United States Patent

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[54] **PIN TUMBLER LOCK**
2 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **70/364,** 70/369, 70/378
[51] **Int. Cl.** **E05b 27/02**
[50] **Field of Search** ..... 70/374 A, 364, 363, 378, 337–345, 411, 405, 406, 182–185, 367–369

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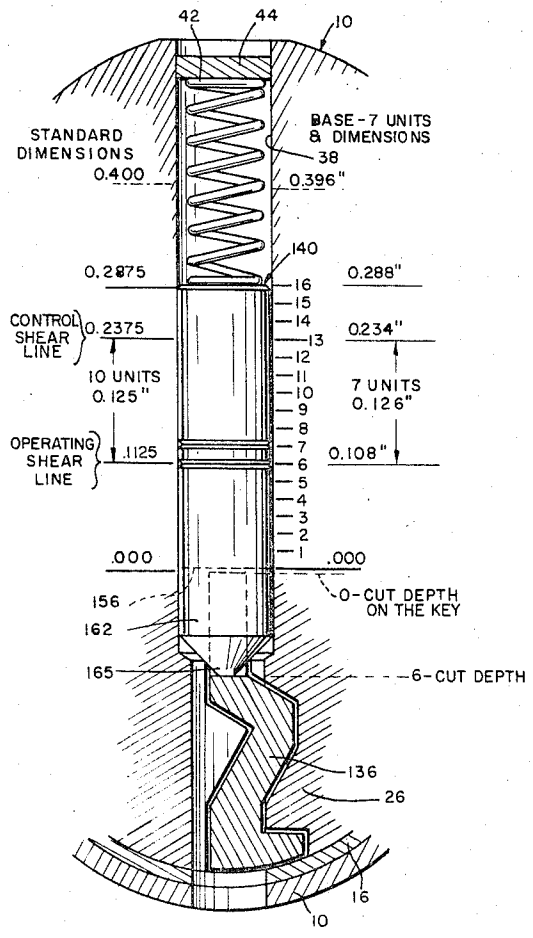
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ABSTRACT: A key-removable, pin tumbler lock core comprises a core body having a bore with a sleeve and a key plug rotatable therein and defining a first or operating shear line at the plug-sleeve interface, and a second or control shear line at the sleeve-housing interface. Pin bores in the body, sleeve, and plug receive columns of pin segments which cross both shear lines and have key-absent positions which block rotation at both shear lines. When the pin columns are raised by a suitable key, shear faces therein come into alignment with a shear line and thereby permit rotation of the key plug or sleeve.

Standard construction of such lock cores uses pin segment lengths and key-cut positions founded on base-10 increments, i.e. a division by 10, of the distance between the two shear lines, and uses standard dimensions and tolerances corresponding thereto. Such base-10 increment pin division and key cuts limit the number of useable lock combinations. The present invention retains the standard dimensions and tolerances of the lock core structure, but enlarges manyfold the number of available lock combinations by using base-7 increments, i.e. a division by 7, of the shear line separation distance for segmenting the pins and locating the key cuts. The base-7 increment pin segments and keys are fully compatible with existing standard dimensions and manufacturing tolerances and provide full interchangeability between old and new lock cores.



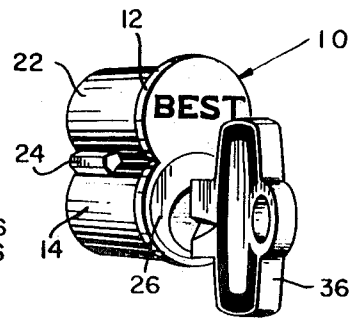


Fig. 1

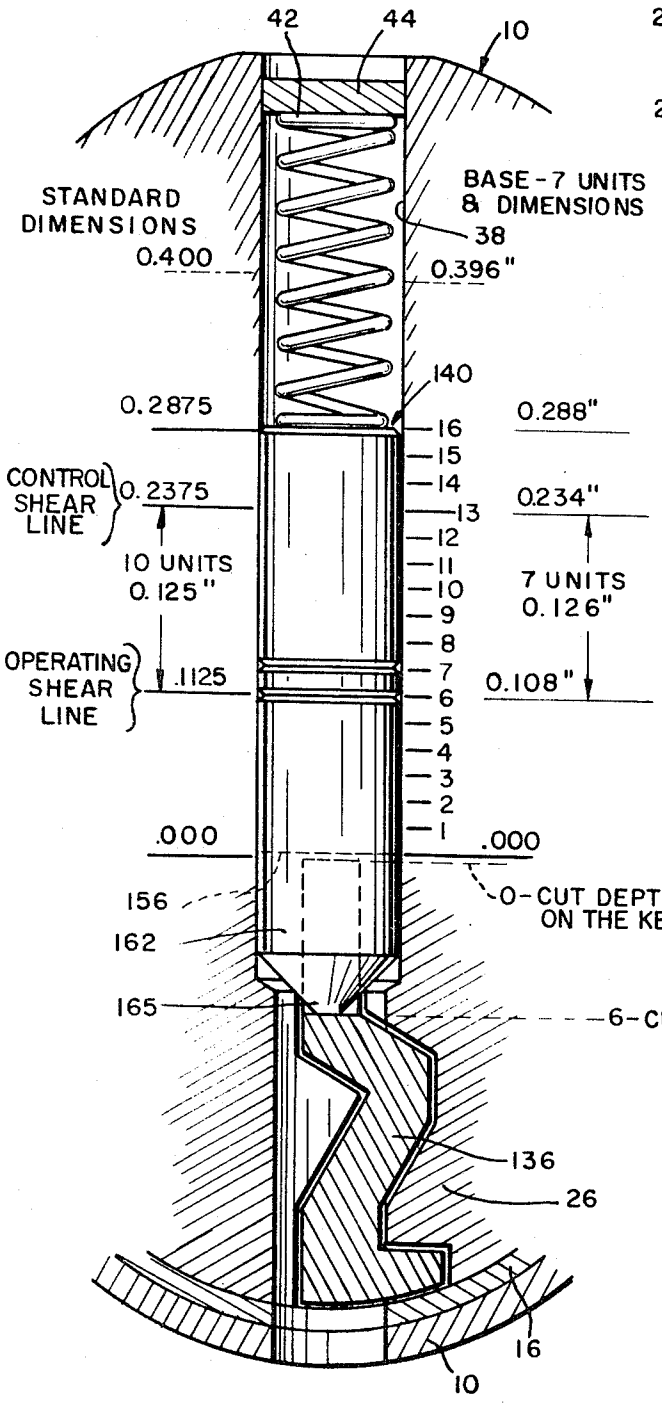


Fig. 4

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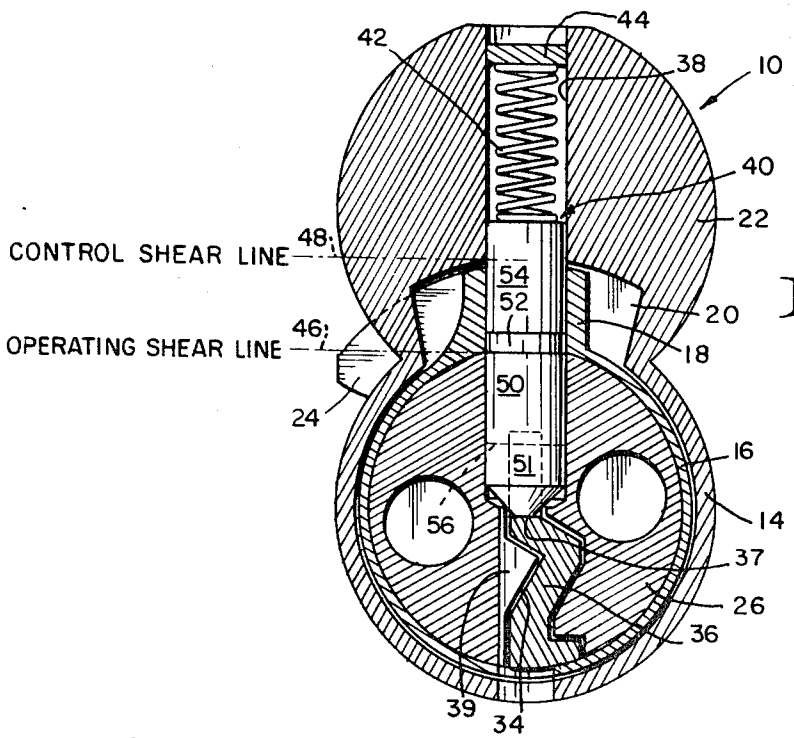


Fig. 2

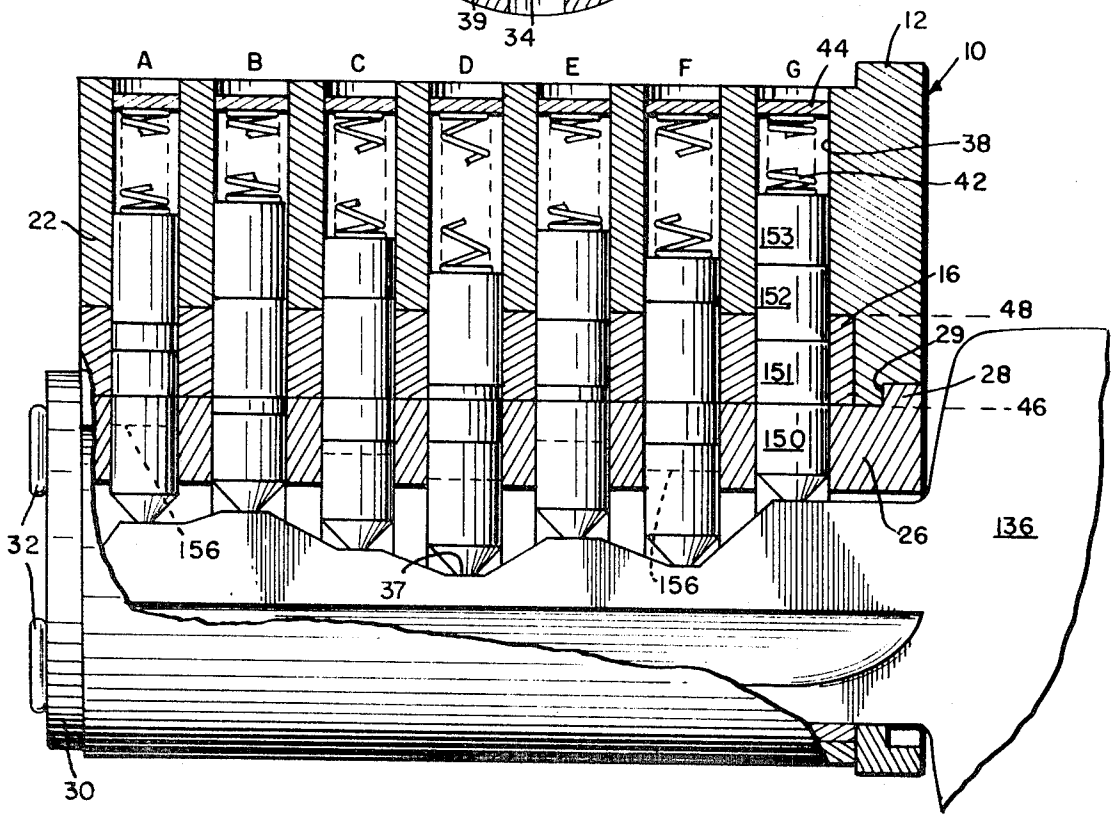


Fig. 3

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PIN TUMBLER LOCK

This invention relates to the key-removable core of a pin tumbler lock. It provides a manyfold increase in the number of useable lock combinations, over that of present standard construction, without changing the standard manufacturing dimensions and dimensional tolerances of the present standard lock cores, so that the new cores can be completely interchangeable with present standard cores and can be manufactured to the same manufacturing dimensions and tolerances as standard cores.

A pin tumbler lock core of the type here involved comprises a cylindrical key plug which is normally prevented from turning in the core body by a number of separate columns of tumbler pin segments slidably mounted in bores which extend from the core body into the key plug. There is an "operating shear line" at the periphery of the key plug, at which the pins normally block rotation of the plug. When a proper key is present in the key slot of the plug, the columns of pins are located by the cut faces on the key at elevations at which in each pin column a shear face between two abutting pin segments is level with the operating shear line, which permits the segments to move out of alignment and permits the key plug to be turned by the key.

In a lock having a key-removable core of the type shown in the Best U.S. Pat. Nos. 1,384,022 and 2,814,941 there is a second or "control shear line" between a sleeve surrounding the key plug and the core body, and limited rotation of such sleeve from its normal position retracts a lug which normally projects to lock the removable core in its mounting in the lock. The several columns of pins extend across such control shear line and are so arranged that when a control key is inserted in the key slot, the pin columns are located at elevations at which a shear face between abutting pin segments is level with the control shear line in each column of pins, and at which the columns contain at least one pin segment which crosses the operating shear line to lock the key plug against rotation in the sleeve. The sleeve and key plug can then be turned in unison by the control key, to thereby retract the core-retaining lug to permit key removal of the core and its replacement by another core which may be differently combinated.

Such interchangeable cores are advantageously employed where a large number of locks are used in groups or sets as in large buildings, institutions, and apartments, having many doors for which locks are provided and where it is desirable to provide for easy and frequent changing of the locks.

To provide the desired security and reliability in such key-removable core locks, the cores contain several columns of pins, commonly from five to seven columns in the standard locks represented by the present Best system, and the cores are made to exacting dimensions and tolerances. The pin columns are assembled from segments having lengths measured in whole numbers of standard increments, and have elevated operating positions located in terms of the same increments. Correspondingly, the keys have cut faces at cut depths measured by the same increments.

In the present standard locks of the type involved, the standard pin segment increments, and pin-column positions, and key cuts are calculated on a base-10 division of the distance between the operating shear line and the control shear line, that is, a division by 10 of that distance. This gives 10 locations along each pin column at which pin shear faces may be located for alignment with the operating shear line, and another 10 locations at which such shear faces may be located for alignment with the control shear line. The corresponding keys have a range of cutting depth divided into base-10 increments to provide 10 cut depth positions, commonly numbered from 0 to 9 inclusive. The pin columns have a range of movement divided into base-10 increments to provide 10 locations for aligning the pin shear faces with the shear lines.

In practice, the standard base-10 increments are too short to permit a single increment pin to be used and the shortest useable pins are two increments long. Moreover, in combinating the locks, it is necessary to avoid combinations which differ from each other by single increments of pin segment lengths. These limitations arise from the shortness of the pin length increment in relation to necessary manufacturing tolerances and in view of unavoidable wear over the useful life of the lock.

In practice, these factors limit to not more than five the number of base-10 shear positions in any column and the number of key cut depths for such column which may be used in combinating any particular system of the base-10 cores, and this greatly limits the number of lock combinations which may be used in combinating the locks of such system. One available position in each pin column is reserved for the master key, which leaves only four positions for use in combinating the control key and the other operating keys —and there may be four or more such other operating keys requiring different combinations. One column will therefore provide four combinations, two columns will provide 16 combinations, three will provide 64, etc. The number of available combinations will be equivalent to the number of combinating positions in each column raised to the power "n" where "n" is the number of pin columns in the core. For example, seven four-position columns will give a maximum of 16,384 available combinations.

Certain other factors have a bearing. The bottom segment of each pin column is a key-engaging segment which has a tapered and rounded lower end adapted to ride on the cut edge of the key. This bottom segment has a certain standard minimum length, which places the upper end face of a minimum-length key-engaging segment in the "0" shear-face position in the pin column when the segment rests on the 0-cut of a key. The pin column also includes two or more upper pin segments of selected lengths.

A combinating kit or set of pin segments for assembling pin columns will consist of two groups of pin segments. One group will include key-engaging bottom pins of 10 different lengths, differing by single base-10 increments, in order to provide for locating shear faces at each of the ten base-10 positions in the pin column, even though not more than five can be used in a given column in any one master-key system. The other group will consist of a supply of various sizes of upper pin segments for use with the key-engaging bottom segments in a base-10 column, and will include pins differing in length by single base-10 increments for all of the useable sizes, to provide for assembling a pin column with shear faces in any of the several positions, although again, not more than five base-10 positions can be used in a given column in any one system.

The topmost pin in each base-10 column has a minimum length of four base-10 increments, and is selected from the combinating kit or set just mentioned.

The pin column has a standard total length, and the bore containing the bore containing the column has a standard depth and relationship to the keyway so that in the absence of a key the pin column will drop to a predetermined locking position with its shear lines. In a standard key-removable core, the operating shear line and the control shear line are spaced from each other a distance of 0.125 inch, which makes each base-10 increment equal to 0.0125 inch. The total length of each pin column is 23 base-10 increments, or a total length of 0.2875 inch, measured from the position from the "0" shear face in the column and excluding the added constant length of the tapered, key-engaging portion of the bottom pin segment.

I have now discovered that a manyfold increase can be obtained in the number of available and useable combinations in any particular master-key system of locks in a manner which is fully compatible with he retains standard manufacturing dimensions and tolerances of the lock core structure, and which thereby provides lock cores which are fully interchangeable with previous standard base-10 cores and which ensure an ample margin of safety in providing security

and reliability in locks and lock systems containing the new cores.

In accordance with my invention, these results are accomplished by using unique base-7 increments instead of the standard base-10 increments. In the new base-7 cores the increment of pin-length, pin-column positions, and key cut depth is a base-7 division of the basic dimension of the standard base-10 cores, that is, a division by 7 of the standard shear line separation distance, and accordingly, a provision of seven pin-column positions and a corresponding seven key-cut depths, separated by base-7 increments, over the same full range of pin-column positions and key cut depths previously taken up by the base-10 dimensions.

The new base-7 cores are unique in that they are compatible with the standard base-10 core structure, they can be manufactured to standard dimensions and manufacturing tolerances, they are fully interchangeable with standard base-10 cores, and they increase manyfold the number of useable combinations.

The base-7 increment length is obtained by a base-7 division of the basic dimension of the prior standard base-10 core. Such basic dimension in the Best-type key-removable cores is the shear line separation distance of 0.125 inch, and the base-7 division of this distance rounded off to a thousandth-inch dimension which is workable with standard tools, is 0.018 inch.

A single such base-7 increment of 0.018 inch provides adequate separation between adjacent shear positions in the pin columns for combinating purposes, so that all positions can be used. Single-increment pin lengths may be used and combinations may be used which differ by only single-increment differences. The base-7 pin columns and key cuts are fully compatible with the present standard core structure, that is, with the present standard core body, sleeve and key plug, and with the standard pin column length and shear line separation distance. The slight differences which occur are well within close operably useable tolerances.

The base-7 pin columns in the otherwise standard core provide a full seven positions which are useable for combinating purposes, so that each pin column provides seven combinations. Reserving one position of the seven in each case for the master key, there are six other positions available in each pin column for the control key and the other operating keys. This gives tremendously more lock combinations than is provided by the previous system. The greater number is shown by the following table:

TABLE I

Number of Columns	Base-10 4 Positions Per Column	Base-7 6 Positions Per Column
1	4	6
2	16	36
3	64	216
4	256	1,296
5	1,025	7,776
6	4,096	46,656
7	16,384	279,936

The base-7 increments give multiple-increment distances which are compatible with standard dimensions and manufacturing tolerances. Thus, seven 0.018-inch base-7 increments give a total dimension of 0.126 inch which is within useable manufacturing tolerances of the standard shear line separation distance of 0.125 inch; and 16 of such base-7 increments give a total length of 0.288 inch, which is within useable manufacturing tolerances of the standard pin-column length of 0.2875 inch provided by 23 base-10 increments.

The base-7 subdivision of the lock pin columns is unique in accomplishing the objects of this invention. While the distance between the operating shear line and the control shear line can be divided into other numbers of equal divisions, no other number provides the benefits and meets the requirements of the present invention. Other numbers of equal divisions either fail to meet operably useable tolerances in other respects, or fail to provide increments of sufficient length to be used in single lengths in forming pin core segments and as increments of separation between close lock combinations.

Experience has shown that base-10 increments are too short to be used singly is secure operation and reliability are to be obtained. A division by either 8 or 9 of the basic core dimensions also fails to give adequately secure operation, and neither division gives increment lengths which are compatible with standard dimensions for both shear line separation distances and pin-column lengths. While a division by 6 can be made, this fails to give increments which provide a satisfactory pin-column length, and represent a much smaller improvement over the standard base-10 arrangement with respect to the number of combinations provided.

The accompanying drawings illustrate the invention. In such drawings:

FIG. 1 is a perspective view of a lock core of the type to which the invention relates;

FIG. 2 is a vertical transverse section of a lock core of the type shown in FIG. 1;

FIG. 3 is an axial section through a lock core of the type shown in FIG. 1, with pin-column segments and key cuts in accordance with the present invention;

FIG. 4 is a fragmental section on an enlarged scale of a pin column as shown in FIG. 2 and showing by chart labeling how the base-7 subdivision of the pin column meets the standard dimensions and manufacturing tolerances of a standard lock core of the type shown in FIG. 1.

The lock core shown in FIGS. 1–3 comprises a core body **10** having the configuration of two intersecting parallel cylinders **14** and **22**, to give a figure-8 shaped cross section. The front of the body carries a stop flange **12** to limit rearward movement of insertion of the body **10** into a conforming opening in a core housing. The lower cylinder **14** is concentrically bored for the reception of a cylindrical core sleeve **16** which at the top carries an upstanding wide rib **18** received in a channel **20** cut into the body of the upper cylinder **22**. The rear section of the rib **18** carries a laterally projecting lug **24** which normally projects outward beyond the surface of the body **10** as shown in FIGS. **1** and **2** to form a lug for retaining the core in its housing. The sleeve **16** is rotatable, clockwise in FIG. **2**, to retract the lug **24** to substantially within the 8-shaped periphery of the core body **10**, to permit such body to be withdrawn axially from its mounting in a core housing.

A key plug **26** is received in the cylindrical bore of the sleeve **16**. It has a front flange **28** seated in a counterbore **29** formed in he front of the core body **10**, and both it and the sleeve **16** are held in the body by a key stop plate **30** fixed to the rear end of the plug by rivet bosses **32** on the plug. The key plug **26** contains a longitudinal key slot **34** for the reception of a key **36**.

A series of tumbler pin bores **38** extend downward in spaced relation longitudinally of the body **10**, on the central vertical axial plane of such body, through the upper cylinder **22**, through the rib **18** of the sleeve **16** and into the key plug **26**. Reduced-diameter extensions **39** of such bores extend from approximately the center of the key plug **26** downward through the bottom half of such key plug **26** and out the bottom of the lower cylinder **14**. The pin bores **38** contain stacks or columns **40** of pin segments urged downward in the bores by springs **42** bearing against plugs **44** in he upper ends of the pin bores **38**.

In the plane of the pin bores **38**, the interface between he key plug **26** and the sleeve **16** defines the "operating shear line" **46**, and the interface between the top of the rib **18** of the sleeve **16** and the overlying face of the core body **10** defines the "control shear line" **48**. Each pin stack or column **40** is made up of a plurality of pin segments which lie in abutting relation at what may be termed "pin shear faces." The pin

column **40** shown in FIG. **2** comprises a lower pin segment **50**, an intermediate pin segment **52**, and an upper pin segment **54**. The pin shear face between the pin segment **50** and the pin segment **52** lies coplanar with the operating shear line **46**, and this relationship will permit the key plug **26** to be turned on its axis to carry the lower pin segment **50** out of alignment with the pin bore **38** and the other pin segments **52** and **54**. The upper pin segment **54** extends across the control shear line **48** and blocks the sleeve **16** and the rib **18** against rotation relative to the core body **10**. An operating key **36** lifts the pin columns in the several pin bores **38** positions at which pin shear faces lie in alignment with the operating shear line **46** in all pin bores. The pin columns **40** are such that under these circumstances at least one pin segment **54** will lie across the control shear line **48** to prevent rotation of the rib **18** and the sleeve **16**. The lock may then be operated by such a key **36** to turn the key plug **26** and actuate the lock in the usual known manner.

A core-removal key or control key, in contrast to an operating key, will position the pin columns **40** in positions at which pin shear faces will lie coincident with the control shear line **48** in every pin bore **38** and at least one pin segment will lie across the operating shear line **46**, and this will permit the manipulation of that core-removal key to rotate the sleeve **16** and rib **18** clockwise in FIG. **2** to retract the lug **24** from its core retaining position, and permit the lock core as a whole to be withdrawn from its mounting.

In a standard core of this type, the lengths of pin segments and the corresponding depths of cut of the key **36** are based on a base-10 division, i.e., a division by 10, of the distance between the operating shear line and the control shear line, to obtain a base-10 increment. The pin segments differ in length by whole numbers of such base-10 increments, and there are 10 depths of cut in the key **36**, equally spaced by such increments, and ranging from zero depth to a depth of nine of these base-10 increments. The lower pin **50** of each pin column **40** has a tapered lower end **51** adapted to ride over the cut face **37** of the key **36**. This lower end **51** is of a constant length from its tip to a zero line **56**, such that when the pin column **40** rests on a zero cut at the top of the key **36**, the zero line **56** will lie coincident with the operating shear line **46**. Each lower pin segment **50** includes a constant-length bottom portion **51**. The set or kit of such segments **50** includes one having that constant length and nine others which also have additional lengths of from one to nine base-10 increments. The additional pin segments **52** and **54** of the column **40** are selected from a set of standard pins in lengths differing by single base-10increments.

In practice it is found that a pin segment having a length of only one base-10 increment is too short to be useful and to provide for proper operation of the lock. It is also found that in combinating a set of locks, it is necessary for the lock combinations to differ from each other by more than single base-10 increments in order to provide proper security and operation of the lock. Accordingly, the number of useable pin shear-face locations in any particular pin column is limited. With the base-10 system, and reserving one of the available positions for a master key, these conditions permit the use of not more than four shear-face locations in any one pin column for lock combinating purposes.

In accordance with the present invention, a base-7 division instead of a base-10 division is used for determining the incremental lengths of the pin segments and the positions of the shear faces in the pin columns **40**, and for determining the corresponding depths of cut in the key. This permits the use of single-increment pin segments and permits combinating with single-increment differences. It provides a total of seven useable shear-face positions in each column, and greatly increases the number of useable lock combinations. Moreover, the base-7 elements are completely compatible with the standard manufacturing dimensions and tolerances of the rest of the lock structure, and their use does not adversely affect the operation of the lock nor interfere with meeting the various requirements which must be met in providing core-removal control keys and operating key systems of master and individual lock keys.

FIG. **3** shows a lock core containing pin columns and a key in accordance with the present invention. The lock core structure is of standard construction and identical with that shown in FIG. **2**. It consists of a core body **10** bored to receive a control sleeve **16** in which a key plug **26** is mounted. The body contains seven pin bores **38** closed at the top by plugs **44** which serve to retain the pin-column spring **42**.

The pin columns **140** in the seven bores **38** each contain four pin segments **150**, **151**, **152**, and **153**. The bottom pin segment **150** includes an arbitrary length between its tip and a zero line **156** from which additional increments are measured. In columns B and G in FIG. **3**, the bottom pin has no additional increments so that the total length of the bottom pin represents the arbitrary length and the top face of such pin in column G is coincident with the control shear line **46**. Additional increments of length of the bottom pins **150**, and the lengths of the other pins **151**, **152**, and **153** are measured in whole numbers of base-7 increments, that is, increments representing a base-7 division, i.e., a division by 7 of the distance between the operating shear line **46** and the control shear line **48** in FIGS. **2** and **3**. The keys for use with this core have seven depths of cut, from 0 to 6, separated by single base-7 increments, as shown by the seven cuts in the key **136** in FIG. **3**. The seven bores **38** in FIG. **3** are labeled A to G inclusive, and the four pin segments in each pin column **140** in such bores have the lengths indicated in the following table, which provide for a control key, one master key, and one operating key, having the lock combinations given in the lower part of the table.

TABLE II

FIG. 3 CORE

Column	Pin segment lengths, in base-7 increments. A	B	C	D	E	F	G
Pin							
Top	8	7	4	9	7	3	5
Third	2	8	8	1	5	8	6
Second	4	1	3	3	1	3	5
Bottom	2	0	1	3	3	2	0
Combinations							
Control Key	1	2	5	0	2	6	4
Master Key	6	0	1	3	4	2	5
Operating Key	2	1	4	6	3	5	0

In each case, the length of the bottom pin given in the table excludes the arbitrary length below the zero line **156**. The key **136** shown is the operating key and the positions in which such key locates the pin columns provide the combination for that operating key as set forth in the bottom line of the table. Thus, in the G column of FIG. **3** and Table II, the operating key has a combination value of "0". Accordingly, the face of the key **136** in line with that column has a 0-cut, which locates the pin column at a height such that the zero line **156** and the top face of the 0-length bottom pin segment **150** in the column are level with the control shear line **46**. Accordingly, the bottom segment **150** and the second segment **151** abut each other and provide a shear face in the column at the level of that shear line **46**, and the presence of that shear face will permit the key plug **26** to be turned to carry the bottom segment **150** out of alignment with the bore **38**.

The master key combination has a value of "5" in column G. Accordingly, the master key face in line with the G column would have a 5-cut—which is that of the key face shown in

column F of FIG. 3—and the length of the second pin segment **151** is five base-7 increments. This provides a shear face between the abutting ends of pin segments **151** and **152** which will be level with the operating shear line **46** when the pin column rests on the key face cut to a depth of five increments.

The control key has a combination value in column G of four base-7 increments, and the pin segment **152** therefore has a length of six increments to position the interface between the segments **152** and **153** four increments above the control shear line **48**, so that when the pin column rests on a key face cut to a depth of four increments, that shear face will be level with the control shear line **48** and will permit the core sleeve **16** to be rotated to carry the lower portion of the pin column out of alignment with the bore **38**.

The top segment **153** is of sufficient length to make the total height of the pin column **140** equal to 16 base-7 increments, in addition to the arbitrary bottom end, so that the upper end of the column will always lie above the control shear line **48** and the pin column will have the desired standard length for use with standard springs **42** and in core structures built to standard dimensions.

The master key combination reduces by one the number of key face locations for the columns which are available for use in the other key combinations, since the same location is not used both for master and operating combinations. When the shear face between segments **150** and **151** in column G is coincident with the operating shear line **46**, the segment **152** lies across the control shear line **48** to block rotation of the sleeve **16** relative to the core body **10**. Conversely, when the shear face between the segments **152** and **153** is coincident with the control shear line **48**, the pin segment **151** will lie across the operating shear line **46** and will block relative rotation of the key plug **26** with respect to the sleeve **16**.

The pin segment lengths in the other columns A to F in FIG. 3 and Table II have corresponding relations with the key combinations given in Table II, and are chosen to provide shear faces in the pin columns **140** at the proper points for operation by key cut to the corresponding combinations shown at the bottom of the table.

FIG. **4** shows how the new base-7 lock meets the critical standard dimensions of the present standard lock. FIG. **4** shown a standard core body **10** and one of its standard pin bores **38** in which is inserted a pin column **140** having a lower portion **162** of constant length below a zero line **156** and having a tapered lower end **165** resting on the bottom cut face of a key **136**. The key is of standard construction and identical with he key **36** previously described except that it is, or is to be, cut to base-7 increment depths instead of the standard base-10 depths. The line **156** designates the zero line from which pin segment increments are measured along the pin column **140**. At the left of the diagrammatic FIG. **4**, the standard positions of the operating shear line **46** and the control shear line **48** are indicated and the standard distance between those lines of 0.125 inch is shown. The total length of the standard pin column is 23 base-10 units which gives a total pin column length measured from the zero line **156** of 0.2875 inch, which is also shown. When the standard pin column is raised to its maximum elevation, by a 0-cut key face, its upper end lies at 0.400 inch on the standard dimension scale, and this point is shown.

At the right of FIG. **4**, 16 base-7 units are laid off. The size of such units is derived by a base-7 division of the distance between the two shear lines **46** and **48**. Mathematically, a division of that design distance of 0.125 **inch by** 7 gives a quotient of 0.017857+ inch, but in practice, this can be rounded off to 0.018 inch, which is the incremental length used in laying out the base-7 unit scale at the right of FIG. **4**. Seven of such incremental units, from point-6 to point-13 on the base-7 scale gives a distance of 0.126 inch, which is within manufacturing tolerances of the 0.125 inch design distance between he interfaces which provide the operating shear line and the control shear line. The base-7 scale is located so that its point-6 position at 0.108 inch, is exactly coincident with the operating shear line, at 0.1125 inch on the standard scale, since such operating shear line is perhaps the most critical position. This locates the point-13 position substantially within the tolerances range of the interface between the boss **18** and the body part **22**, which locates the control shear line **48**.

The total length of the base-7 pin column is 16 base-7 units, or 0.288 inch, which is within operably useable manufacturing tolerances of the 0.2875-inch length of a standard-dimension pin column. The total range of movement which is necessary for the pin column in order for it to take all its combinating positions is likewise within an operably useable tolerance relation to the corresponding range and positions of movement in standard base-10 cores.

The total range of key cut depth with base-7 cuts, from the 0-cut position to the seventh or 6-cut position is within the corresponding range on the standard-dimension base-10 scale.

The base-7 system of the present invention is unique in the very close relationship which exists between the critical points and dimensions in the base-7 system and the corresponding critical points and dimensions in the standard base-10 system. That uniquely close relationship makes the base-7 pin columns and key cuts entirely compatible with the standard dimensions and tolerances of the present standard locks. It permits the new lock cores to be manufactured to such standard dimensions and tolerances, and to be fully interchangeable with previous cores of standard dimensions. Yet, as shown in Table I above, it increases manyfold the number of useable combinations which can be used in combinating the resulting locks.

I claim:

1. A key-removable pin tumbler lock core comprising

core body having an axial bore,

a sleeve mounted for limited rotation in said bore and carrying a lug movable therewith between a retracted position and an advanced position for retaining the core in a housing,

a key plug having an axial keyway, rotatably mounted in the sleeve,

a plurality of pin bores extending from said core body through the wall of said sleeve and into the key plug for receiving pin columns to be acted on by a key in said keyway,

the interface between said sleeve and core body defining a control shear line at which such pins may block lug-retracting rotation of said sleeve,

the interface at the periphery of said key plug defining an operating shear line at which such pins may be block rotation of said key plug,

said control shear line and operating shear line being spaced from each other by a distance of 0.125 inches,

said pin bores being constructed and arranged to receive columns of pin segments, each of said columns includes a lower segment having tapered lower end of arbitrary length forming a key-engaging end for engagement with cut faces on a key inserted in said keyway and is otherwise composed of segments which have lengths in whole numbers of 0.0125-inch increments,

with each column axially movable in its bore to 10 combinating positions therealong spaced from each other by whole 0.0125-inch increments, the key-engaging ends of said pin columns having corresponding predetermined combinating positions spaced from each other by whole 0.0125-inch increments over a predetermined key-cut range within said keyway,

and with each column extending upward from said tapered lower ends a distance in whole 0.0125-inch increments such as to extend across both shear lines and into the core body in all said positions of the column and to dispose the top of the column in positions within a predetermined top-end range corresponding to the key-cut range,

said pin extending upward beyond such column to receive springs for urging such column toward the keyway and operative over said predetermined top-end range,

10 of said whole increments being equal in length to the 0.125-inch spacing between said shear lines, the core being thereby operable with a control key for shear separation at said control shear line and with an operating shear line, with columns of pin segments which have lengths, excluding the arbitrary length of said tapered end, in whole numbers of said 0.0125-inch increments, to dispose shear faces therebetween at either of said shear lines with keys having key cuts in the same predetermined combinating positions for both operating and control actuation, wherein the improvement comprises

said lock core being provided in each pin bore with a column of base-7 pin segments including a lower segment having a tapered lower end of arbitrary length forming a key-engaging end for engagement with cut faces on a key inserted in said keyway and being otherwise composed of segments which have lengths in whole numbers of 0.018-inch increments,

each column of said base-7 segments being axially movable in its bore to seven combinating positions therealong spaced from each other by whole 0.018-inch increments, the key-engaging ends of said pin columns having seven corresponding combinating positions spaced from each other by whole 0.018-inch increments in the same said predetermined key-cut range,

each column extending upward from said tapered lower end a distance in whole 0.018-inch increments such as to extend across both shear lines and into the core body in all positions of the column and to dispose the top of the column substantially within the same said predetermined top-end range,

springs in said pin bores for urging said base-7 columns toward the keyway and operative over the top end range of said base-7 columns,

seven of said whole 0.018-inch increments being equal in length to a distance which is operably equivalent to the 0.125-inch spacing between the said shear lines, the core being thereby made operable with control and operating keys for shear separation at each of said shear lines with keys cut to support said base-7 segment columns in said seven combinating positions spaced from each other by such 0.018-inch increments in said same predetermined key cut range,

whereby the lock core is provided with wider separations between shear face positions in its pin columns than with said 0.0125-inch increment pins and the number of useable combinations therein is increased.

2. A pin tumbler lock core as set forth in claim **1** wherein the pin bores are constructed and arranged to receive pin columns having a total length, excluding the arbitrary length of the tapered lower end, of 23 whole 0.0125-inch increments equaling 0.2875 inch, and the base-7 pin columns provided therein have a corresponding total length of 16 whole 0.018-inch increments equaling 0.288 inch.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,603,123 Dated September 7, 1971

Inventor(s) Walter E. Best

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

Column 2, line 57, delete "the bore containing";
line 60, before "lines" insert -- face positions all out of alignment with the two shear --;
line 71, change "he" to -- and -- .
Column 4, line 52, change "he" to -- the --.
Column 5, line 11, before "positions" insert -- to --.
Column 7, line 43, change "shown" to -- shows --;
line 48, change "he" to -- the --;
line 72, change "he" to -- the --.
Column 8, line 53, change "said" to -- which --;
line 73, after "pin" insert -- bores --.
Column 9, between lines 4 and 5, insert -- key for shear separation at said operating --.

Signed and sealed this 21st day of March 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents