United States Patent [19]

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[54] **PIN TUMBLER LOCK SYSTEM**

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[52] **U.S. Cl.** **70/358,** 70/421

[51] **Int. Cl.** **E05b 27/06**

[58] **Field of Search** ..... 70/358, 364 R, 364 A, 70/419, 421, 407, 409, 406

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Primary Examiner—Robert L. Wolfe
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[57] **ABSTRACT**

A pin tumbler lock of the Yale type additionally equipped with blocking pins spaced in the direction of the cylinder axis in respective bores which extend in the cylinder in a common plane perpendicular to the plane of the key slot and are freely movable in the associated bores between a position in which their rounded outer ends engage a concavely arcuate groove in the lock case and a position in which their similarly rounded inner ends engage corresponding lateral recesses or a groove in the key, the blocking pins permitting a further increase of the number of combinations available in a lock system having a common master key.

10 Claims, 10 Drawing Figures

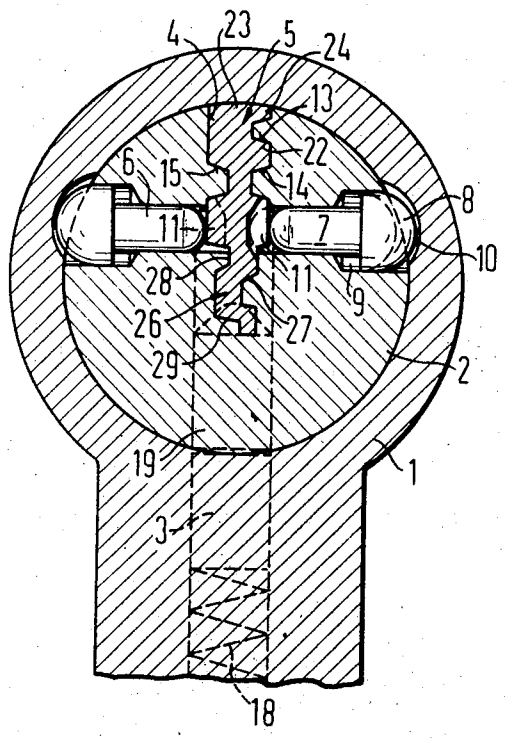

Fig. 1

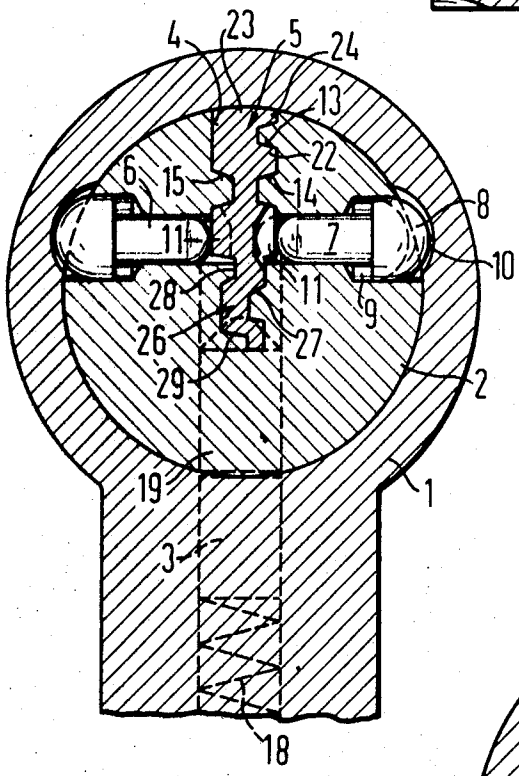

Fig. 4

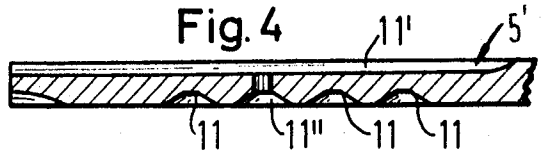

Fig. 5

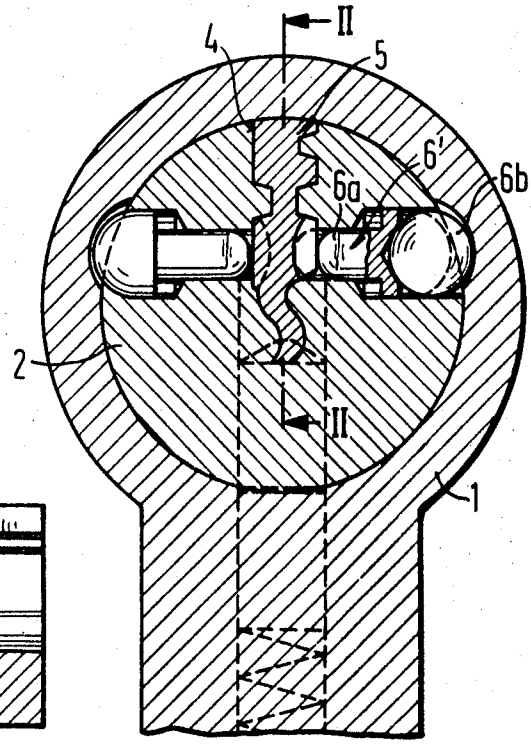

Fig. 2

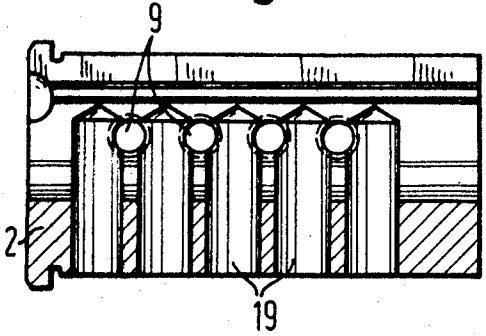

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Fig. 3

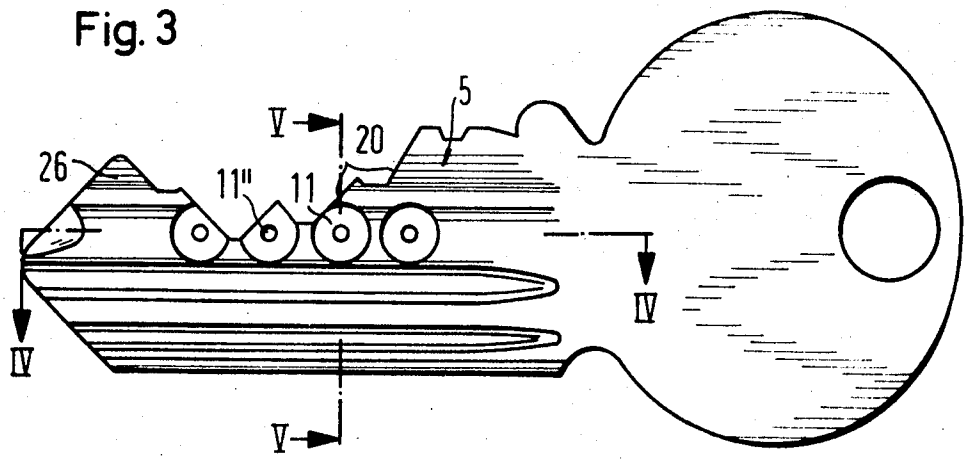

Fig. 6

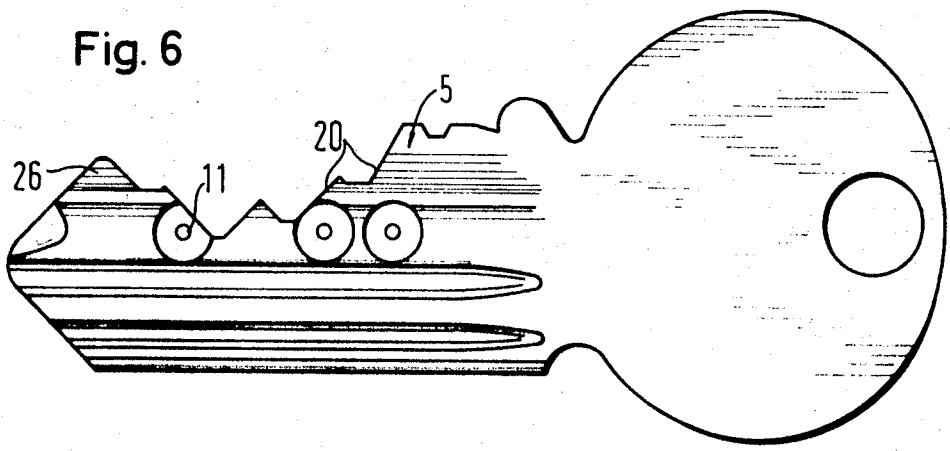

Fig. 6a

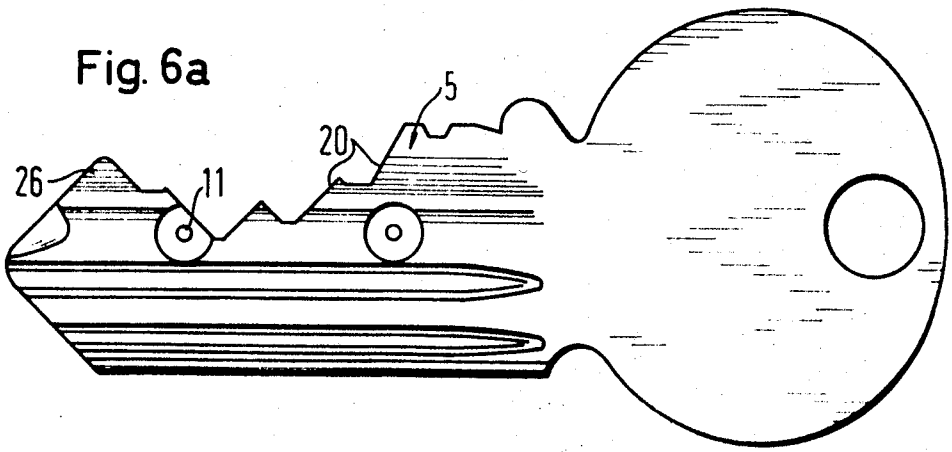

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Fig. 6b

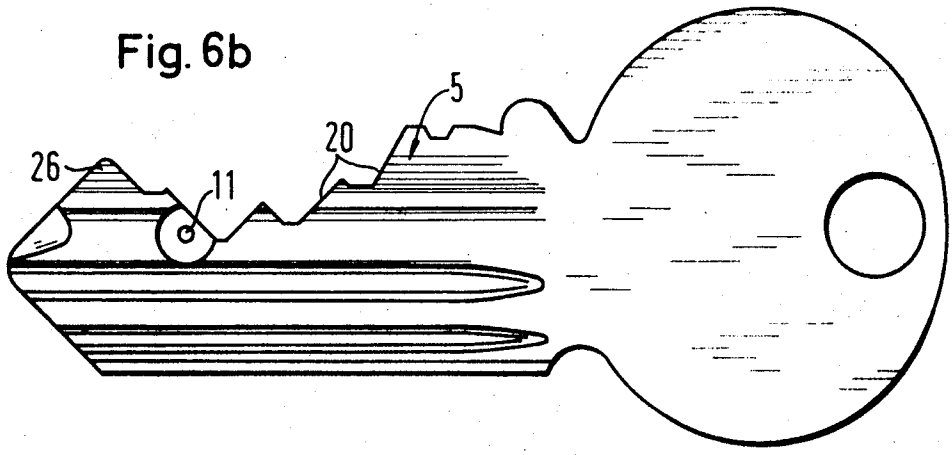


Fig. 6c

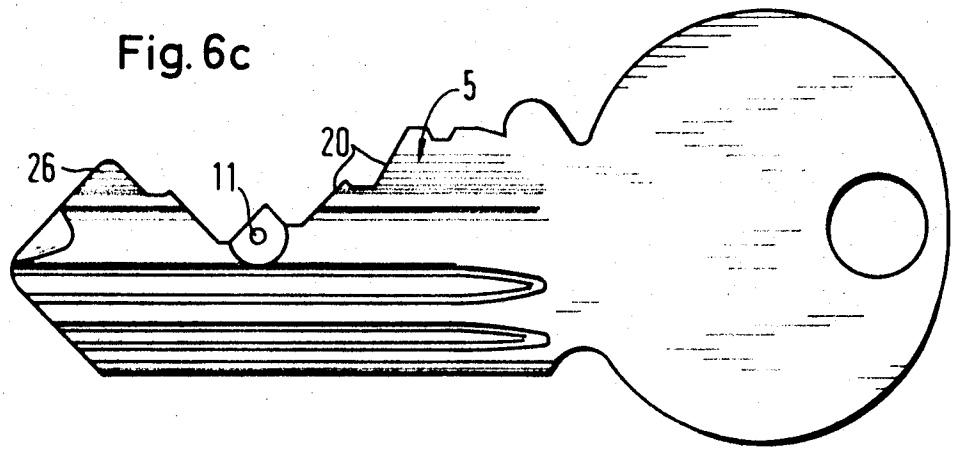
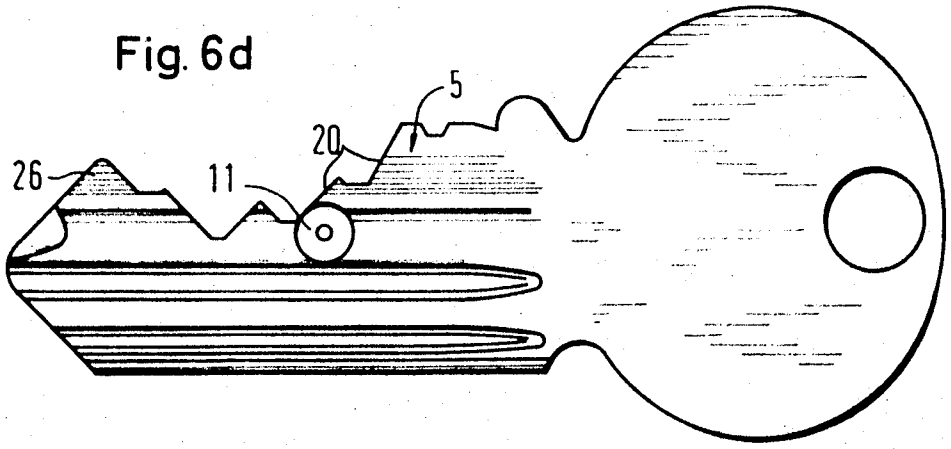


Fig. 6d



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PIN TUMBLER LOCK SYSTEM

This invention relates to pin tumbler locks of the Yale or cylinder type, and particularly to an improvement in a known modified pin tumbler lock in which additional blocking pins, not spring-loaded, are provided in the cylinder for engagement by the key.

In its more specific aspects, the invention is concerned with an improvement in the lock disclosed in the German Patent No. 1,260,340 in which the blocking pins are biased by gravity inward of the key slot in the normal mounted condition of the lock. The cylinder bores in which the blocking pins are slidably received are obliquely inclined relative to the plane of the key slot which is normally vertical in the locking position of the cylinder. The force required for displacing the blocking pins by means of a key inserted in the direction of the cylinder axis is relatively great, and it may be impossible to insert a key against the resistance of the blocking pins under unfavorable conditions.

A primary object of the invention is an improvement in the known lock arrangement in which the force for translatory movement of the blocking pins is transmitted from the key in a more effective manner, and the risk of inoperativeness is accordingly reduced.

Another object is the provision of a very numerous system of such lock arrangements capable of being operated by means of a common master key yet differing from each other by variations in detail structure.

With these and other objects in view, the invention, in one of its aspects, resides in a system of pin tumbler lock arrangements of the type in which a cylinder is rotatable in a case about an axis toward and away from a locking position. A plurality of axially spaced first bores extends substantially in the plane through the axis which is the plane of an axially open, narrow key slot and communicate with the slot. Axially spaced second bores extend through the cylinder from the case to the key slot. The first bores hold respective pin tumblers resiliently biased toward the slot, and blocking pins are respectively slidable in the second bores.

The case is recessed in alignment with the second bores in the locking position of the cylinder for receiving respective first portions of the blocking pins. Cooperating first cam faces on the blocking pins and the case move the blocking pins inward of the associated bores when the cylinder rotates away from the locking position.

The arrangement further includes a key shaped and dimensioned for axial movement in the key slot in conforming engagement with the cylinder toward and away from an operative position. A longitudinal edge portion of the key has projections and notches and simultaneously engages the pin tumblers in the operative key position. The key also has lateral recesses aligned with the second bores in the operative key position for receiving respective second portions of the blocking pins. Cooperating second cam faces of the key and of the blocking pins move the latter inward of the second bores when the key moves axially away from its operative position.

In the afore-described structure, whose elements are known, the invention arranges the second bores perpendicular to the plane of the key slot, and horizontally in the usual mounted position of the lock arrangement when the cylinder is in the locking position. The corresponding lateral recesses of the key are formed contiguously adjacent the projections on the afore-mentioned

longitudinal edge. The several lock arrangements differ in the number and/or locations of the lateral recesses in the associated keys and in the corresponding arrangement of the blocking pins.

Other features, additional objects, and many of the attendant advantages of this invention will readily be appreciated as the same becomes better understood by reference to the following detailed description of a preferred embodiment when considered in connection with the appended drawing in which:

FIG. 1 shows a pin tumbler lock arrangement of the invention in section through the cylinder axis;

FIG. 2 shows the cylinder of the arrangement of FIG. 5 in section on the line II—II;

FIG. 3 is a side-elevational view of the master key for a system of lock arrangements of the type illustrated in FIG. 1;

FIG. 4 illustrates a modified master key in a fragmentary sectional view corresponding to a section on the line IV—IV in FIG. 3;

FIG. 5 shows a modified lock arrangement in a view analogous to that of FIG. 1; and

FIGS. 6 to 6*d* show individual keys in respective views similar to that of FIG. 3, some details being omitted.

Referring now to the drawing in detail, and initially to FIGS. 1 and 2, there is seen a lock arrangement of the Yale type in which a tubular lock case 1 receives a cylinder 2 in its conforming cavity for rotation about the axis of the cavity. Five pairs of pin tumblers 3 are received in respective portions of bores 19 in the case 1 and the cylinder 2 which are axially spaced in a plane through the cylinder axis, the plane being vertical in the illustrated, normal position of the case 1.

A key slot 4 extends in the same plane and communicates with the portions of the bores 19 in the cylinder 2, both portions of the bores 19 being aligned with each other in the locking position of the cylinder. In that cylinder position, helical compression springs 18 in the case 1 bias the pin tumblers 3 inward of the key slot 4.

The key slot 4 extends inward from the circumference of the cylinder 2 and is axially open. It receives an elongated key 5 for axial movement toward and away from the fully inserted, operative position. The key 5 cooperates with the pin tumblers 3 and with two groups of identical blocking pins 6. Each blocking pin 6 has two portions 7, 8 which are slidably received in respective conforming parts of a bore 9 in the cylinder 2 perpendicular to the plane of the key slot 4 and of the bores 19, all bores 9 being arranged in a common plane which is nearer the cylinder axis than the open side of the key slot 4 in the circumference of the cylinder 2. The pin portion 7 is approximately cylinderical, and its end near the key slot is spherically rounded. The pin portion 8 is approximately hemispherical and of much greater radius of curvature or cross section than the pin portion 7. The bores 9 are uniformly spaced in the direction of the cylinder axis and arranged in pairs in four radial planes through the cylinder axis between axially adjacent bores 19.

The cylindrical inner face of the case 1 has two axial grooves 10 of circularly arcuate cross section, the radius of curvature of the grooves 10 being somewhat greater than that of the blocking pin portions 8. The key 5 is formed with spherically arcuate recesses 11 also seen in FIGS. 3 and 4, whose radius of curvature is greater than that of the rounded ends of the blocking

pin portions 7. When the key 5 is in its operative position in an associated cylinder 2, and the cylinder 2 is in its locking position, respective portions of the grooves 10, the pins 6, and the recesses 11 are aligned in the direction of the bores 9.

The length of each pin 7 is slightly greater than that of the associated bore 9 so that either the pin portion 7 projects into the key slot 4 or thep n portion 8 projects into the groove 10. When the key 5 enters the slot 4, it cammingly engages the rounded ends of the pin portions 7 and pushes the pins 6 into the grooves 10 in the locking position of the cylinder 2. The key is blocked from fully entering the slot 4 in all other angular positions of the cylinder 2 in which the pins 6 cannot be dislodged from the slot 4. When the pins 6 are aligned with recesseo 11 in the key 5, and the cylinder 2 is turned by means of the key, the walls of the grooves 10 cammingly engage the rounded ends of the pin portions 8 and shift the pins 6 into the recesses 11, therebg permitting rotation of the cylinder 2. The cylinder 2 cannot be turned unless the proper key is inserted in the slot 4. When the key is withdrawn in the locking position of the cylinder, the walls of the recesses 11 cammingly cooperate with the rounded end faces of the pin portions 7 and shift the pins 6 into the illustrated position. Because the bores 9 are normally horizontal, the pins 6 normally maintain the positions reached by camming interaction with the case 1 or the key 5 because of friction.

The narrow longitudinal edge portion 26 of the key 5 which is near the cylinder axis in the inserted key is formed with teeth or projections 20 which are separated by notches. The edge 26 acts on the pin tumblers 3 in the manner conventional in such lock arrangements so that the tumbler portions held in the cylinder 2 terminate at the interface of the case 1 and of the cylinder 2 and do not interfere with cylinder rotation when the proper key is inserted in the slot 4. Grooves 13, 14, 15 extend over the entire inserted length of the key 5 in its side walls between the recesses 11 and the smooth edge portion 23 of the key opposite the toothed edge portion 26. Ribs 22 integrally projecting from the cylinder 2 into the slot 4 conformingly engage the grooves in the key. A guide rib 24 extending along the edge portion 23 engages a groove in the cylinder. Ribs 27, 28, 29 on the edge portion 26 of the key are partly interrupted by the notches between the projections 20.

As is best seen in FIG. 3, the recesses 11 are aligned in the direction of key movement contiguously adjacent the projections 20 and the associated notches, and at least their centers are offset from the nearest groove 14 or 15, thereby leaving a relatively wide portion of the key 5 to the edge 23 uninterrupted and available for ribs and grooves. The key 5 shown in FIGS. 1 and 3 is a master key suitable for operating all locks of a system of locks equipped with two rows of four bores 9 as shown in FIG. 2, but differing from each other in the number and spacing of at least functionally identical pins 6. The key has eight recesses 11, and thus permits any and all pins 6 of the system to be displaced inward of the slots 4 by the camming effect of the case 1 when the cylinder 2 is turned. The individual keys for the several locks are shown in FIGS. 6 to 6*d* in a simplified manner, and the distribution of the pins 6 in the locks, not themselves shown, will be obvious from that of the recesses 11 in the keys.

While the key illustrated in FIGS. 1 and 3 is equipped with two rows of individual recesses 11, several such recesses may be combined without changing the operation of the key as is shown in FIG. 4 in a modified master key 5'. The recesses on one side of the key are merged into a lateral, axially elongated groove 11', and a bore 11'' extending through the key 5' from side to side transversely of the key slot plane replaces two opposite recesses 11. Obviously, the key 5' may be equipped with two grooves 11' only on its two opposite sides, or only with four through-passages such as the bore 11'', the edges of the bores cammingly cooperating with the spherically arcuate end faces of the pin portions 7.

It is preferred, however, to provide the master key with not more than one groove 11', and to make the necessary depth of the groove and of the recesses 11 in the other side face of the key sufficiently great that two continuous grooves of such depth would weaken the key to make it inoperative. This makes it more difficult for unauthorized persons to open the lock without the proper master key equipped with properly spaced depressions 11 or bores 11'' on at least one side of the key.

If so desired, the grooves 10 in the inner face of the case 1 may be replaced by individual recesses or by through bores analogous to the recesses 11 and bores 11'', but it is normally simpler to form axial grooves in the inner case surface than blind recesses, and the grooves are more effective than through bores.

While the lock arrangement of the invention has been described so far with reference to unitary pins 6, FIG. 5 shows an otherwise unchanged lock equipped with functionally equivalent two-part pins 6'. One pin part 6*a* combines the features of the afore-described pin portion 7 with a terminal flange in the enlarged portion of the bore 9, and a central depression in the flange seats a bearing ball 6*b* which constitutes the functional equivalent of the afore-described pin portion 8. When the pin part 6*a* engages a recess in the key 5, the ball 6*b* is free to roll toward and away from the part 6*a* if aligned with a groove in the case 1. Under all other conditions, the two parts of the pin 6' move jointly, and movement of the pin part 6*a* inward of the slot 4 is limited by its flange.

Because the pins 6, 6' move in a common plane at right angles to the plane of the key slot 4, the cam engagement of the key with the pins transmits forces from the key to the pins in an advantageous manner which permits the pins to be shifted by the inserted key even when the lock is contaminated after a long period of idleness.

The variation in the number and location of the pins 6, 6' illustrated indirectly in FIGS. 6 to 6*d* greatly increases the number of combinations otherwise available from varying the lengths of the pin tumblers 3 in the usual manner. The relatively wide space between the recesses 11, 11', 11'' and the key edge 23 accomodates numerous combinations of grooves 13, 14, 15 so as to provide many sets consisting of a system of individual keys and a master key which have a common arrangement of grooves 13, 14, 15. It is less desirable to rely on the interrupted ribs 26, 27, 28 for preventing insertion of a key into a wrong lock since these ribs are mechanically relatively weak aud may be deformed.

It is advantageous to locate the bores 9 close to the axis of the cylinder 2 and the toothed edge 26 of the

key 5 for the additional reason that the bores 9 and the associated pins 6, 6' have their greatest possible length there so that the pins are securely guided.

It should be understood, of course, that the foregoing disclosure relates only to preferred embodiments of the invention, and that it is intended to cover all changes and modifications of the examples of the invention herein chosen for the purpose of the disclosure which do not constitute departures from the spirit and scope of the invention set forth in the appended claims.

What is claimed is:

1. A lock system including a plurality of pin tumbler lock arrangements, each arrangement having a case; a cylinder rotatable in said case about an axis toward and away from a locking position, said cylinder being formed with an axially open key slot extending in a plane substantially through said axis, with a plurality of axially spaced first bores extending substantially in said plane and communicating with said slot, and with a plurality of axially spaced second bores transverse to said plane, said second bores extending through said cylinder from said case to said slot; a plurality of pin tumblers in said first bores respectively; resilient biasing means biasing said pin tumblers in said first bores toward said slot; a plurality of blocking pins respectively slidable in said second bores, said case being recessed in alignment with said second bores in said locking position of the cylinder for receiving respective first portions of said blocking pins; cooperating first cam means on said blocking pins and said case for moving the received portions of said blocking pins inward of said second bores when said cylinder rotates away from said locking position thereof; an elongated key shaped and dimensioned for axial movement in said key slot in conforming engagement with said cylinder toward and away from an operative position, said key having a longitudinal edge portion formed with projections and notches, said edge portion being adapted simultaneously to engage said pin tumblers in said operative position, said key being formed with a plurality of lateral recesses aligned with said second bores in the operative position of said key for receiving respective second portions of said blocking pins; and cooperating second cam means on said key and on said blocking pins for moving the received second portions outward of said second bores when said key moves axially away from said operative position, wherein the improvement comprises;

a. the -distribution of said blocking pins in the second bores of each arrangement and the distribution of recesses in each key being different, the pin recesses thereby

b. said second bores in each arrangement being located in a common plane parallel to said axis,

c. said lateral recesses being aligned in the direction of key movement,

d. each key being elongated in said direction,

e. said recesses in each key being of equal depth,

f. said blocking pins being of equal length, and

g. said second bores being of equal number in each of said arrangements.

2. A lock system comprising, in combination:

a. a plurality of pin tumbler lock arrangements, each arrangement including

1. a case,

2. a cylinder rotatable in said case about an axis toward and away from a locking position, said cylinder being formed

i. with an axially open key slot extending in a plane substantially through said axis,

ii. with a plurality of axially spaced first bores extending substantially in said plane and communicating with said slot, and

iii. with a plurality of axially spaced second bores in a common plane parallel to said axis, said second bores extending through said cylinder from said case to said slot,

3. a plurality of pin tumblers in said first bores respectively,

4. resilient biasing means biasing said pin tumblers in said first bores toward said slot,

5. a plurality of blocking pins respectively slidable in said second bores, said case being recessed in alignment with said second bores in said locking position of the cylinder for receiving respective first portions of said blocking pins,

6. cooperating first cam means on said blocking pins and said case for moving the received portions of said blocking pins inward of said second bores when said cylinder rotates away from said locking position thereof,

7. an elongated individual key shaped and dimensioned for axial movement in said key slot in conforming engagement with said cylinder toward and away from an operative position,

i. said key having a longitudinal edge portion formed with projections and notches for simultaneous engagement with said pin tumblers in said operative position,

ii. said key being formed with a plurality of lateral recesses aligned with said second bores in the operative position of said key for receiving respective portions of said blocking pins,

8. cooperating second cam means on said key and on said blocking pins for moving the receiving second portions outward of said second bores when said key moves axially away from said operative position,

i. the distribution of said blocking pins of each arrangement and the distribution of recesses in each key being different,

ii. said arrangements differing in the number of said blocking pins and in the number of said lateral recesses in said individual keys aligned with the second bores of the associated cylinders when said individual keys are in the respective operative position,

iii. said blocking pins being of equal length and said second bores being of equal number in each of said arrangements;

b. a master key shaped and dimensioned for axial movement in each key slot of said system toward and away from an operative position,

1. said master key being formed with a group of lateral recesses,

2. the second bores of each cylinder being aligned with respective recesses of said last-mentioned group in the operative position of said master key.

3. A system as set forth in claim 2, wherein said second bores in each arrangement are located in a common plane parallel to said axis, and said lateral recesses

are aligned in the direction of key movement, each key being elongated in said direction.

4. A system as set forth in claim **3**, wherein said recesses in each key are of equal depth.

5. A system as set forth in claim **1**, wherein said second cam means include respective spherically arcuate, mutually engageable faces on said blocking pins and in said lateral recesses.

6. A system as set forth in claim **1**, wherein each cylinder has a plurality of axially elongated ribs laterally projecting into said key slot thereof, each key being formed with grooves conformingly engaging said ribs, said lateral recesses having respective centers transversely offset from each of said grooves.

7. A system as set forth in claim **1**, wherein the cross section of the first portion of each blocking pin in one of said arrangements is greater than the cross section of the second portion of said blocking pin.

8. A system as set forth in claim **1**, wherein said arrangements differ in the numbers of said blocking pins and in the numbers of said lateral recesses in said key aligned with the second bores of the associated cylinders when said key is in the operative position, the system further including a master key shaped and dimensioned for axial movement in each key slot of said system toward and away from an operative position, and being formed with a group of lateral recesses, the second bores of each cylinder being aligned with respective recesses of said group in the operative position of said master key.

9. A system as set forth in claim **1**, wherein said arrangements differ in the axial spacing of said second blocking pins and the axial spacing of said lateral recesses in said key aligned with the second bores of the associated cylinders when said key is in the operative position, the system further including a master key shaped and dimensioned for axial movement in each key slot of said system toward and away from an operative position, and being formed with a group of lateral recesses, the second bores of each cylinder being aligned with respective recesses of said group in the operative position of said master key.

10. A system as set forth in claim **1**, wherein said common plane is perpendicular to said plane in which said key slot extends, said lateral recesses being formed in said key contiguously adjacent said projections.

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