped thin wall corresponding in shape to the continuous polygonal-shaped key receiving entrance, a plurality of outwardly projecting bitings selectively disposed about said cylindrical body portion generally adjacent said polygonal-shaped forward end portion, said projecting bitings being adapted for introduction into the outwardly directed slots of the key receiving entrance upon entry of the key into the lock, said projecting bitings having tumbler pin engaging edges selectively spaced rearwardly from said forward end portion, said cylindrical portion of said body rearwardly adjacent said bitings having an outer diameter less than the diameter of the largest diameter cylinder which could

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be received within the envelope of the outer surface of said polygonal-shaped thin wall, and torque applying means operatively associated with said cylindrical body portion for effecting rotational movement of the key.

10. A key as defined in claim 9 wherein said outwardly projecting bitings are radially disposed about said cylindrical body portion in circumferential spaced relation.

11. A key as defined in claim 9 including a longitudinally extending outwardly projecting driver fin adapted to engage the reaction surface upon entry of the key into the tumbler lock.

12. A key as defined in claim 9 wherein said outwardly projecting bitings are arcuately disposed relative to the axis of said cylindrical body portion when considering the bitings and body portion in transverse cross section.

13. A key as defined in claim 9 wherein said cylindrical body portion comprises a hollow sleeve, and including a cylinder shank disposed in fixed relation within a portion of said hollow sleeve.

14. A method of making a key having a body including a generally cylindrical portion and a hollow forward end portion defined by a polygonal-shaped thin wall, a plurality of outwardly projecting bitings selectively disposed in circumferential spaced relation about the cylindrical body portion, an outwardly projecting driver fin, and torque applying means, comprising the steps of forming from flat sheet metal a generally rectangular blank having a forward edge and outwardly extending opposed side edge portions, forming a plurality of uniformly outwardly projecting bitings from one surface of said blank, forming a portion of the blank into a cylindrical body with the bitings projecting outwardly therefrom and with associated opposed portions of the extending side edges in adjacent relation, interlocking the adjacent outwardly extending opposed edge and outwardly extending opposed side edge portions, and forming the forward end portion of said blank into a hollow polygonal thin walled configuration.

15. The method as defined in claim 14 including the step of interlocking the outwardly extending opposed edge

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portions associated with said forward polygonal thin walled end portion of said blank to establish an outwardly projecting driver fin.

16. The method as defined in claim 15 wherein said step of forming a portion of the blank into a cylindrical body includes forming said cylindrical body about a cylindrical shank having a torque applying flat thereon.

17. The method of claim 15 wherein said outwardly projecting bitings are formed at varying distances from said forward edge of said blank.

18. The method of claim 15 wherein said outwardly projecting bitings are formed into generally arcuate projections when considered in transverse cross section.

19. A tumbler lock as defined in claim 1 wherein said locking barrel includes a spring cap supported on the rearward end thereof, said spring cap having a plurality of spring fingers each corresponding to a tumbler pin in the locking barrel and urging the corresponding tumbler pin toward said first locking position.

References Cited

UNITED STATES PATENTS

240,397	4/1881	Ehmer	70—156
2,982,121	5/1961	George	70—363
2,993,361	7/1961	Van Lahr	70—363
3,237,436	3/1966	Williams	70—363
3,320,783	5/1967	Kerr	70—401

FOREIGN PATENTS

333,162	12/1935	Italy.
1,143,124	3/1960	Germany.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,524,335

August 18, 1970

Harry F. George

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 15, line 18, "cylinder" should read -- cylindrical --;
line 35, "and outwardly extending opposed side edge portions,"
should read -- portions associated with said cylindrical body
por- --.

Signed and sealed this 16th day of March 1971.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

WILLIAM E. SCHUYLER, JR.

Commissioner of Patents