June 12, 1951 L. E. DEUTSCH 2,557,028

KEY-OPERABLE PERMUTATION LOCK

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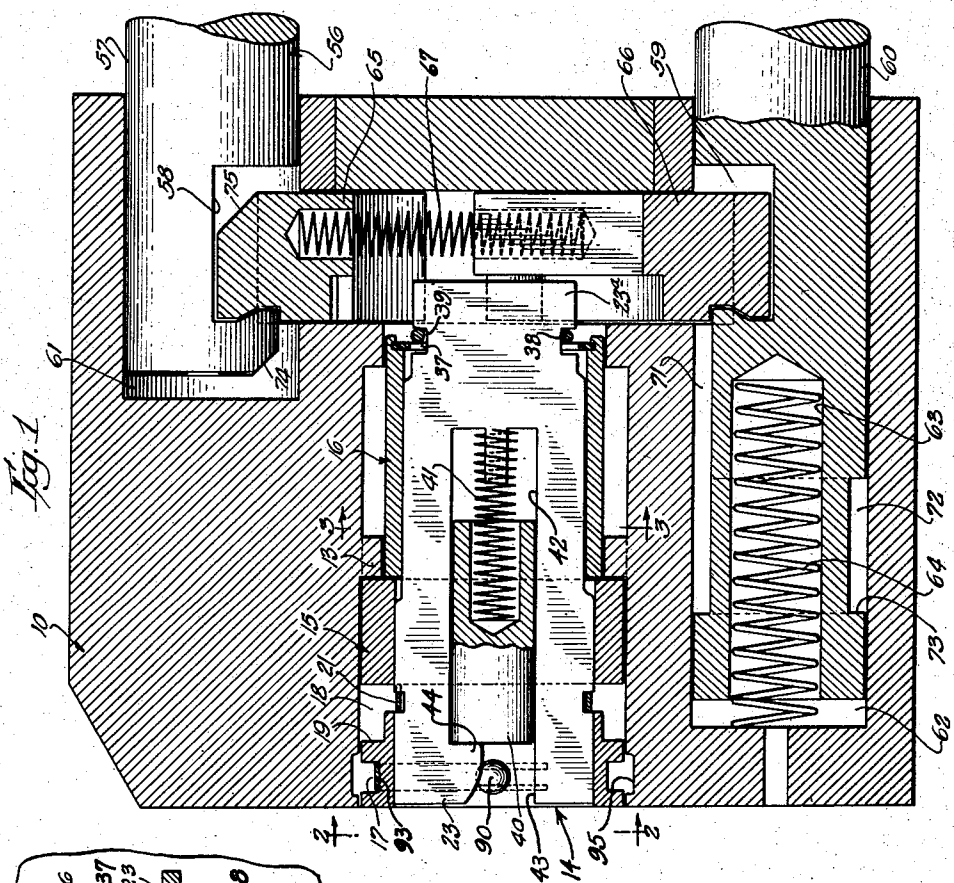


Fig. 1

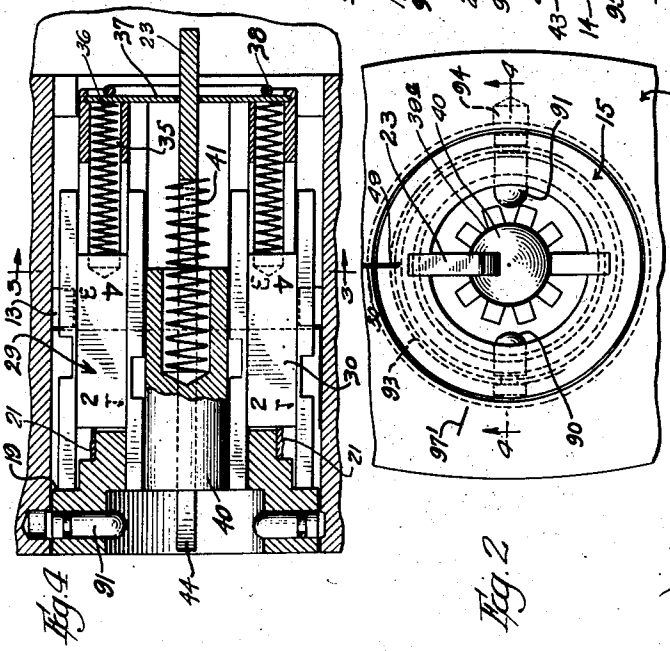


Fig. 4

Fig. 2

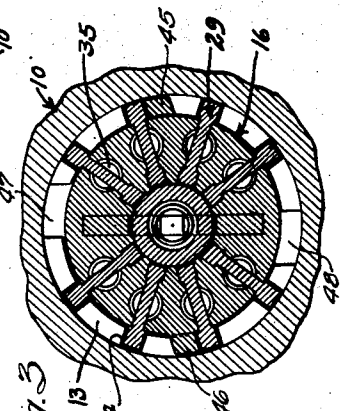


Fig. 3

INVENTOR.
Leo E. Deutsch
BY
Sheridan, Davis & Cargill
Attys.

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Fig. 5

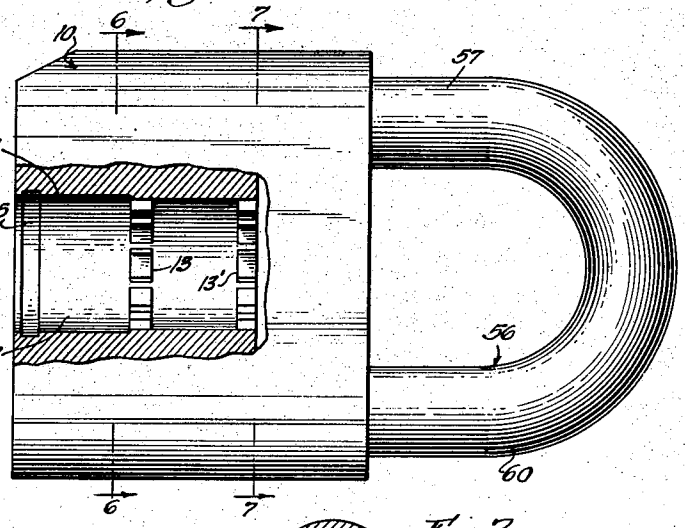


Fig. 8

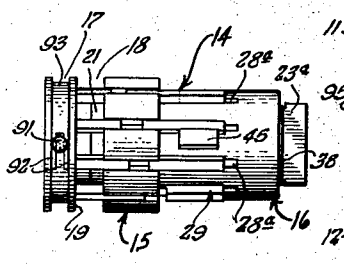


Fig. 6

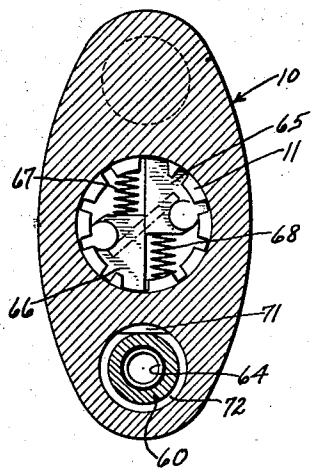


Fig. 9

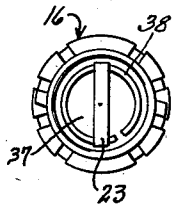


Fig. 7

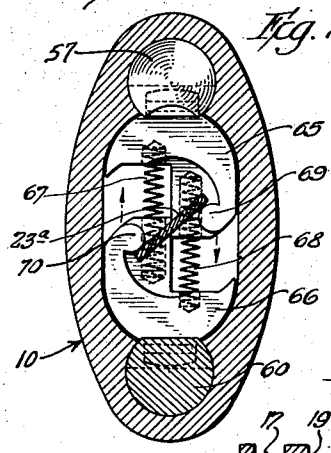


Fig. 11

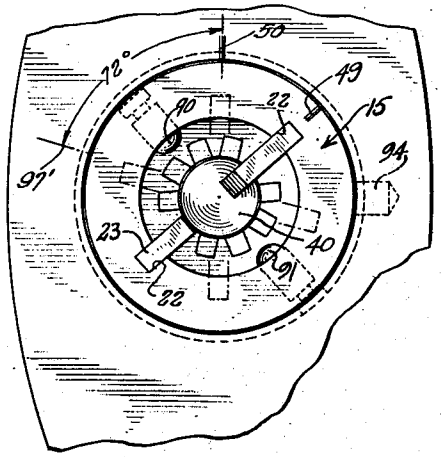
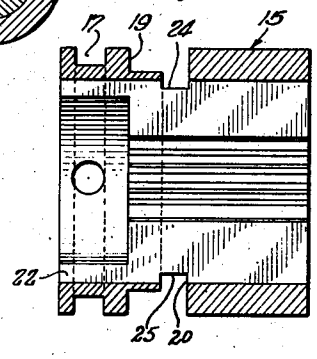


Fig. 10



INVENTOR.
Leo E. Deutsch
By: Sheridan, Davis & Cargill
Attys.

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Fig. 12

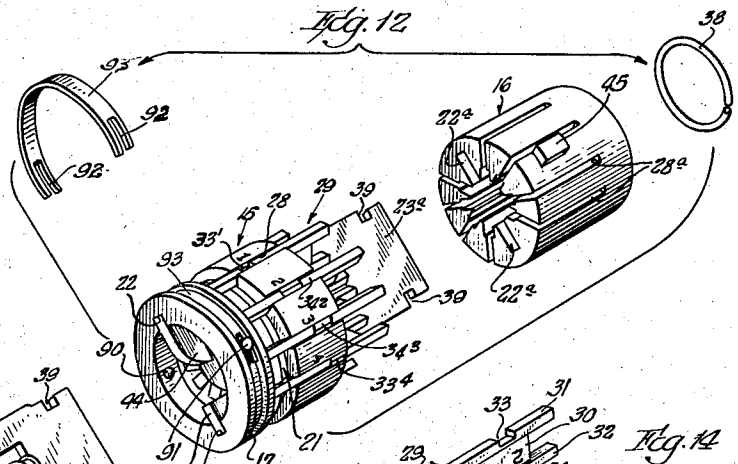


Fig. 13

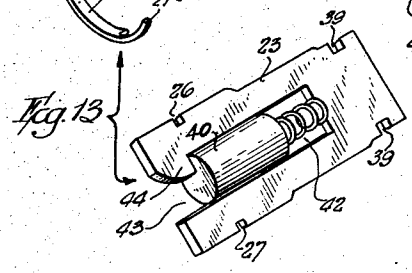


Fig. 14

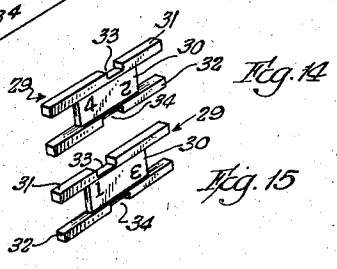
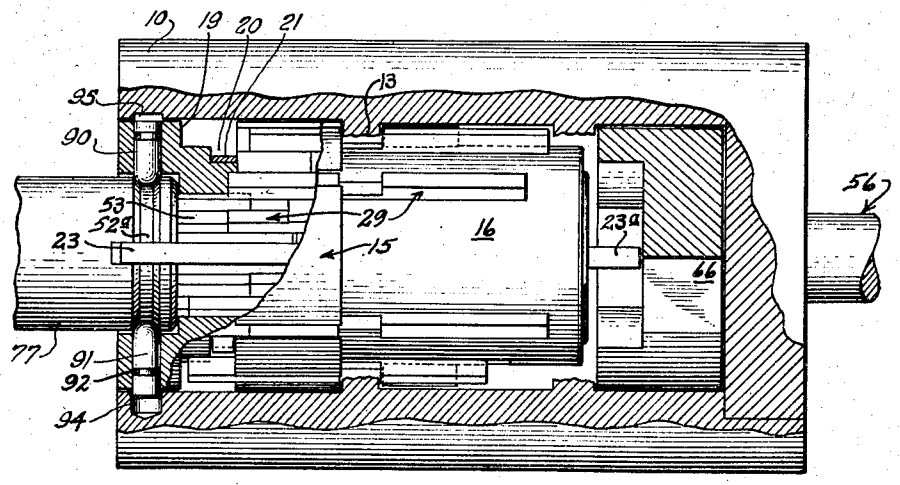


Fig. 15

Fig. 16



INVENTOR.
Leo E. Deutsch
By: Sheridan, Davis & Cargill
Attys.

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Fig. 19

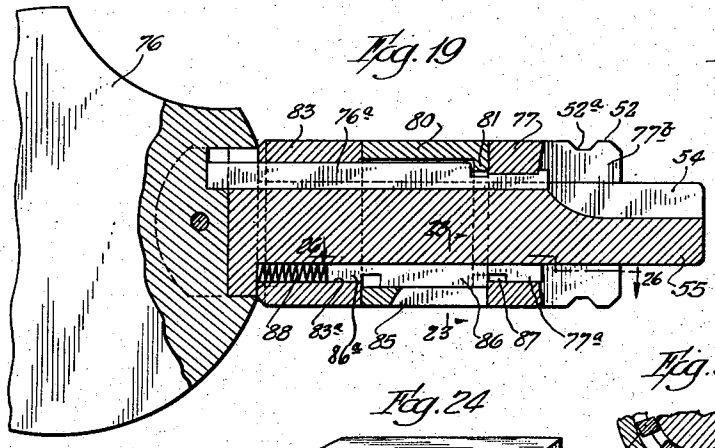


Fig. 18

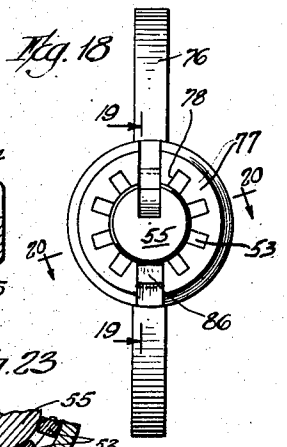


Fig. 23

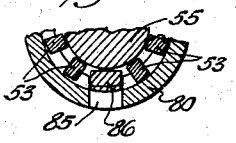


Fig. 24

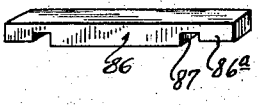


Fig. 20

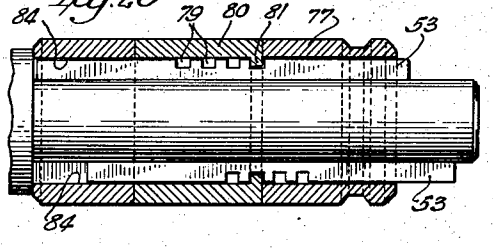


Fig. 17

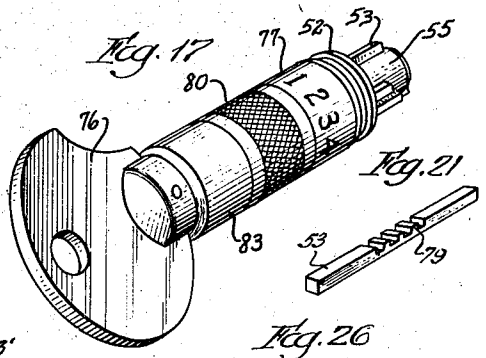


Fig. 21

Fig. 22

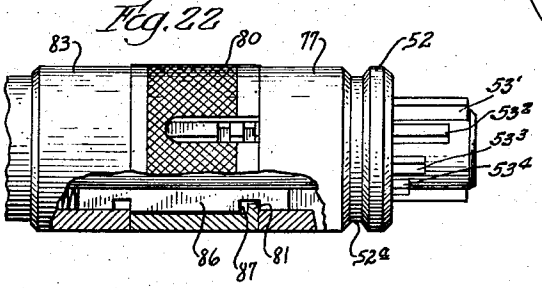


Fig. 26

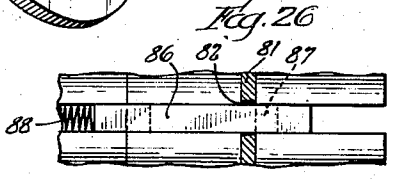


Fig. 27

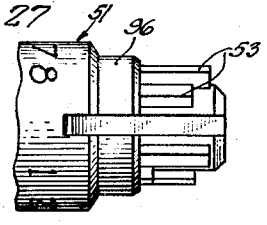
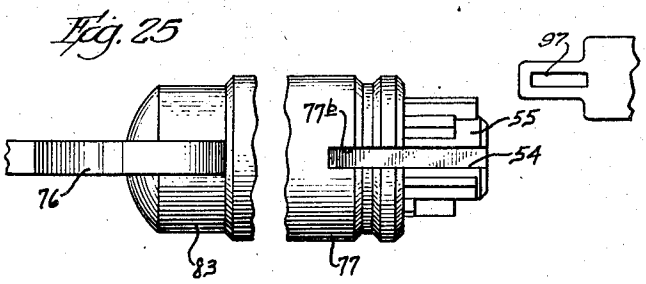


Fig. 25



INVENTOR.
Leo E. Deutsch
BY
Sheridan, Davis & Cargill
Attys.

Patented June 12, 1951

2,557,028

UNITED STATES PATENT OFFICE

2,557,028

KEY-OPERABLE PERMUTATION LOCK

Leo E. Deutsch, Hammond, Ind., assignor to Deutsch Lock Company, Hammond, Ind., a corporation of Indiana

Application February 9, 1946, Serial No. 646,600

12 Claims. (Cl. 70—363)

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This invention relates to improvements in key operable permutation locks.

One object of the invention is to provide a lock having a selected number of structurally similar locking elements each of which can be placed in any one of several relative positions for effecting desired locking combinations of the locking elements.

Another object of the invention is to provide a lock of the character mentioned which comprises a locking unit provided with a cylindrical carrier for the locking elements and means affording ready removal of the carrier from the lock casing whereby the selected locking combination can be altered by changing the relative position or positions of one or more of the locking elements.

An additional object of the invention is to provide, in a lock of the character referred to, means for retaining an operating key against withdrawal from the lock until the locking unit shall have been returned to a locked position. The lock mechanism therefore, cannot be left in an unlocked condition without leaving the key in the lock, although when the lock latch has been released and the locking unit has been restored to locking position and the key removed, the latch may thereafter be closed in instances where the improvements are employed in those types of locks which are self-latching, as padlocks, for example. In other words, the improvements may be embodied in locks of the type that are key-operable to latched position or in the type that may be merely snapped to latched position without use of a key.

An additional object of the invention is to provide a permutation lock that may be masterized, that is, a lock that is operable by a key designed particularly for that lock as well as being operable by a master key that will operate a group of other locks set at different locking combinations. Thus each of a group of locks used on a similar number of doors, as apartment house doors, for example, may be set each for operation by a particular key of the respective tenant, and all the locks may be operable by a master key in the custody of the janitor or other authorized person. Likewise, the locking elements of a particular lock of the improved type may be arranged for operation by each of the keys of a group of locks each of the latter of which has locking elements thereof arranged for operation only by the key for that particular lock. Thus, for example, an outer door of an apartment building may have a lock that is operable by each of the keys for the locks of the apartment doors al-

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though each key is ineffective to operate other than a particular apartment door lock.

Another object of the invention is to provide an improved key structure for use with the improved lock mechanism.

Other objects of the invention relate to various features of construction and arrangement of parts which will be apparent from a consideration of the following specification and accompanying drawings wherein:

Fig. 1 is a broken longitudinal sectional view of a padlock provided with locking mechanism that is illustrative of the present invention.

Fig. 2 is a broken front elevational view of the lock shown in Fig. 1 and viewed in the direction of arrow 2—2, the lock mechanism being in locking position within the casing.

Fig. 3 is a broken sectional view taken on line 3—3 of Fig. 1.

Fig. 4 is a broken longitudinal sectional view taken on line 4—4 of Fig. 2.

Fig. 5 is a broken side elevational view of the padlock shown in Fig. 1 and illustrating a suitable lock-chamber within the casing of the padlock for receiving the improved lock mechanism.

Fig. 6 is a sectional view taken on line 6—6 of Fig. 5.

Fig. 7 is a sectional view taken on line 7—7 of Fig. 5.

Fig. 8 is an elevation of an improved lock unit removed from the casing shown in Fig. 5.

Fig. 9 is a rear or inner end view of the lock mechanism shown in Fig. 8.

Fig. 10 is a longitudinal sectional view of a detached cylindrical locking element carrier taken on a vertical plane when the carrier is in the relative locking position shown in Fig. 2.

Fig. 11 is a front elevation of the lock with the lock unit moved clockwise from the position shown in Fig. 2 toward the position at which the shackles of the padlock shown in Fig. 1 will be unlatched.

Fig. 12 is an exploded perspective view showing separately certain parts of the lock unit in separated relation.

Fig. 13 is a perspective view of a latch actuating bar constituting part of the lock unit and also a retainer spring in detached relation of a type suitable for retaining the bar in assembled relation in a locking element carrier.

Fig. 14 is a perspective view showing one side of one of the locking elements or "tumblers."

Fig. 15 is a perspective view showing the opposite side of the same or a different locking element.

Fig. 16 is a broken top plan view of the lock shown in Fig. 1, with a key in position in the lock ready to be turned to release the shackle latch.

Fig. 17 is a perspective view of a key for use in operating a lock of the type shown in the preceding figures.

Fig. 18 is a front end elevation of the key.

Fig. 19 is a sectional view taken on line 19—19 of Fig. 18.

Fig. 20 is a broken longitudinal sectional view of the key illustrating two actuator members in different relative positions in the key.

Fig. 21 is a perspective view of a detached actuator element.

Fig. 22 is a broken side elevation of the key illustrating an aperture closure slide in a retracted position within the key and a rotatable sleeve moved to a position giving access to one of the actuator members.

Fig. 23 is a broken sectional view taken on line 23—23 of Fig. 19.

Fig. 24 is a perspective view of a closure slide removed from the key.

Fig. 25 is a broken top plan view of the key.

Fig. 26 is a broken sectional view taken on line 26—26 of Fig. 19.

Fig. 27 is a broken top plan view of a special key for use in removing a locking unit from a lock casing.

In the drawings, the lock selected for the purpose of illustrating the invention is a padlock having a casing 10, but the improved lock mechanism may be utilized in locks of other types such as door locks, desk locks or safety deposit locks, for example, as well as with locks of types intended for various special purposes as will be apparent from a consideration of the following specification.

The lock casing 10 as illustrated in Fig. 5, whether formed as a movable or portable body portion of a padlock or of a lock housing insertable in a door stile or the like, is provided with a lock chamber 11. The wall 12 of the chamber 11 is provided, intermediate the ends of the chamber, with an annular row or ring of spaced apart locking lugs 13 which are shown as integral with the chamber wall of the lock. In Fig. 5 there is also shown a second annular row of lugs 13' which are similar to lugs 13 but the lugs 13' perform no locking function and could have been represented in the drawing merely as a continuous annular rib similar to the flange from which the lugs 13 are formed but as a matter of convenience in shop operations, the lugs 13' are cut in the machine operation that forms the lugs 13.

The lock mechanism or unit 14 fits within, and is releasably retained in, the chamber 11 and, as shown in Fig. 12, the unit 14 comprises a locking element carrier 15 and a spring carrier 16 each generally of cylindrical shape and adapted to be assembled into the unitary form shown in Fig. 8. When in assembled relation the carrier 16 cooperates with carrier 15 in supporting the locking elements hereafter described.

The element carrier 15 is of an external diameter for rotatably seating within the chamber 11 and, in the exterior surface is provided with a forward annular channel 17 and an adjacent second channel 18. Channel 18 has a forward vertical wall 19 which forms a forward stop for the locking elements as hereinafter described and is provided also with a ring-receiving groove 20 formed somewhat deeper than the remaining portion of the channel 18 for receiving a locking ring 21. The hollow element carrier 15 is provided with two longitudinal, diametrically opposed slots 22, in its inner periphery for receiving a bar 23 which serves as a connector for the element carrier 15 and the spring carrier 16 as later described. The outer portions of the slots 22 intersect the annular groove 20 to provide two radial apertures 24 and 25 in the carrier 15 with which apertures the opposed transverse notches 26 and 27 of the bar 23 register when the latter is in position within the carrier. The spring ring 21, somewhat greater than 180° of arc, seats within the groove 20 and has ends 21a of reduced width which are disposed within the notches 26 and 27 for latching or retaining the bar 23 in position within the carrier 15.

The carrier 15 is provided also with longitudinal or axially directed slots or passages 28 which are disposed in radial planes and slidably receive locking elements, each of the elements being indicated generally by the numeral 29.

The elements 29, as illustrated particularly in Figs. 14 and 15, preferably are of identical form, each comprising a mid web 30 and two longitudinal bars 31 and 32 of equal length. The bars are provided with notches 33, 34 of equal length but spaced unequal distances from the ends of the respective bars 31, 32. In Figs. 14 and 15 are shown the opposite sides of the same element, or the figures may be considered as showing the reverse side of one element and the obverse side of another element since, as stated, the elements are identical. It will be noted that the elements 29 are symmetrical except for the location of the notches 33, 34. The webs are shown as bearing indicia on one side in the form of numerals 1 and 3 and on the other side the numerals 2 and 4. The indicia indicate selective positions in which an element may be inserted in a slot 28 in setting up a selected locking combination. This important aspect of the invention will be described later in greater detail since it makes possible the use of identical locking elements each in any one of four different operative positions within a given slot or passage 28 which, as shown in Fig. 3, are shaped to accommodate the cross sectional form of the elements 29 and to act as guides for the latter to avoid cocking or binding of the same as the elements are moved within the respective passages.

The spring carrier 16 is provided with diametrical slots 22a which form extensions of the slots 22 for accommodating the bar 23 when the spring carrier is assembled on the bar 23. The bar projects beyond the rear end of the carrier 16, as shown at 23a in Fig. 1.

The carrier 16, as shown in Fig. 12, is provided with radial slots 28a which, when the carriers are assembled upon the bar 23 constitute extensions of the slots 28 of carrier 15. The carrier 16 is also provided with spring chambers 35 bored from the rear end of the carrier as illustrated in Fig. 4 and each having its longitudinal axis disposed within the radial plane of a slot 28a. Springs 36 are disposed in the chambers 35 and at the forward ends engage the adjacent ends of the webs 30 of the respective locking elements, urging the latter to the left or toward the forward end of the lock as viewed in Fig. 4.

A disc-like closure 37 is secured to the rear end of the carrier 16 for retaining the springs 36 under compression. At the rear of the member 37 a split spring-ring 38 is provided which seats in notches 39, 39 in the rear portion of the bar 23 for releasably retaining the carrier 16 upon the bar in assembled or unitary relation with

respect to the carrier 15 as indicated in Fig. 8.

The carriers 15 and 16 also are provided with co-axial bores which provide a chamber 39a for a cylindrical plug or piston 40. A spring 41 urges the plug to the left as viewed in Fig. 1. The plug is positioned within a slot 42 provided in the bar 23. The slot 42 is open at the forward end, as at 43, for admitting insertion of a proper key into the carrier 15, while the upper forward portion of the bar is shaped to provide a stop 44 which limits forward movement of the plug under the action of the spring 41. When the carriers 15 and 16 have been assembled upon the bar 23 and secured thereto as above described, they can be inserted as a unit into the chamber 11. Viewing Figs. 5 and 8, it will be seen that in inserting the lock unit in the lock chamber, the spring carrier 16, being of less external diameter than the internal diameter of the rib from which the lugs 13 were formed, will pass into the central passage defined by the inner ends of the lugs as shown in Fig. 1. The diameter of the rear portion of the element carrier 15 is such that the lugs arrest the inward movement of the unit in the position shown in Fig. 1.

There are shown two retaining lugs 45 and 46 on the exterior of the spring carrier 16 which are wider than the spaces 13a between adjacent lugs 13. Hence to enable the lugs 45, 46 to pass inwardly beyond the lugs 13, two special notches 47, 48 are provided in the ring of lugs as shown in Fig. 3 through which spaces the lugs 45, 46 respectively may be passed. The lugs are so positioned on the carrier 16 that it is necessary (in the particular construction illustrated) to turn the locking unit to the left beyond the normal locking and unlocking range of movement of the unit, to permit insertion in or removal of the unit from the casing.

As indicated in Fig. 2, in the illustrated embodiment of the invention, the locked position of the unit is the vertical position, that is, the positions wherein a mark 49 on the unit 15 is aligned with a mark 50 of the casing. The unit is designed to be turned clockwise, in the particular lock illustrated, to effect the release of the particular latching means employed. The latching mechanism of the illustrated padlock will be described later. In removing the locking unit from the casing, the units must be turned by a special key to the left or counter-clockwise from the vertical or locked position shown in Fig. 2 or until the lugs 45, 46 register with the respective notches 47, 48. This position of registration of the lugs and notches is indicated in Fig. 11 to be about 72° from the vertical or locked position. In this relative angular position of the locking unit, the lugs 45 and 46 will be in registration with notches 47 and 48 and hence the unit can be moved axially outward from the casing. The same relative position of the unit with respect to the casing is required in replacing the unit in the chamber 11.

In removing or replacing a unit it can not be rotated into or from the normal or locked position wherein marks 49 and 50 register unless the locking elements 29 are shifted axially to cause the operative notches 33 or 34, whichever are on the radial outermost edge of the elements 29, to register with the locking lugs 13 in the lock chamber. A special removal key 51 shown in Fig. 27 is provided for that purpose. The key 51 is similar to the service key shown in detail in Figs. 17 to 26, inclusive, and later described in detail, except that the key 51 is not provided with a retaining rib 52 nor a pin receiving channel 52a shown in Fig. 19. The key 51, however, is provided with adjustable actuator members or pins 53 corresponding in number and adjusted correlatively to the locking elements 29 and each of which actuator members is adapted to engage the forward end of the inner-most bar 31 or 32 of the respective locking elements for shifting the elements inwardly. When a proper removing key 51 is in position in the locking unit, the respective outer-most slots 33 or 34 of the locking elements will be aligned with the plane of the lugs 13 and thus permit the locking unit to be turned clockwise or counter-clockwise as viewed in Fig. 11. The unit may be turned until the mark 49 has been moved to a position indicating registration of lugs 45 and 46 with the notches 47 and 48 as in removing a unit from the casing or until marks 49 and 50 are in vertical registration as shown in Fig. 2 when the unit is in the locked position. When the key 51 is withdrawn after the unit has been turned to the locked position just mentioned, the springs 36 slide the locking elements 29 forwardly until the same are arrested by engagement of the forward ends of the radially outer-most bars of each element with the vertical stop wall 19 as shown in Fig. 4.

When the various locking elements are in the position shown in Fig. 4, that is, when the forward ends of the outer-most bars thereof are in contact with the wall 19, the notches in said bars are out of registration with the lugs 13 and the rear portions of said bars extend between adjacent lugs 13 and hence the locking unit can not be turned in either direction. Neither can the unit be moved forwardly from the chamber when the unit is in locked position by reason of the fact that the retaining lugs 45 and 46 are out of registration with their respective notches 47 and 48.

When the lock is to be operated by an appropriate service key such as a key shown in Figs. 17 to 26, inclusive, the key is inserted in the forward end of the lock whereby a slot 54 in a core member 55 of the key registers with the forward hooked end of the bar 23. The forward end of the core engages the spring actuated plug 40 while the forward ends of the actuator members 53 engage the forward ends of the corresponding inner-most bars of the locking element which are exposed at the forward end of the carrier 15 (as shown in Fig. 2), thus moving the locking elements to the right as viewed in Fig. 4 until the outer-most notches 33 or 34 thereof register with or are disposed in the plane of the lugs 13. When the locking elements have been thus moved, the locking unit can be turned clockwise by the key as viewed in Fig. 11 thus turning the bar 23, the inner end of which, as above described, projects beyond the inner end of the spring carrier 16.

The inner projecting end of the bar 23 is indicated by numeral 23a and is utilized for releasing the latching mechanism of the particular type of lock with which the improvements are employed. The latching means may comprise a bolt or other conventional form of latching element but the particular type of lock shown in the drawing is a padlock having a shackle 56 provided with arms of different length. The shorter arm 57 is provided with an under-cut locking recess 58 therein while a similar locking recess 59 is provided in the longer arm 60 of the shackle. The shorter arm is adapted to project into a chamber 61 provided

in the casing 10 while the longer arm projects into a chamber 62 also formed in the casing. The longer arm is provided with a chamber 63 in which is seated a spring 64 which shifts the shackle to the right or outwardly as viewed in Fig. 1 whenever the latching members are moved inwardly, as viewed in Fig. 1, by rotation of the bar 23 as above described.

The arms 57 and 60 of the shackle 56 are latched in inner positions by means comprising a pair of similar locking dogs 65 and 66 shown in Fig. 7. A pair of springs 67 and 68 is provided which urge the dogs in an outward direction or into position wherein the outer notched ends extend into the respective recesses 61 and 62. The shape of the recesses 58, 59 cooperate with the mating forms of the dogs to prevent the latter being jarred from latching relation without use of a proper key. The dogs 65 and 66 are provided with cam like formations 69 and 70 each of which is adapted to be engaged and actuated by an edge portion of the rear end 23a of the bar 23. Hence as shown in Fig. 7, when the bar 23 is turned clockwise sufficiently by a proper key the dogs 65 and 66 will be retracted inwardly of the casing against the action of the respective springs 67 and 68 until the outer ends of the dogs recede from the notches 58 and 59 of the shackle arms, whereupon the spring 64 will shift the shackle to the right as viewed in Fig. 1, to a position wherein the shorter arm 56 is outside the chamber 61. The padlock thus will be unlatched. The longer shackle arm 60 is provided with an axially directed groove 71 which communicates with an annular groove 72. The groove 71 receives the outer end of the dog 66 and permits the shackle to be moved outwardly by the spring 64 when the dog 66 has been moved inwardly sufficiently to register with the groove 71. When the shackle has been moved to the outer-most position, the inner end of the dog 66 is engaged by the shoulder 73 which resists further outward movement of the shackle but the shackle can be swung about the axis of the longer arm 60 by reason of the provision of the annular groove 72 as will be understood.

In re-latching the padlock, the locking unit may be turned by the key to the position shown in Fig. 2 whereupon the plug or plunger 40 expels the key from the lock and the springs 36 shift the locking elements 29 forwardly or to the left to the position shown in Fig. 4 thereby preventing the locking unit from being turned without reinsertion of a proper key. The shackle 56 may then be swung until the groove 71 registers with the end of the retracted dog 66 and the shackle then pressed inwardly, the groove 71 effecting alignment of the shorter arm 57 with the chamber 61. Pressing inwardly on the shackle causes the oblique surface 74 to engage the oblique surface 75 of the dog 65 and thus force the dog 65 inwardly against the action of its spring until the shackle has been returned to the position shown in Fig. 1 whereupon the dogs are snapped outwardly by their springs, into their respective locking recesses 58 and 59 of the shackle arms as shown in Fig. 1. If desired the shackle may first be pressed inwardly as described and the locking unit then key-actuated to the locked position.

Refering again to Figs. 14 and 15, it will be seen that each locking element 29 can be inserted in any receiving slot 28 in any one of four relative positions within the same or other passage 28. For example, the element shown in Fig. 14 may be inserted in a passage 28 with the notch 33 thereof in the radial outer-most position. In that instance, the slot 34 of the element 29 will be ineffective in the locking operation since it lies in the radially inward edge of the element. Since the slot 33 is offset from the center of the bar 31, the notch 33 will occupy a different position with respect to the lugs 13 if the element is withdrawn from the notch 28 and reinserted with the other end of the bar 31 adjacent the wall 19. Likewise, it will be seen that the element 29 shown in Fig. 4 may be inserted in a slot 28 with the notch 33 outer-most and with either end of the bar 32 in contact with the wall 19. Since the notch 34 is offset from the transverse center line of the bar 32 a distance different from that of notch 33, it will be seen that each locking element may be inserted in a slot 28 of the carrier 15 in any one of four different positions and that to move such locking element into unlocking position wherein the outer-most notch 33 or 34 thereof will lie in the plane of the locking lugs 13, the particular element 29 will require inward shifting a different distance for each of the said four possible positions mentioned. The particular lock shown is provided with eight locking elements which are identical and each of which, as stated, can be inserted in one of the slots 28 in any one of four positions.

A particular combination to which the lock is set may readily be changed by withdrawing the locking unit from the chamber 11 by use of the special key 51 shown in Fig. 27, and thereafter releasing the spring 38 and sliding the spring carrier 16 from the bar 23 as illustrated in the exploded view, Fig. 12. When the spring carrier 16 has been removed as mentioned, the locking elements 29 in the carrier 15 can be slid from their respective positions and the relative position of all or some of the elements altered thereby altering the lock combination. Altering the lock combination necessitates re-setting the service key for that particular lock since varying the position of the outer slots 33 or 34, whichever may be radially outer-most with reference to the carrier 15 requires different degrees of sliding movements of the reset elements 29 to effect registration of the outer-most notches thereof with respect to the plane of the lugs 13 for unlocking purposes.

As above stated, a service key for use with the improved lock is shown in Figs. 17 to 26, inclusive. The key comprises a core member 55 to the rear end of which is attached a finger piece 76. Mounted on the forward portion of the core 55 is a non-rotatable cylindrical casing member 77 which, as shown in Fig. 18, is provided with eight channels 78 in its inner periphery, which channels extend in an axial direction. Each channel 78 is adapted for receiving the forward portion of one of the actuator pins 53 which, as shown in Fig. 21, are provided with four transverse notches 79. The actuator pins 53 are disposed upon the exterior surface of the core 55 and may be adjusted outwardly or inwardly to various positions as indicated in Figs. 22 to 25, inclusive, whereby each pin is adapted to contact the exposed end of the radially inner-most bar 31 or 32 of a particular locking element 29 and to move it to the right as viewed in Fig. 4, to shift the element to the unlocking position, that is, to a position wherein the outer-most notch 33 or 34 thereof will be disposed in the plane of the locking lugs 13. For the purpose of

retaining the actuating pins 53 in properly adjusted positions, a rotatable cylindrical sleeve 80 is provided which is shown as knurled at its outer surface and which at its forward end is provided with an inwardly directed flange 81 which is continuous about the inner periphery of the sleeve 80 except that it is provided with a cross notch 82 as shown in Fig. 26. A second cylindrical member 83 is shown at the rear end of the core 55 which is non-rotatable and is provided with channels 84 which are axially aligned with the channels 78 of the other non-rotatable sleeve 77. The sleeves 77 and 83 are secured in position by a spline 76a which at its rear end is anchored to the core 54 by any suitable means as by swaging the same to prevent its forward movement within the spline grooves provided within the members 77 and 83. The aligned channels 78 and 84 thus retain the respective actuator members 53 in properly aligned position along the surface of the core 55 but permit the actuator elements 53 to be shifted to the right or left as viewed in Fig. 19 for adjusting the outer ends of the actuator elements to positions for effecting the movement of the corresponding lock elements 29 to unlocking positions when the key is inserted in the lock.

As shown in Fig. 19, the rotatable sleeve 80 is provided with an aperture or window 85 which normally is closed by a spring actuated gate or slide 86 having ends 86a of reduced thickness that are slidably guided in channels 77a and 83a of the sleeves 77 and 83. The forward portion of the closure gate 86 extends, as shown in Fig. 26, normally through the notch 82 provided in the annular flange 81 of the sleeve 80. When the gate 86 extends through the notch 82 as shown in Figs. 19 and 26, the sleeve 80 cannot be rotated. The gate 86, however, is provided with a transverse notch 87 in the forward portion as shown in Fig. 19 which, by moving the gate to the left as viewed in Fig. 19 against the action of a spring 88, will register with the flange 81 and thus permit the sleeve 80 to be rotated. The positioning of the flange 81 within the notch 87 retains the gate 86 in the retracted position during rotation of the sleeve but when the sleeve has been restored to the position wherein the notch 82 of the flange registers with the gate 86, the latter will moved by the spring 88 to the right as viewed in Fig. 19 thus re-latching the sleeve against rotation and closing the aperture 85 to prevent entrance of foreign matter into the interior of the key.

Upon retraction of the gate 86 as above described, the sleeve 80 may be rotated to bring the aperture 85 into registration successively with the notched portions of the various actuator pins 53. When the aperture 85 registers with a particular actuator pin 53, the notch 82 in the flange 81 will register with that particular pin thus enabling that pin to be shifted axially forwardly or rearwardly as desired.

The channel 77a of the cylindrical member 77 extends to the forward end of the member and permits the insertion of a pin or wire therein for shifting the gate rearwardly as above described. A shoulder of the notch 87 engages the forward edge of member 77 as a stop when the gate 86 is spring actuated to the forward position shown in Fig. 19. The ends of the gate 86 are shown as symmetrical but the reduced rear end and rear transverse notch thereof do not perform any function. The ends of the gate are symmetrically formed since such is of advantage in the assembly of the gates within the keys inasmuch as a gate may be inserted in a key with either end of the gate outermost.

As shown in Fig. 20, the fourth notch 79 of the uppermost pin 53 therein shown (counting from the left) receives the flange 81 and thus that pin is retained in an axially adjusted position shown. The lower-most pin 53 shown in Fig. 20, has its second notch (counting from the left) in registration with the flange 81, thus retaining that pin 53 against axial displacement.

The four notches 79 of each pin are correlated to the indicia on the locking elements 29 comprising the numerals 1, 2, 3, and 4 which preferably are applied to the elements as shown in Figs. 14 and 15. Referring to Fig. 20, the upper pin 53 therein shown extends a minimum distance beyond the forward end of sleeve 77 by reason of the fact that the flange 81 is located within the fourth notch 79 counting from the left. In Fig. 22, four actuator pins are shown in four different positions, the pins being indicated in said figure by numerals 53 with distinguishing exponents 1, 2, 3, and 4. Pin 53^1 extending farthest to the right while pin 53^4 extends the least distance to the right of the end of the sleeve 77. Referring to Figs. 14 and 15, it will be seen that the numerals 1 and 4 on the respective sides of the locking elements therein shown are in the up-right position. If the element shown in Fig. 14 is inserted in one of the slots 28 with the numeral 4 remaining in the up-right position and with the left hand end of the element shown in Fig. 4 first inserted in a slot so that it contacts the stop wall 19, the uppermost slot 33 of the element will occupy what may be designated position number 4, that is, it will be located in position adjacent the right hand end of the carrier 15 or in the relative position designated 33^4 in Fig. 12. If the element shown in Fig. 15 is next inserted in one of the slots 28 without changing its relative position with reference to the carrier shown in Fig. 12, the slot 33 will occupy the position indicated at 33^1 in Fig. 12, that is, slot 33^1 will occupy the extreme left position, whereas, as stated, slot 33^4 occupies the extreme right hand position. If a locking element, such as the element shown in Fig. 15, is rotated in its own plane through an arc of 180° from the position shown in said figure, the numeral 3 will be in the vertical position corresponding to the numeral 1 of Fig. 15. If such element in the altered relative position described should then be placed in a slot 28, the slot 34 will be outer-most and will occupy a position corresponding to that indicated at 34^3 in Fig. 12. That is, it will be positioned slightly to the left of the vertical transverse plane of the slot 33^4 in Fig. 12. If an element in the position of element 29 of Fig. 14 should be similarly rotated in its own plane through an arc of 180°, the numeral 2 will be in an up-right position occupying the relative position now occupied by said numeral 4 in said figure, and the slot 34 in bar 32 will then be upper-most. If such element while in such reversed position should be placed in a slot 28, the slot 34 would then occupy a position corresponding to position of slot 34^2 of Fig. 12. Axially considered, slot 34^2 is disposed in a transverse plane between slot 33^1 and slot 34^3. These several positions of the slots 33 and 34 are correlated to the positions of the actuator pins of the key. Since a slot 33 in the position of slot 33^4 is disposed in the position closest to the plane of the locking lugs 13, it will be seen that

to bring such slot 33^4 into the plane of the lugs, the respective actuator element will require movement to the right a minimum distance as viewed in Fig. 12. The projecting end of the pin indicated at 53^4 in Fig. 22 will so move the element bearing the notch 33^4 when the key is moved into the lock for unlocking the same. Likewise the locking elements shown in Fig. 12 bearing the slots 34^3, 34^2 and 33^1 being spaced progressively greater distances to the left from the plane of the locking lugs will be moved into such plane by the progressively longer effective end portions of the actuator elements 53^3, 53^2 and 53^1 respectively when the key is pressed into the lock.

From the above, it will be understood that where a locking element is re-set in the locking unit to alter the normal position of its slot 33 or 34, a corresponding adjustment must be made for the respective key actuator member 53 so that when the key is pressed into position in the lock, the exposed portion of the key actuator member for each locking element will be capable of shifting the respective elements 29 the precise distances required to cause the outermost slots 33 and 34 to be aligned with the plane of the locking lugs 13 whereby the locking unit can be rotated within the chamber 11. It is for the purpose just described that the sleeve 80 may be rotated, when released by the shifting of the gate 86, to provide access through the aperture 85 to each of the actuator elements 53 so that by the use of a pick or pin or other small tool, the actuator elements can be shifted to bring any one of the respective notches 79 into the plane of the flange 81. As the aperture 85 progresses from one actuator element to the next and the flange 81 passes through the annularly aligned notches 79 of the adjusted elements 53 and retains them in the re-adjusted position.

When the sleeve has been returned to the normal position shown in Fig. 17, the notch 82 in the flange 81 will permit the spring 83 to move the slide 86 into the position shown in Fig. 19 thereby closing the aperture and retaining all the actuator elements in their adjusted positions which, as stated above, must be correlated to the relative positions of the respective outer-most notches 33 or 34 of the elements 29.

As stated above, the service key shown in Figs. 17 to 26, inclusive, is provided with a rib 52 at the forward end of the sleeve 77 and an annular channel 52^a. It will also be noted in Fig. 19 that the forward portion of the sleeve 77 is provided with a slot which is in effect a continuation of the slot 54 of the core 55, the slot of the sleeve 77 being indicated by the numeral 77^b in Fig. 19. When a service key is inserted in the lock the slot 54 and slot 77^b accommodate the upper forward hooked portion of the bar 23 and provide engagement with the bar 23 for turning the same when the key is turned. The rib 52 above mentioned is insertable in the forward end of the carrier 15 but in entering the carrier, the rib acts against pins 90 and 91 provided in the forward portion of the carrier. The outer ends of the pins extend into the annular channel 17 formed in the exterior surface of the forward end of the carrier 15 and are engaged by the bifurcated ends 92 of a spring 93 which is disposed within the channel 17. The spring normally urges the pins 90 and 91 inwardly so that the inner ends thereof project inwardly of the inner face of the carrier 15. Hence, in placing the key in position in the lock, the pins are cammed outwardly by the rib 52 of the key as shown in Fig. 16. Pin 91 is somewhat longer than pin 90 so that to enable the pin 91 to be moved outwardly a sufficient distance to admit the key into the position shown in Fig. 16, a recess 94 is provided which extends radially outward from an annular channel 95 provided in the wall of the chamber 11. The recess 94 is located to register with the pin 91 when the lock is in the locked position shown in Fig. 2, that is, when the marks 49 and 50 are in registration. The pin 90 being of less length than pin 91 requires no recess for accommodating its outward movement when the key is inserted, the depth of the channel 17 being adequate. Hence, when a service key is pressed into a lock when the latter is in the position shown in Fig. 2 and then turned in either direction, the key is retained in position against the expelling action of the spring operating plunger 40 and of the spring pressed locking elements 29, since to enable the key to be withdrawn, the pin 91 would be required to move outwardly, but such movement can not occur since by reason of such rotative movement of the pin 91 with the unit, the pin is no longer in registration with the recess 94 and the depth of the channel 95 is inadequate to accommodate the required outward movement of the pin to release the key. Hence the pins 90 and 91 serve to retain the service key in the lock from the instant the key is moved from the locked position shown in Fig. 2. Not only is the service key locked against removal when the unit is out of the vertical or locked position, but since the diameter of the pin receiving channel 52^a of the key causes the outer end of the longer pin 91 to project into the channel 95, should the unit be turned by the service key to the position wherein the lugs 45, 46 register with the slots 47 and 48 the unit can not be removed from the chamber. The service key is retained in the lock by the pins 90 and 91 until the lock is returned to the locking position shown in Fig. 2 whereupon the pin 91 registers with the recess 94 and permits the spring actuated plunger 44 and the pressed elements 29 to expel the key from the lock. When the key is expelled, all the locking elements 29 are shifted to the left as viewed in Fig. 4 by the respective springs 36 to move the respective outer slots 33 and 34 out of registration of the plane of the locking lugs 13 thereby preventing rotation of the locking unit except by the reinsertion of a proper key. The two spring pressed pins 90, 91 acting on opposite sides of a key, tend to center it upon insertion in the lock.

From the above description, it will be obvious why a special key 51 is required in removing the locking unit from the chamber. As stated, the key 51 shown in Fig. 27 is not provided with a rib corresponding to rib 52 of the locking key but on the contrary is provided with an annular surface 96 of a diameter such that it may be inserted in the lock without causing the outer end of the longer pin 91 to extend into the channel 95 of the casing as occurs when a service key, by reason of the diameter of the pin receiving channel 52^a, is inserted in the lock as shown in Fig. 16. The actuator elements 53 of the removing key 51 are set to correspond to the combination set up in the particular lock, the locking unit of which is to be removed, and when inserted in such lock is rotated to the left as above described to move the retainer lugs 45 and 46 into registration with the slots 47 and 48 in the ring of lugs 13, as described. In the particular structure disclosed, the angular range of movement of

the unit from the vertical position shown in Fig. 2 to the unit-removing position is about 72°, that is, from the position wherein the mark 49 registers with the mark 50 to the position where the mark 49 registers with the mark 97'. When in this position, the frictional engagement of the special key 51 with the locking unit may enable the unit to be slid forwardly from the casing whereupon the particular setting of the locking elements 29 can be changed if desired. However, the removing key 51 preferably is provided with an eye 97 at its rear end which can be engaged with the hook or stop 44 of the bar 23 for withdrawing the lock unit from the chamber when the unit has been moved to the removal position above mentioned. Any change in the setting of the locking elements 29 must, of course, be accompanied by corresponding changes in the relative positions of the corresponding actuator elements 53 of the service key. Similar changes must, of course, be made in the positions of the actuator elements 53 of the special removal key 51 to enable subsequent removal of the locking unit.

The improved lock structure is such that a number of locks may be correlatively set so that each is adapted to be operated by a particular key and all adapted to be operated by a master key. The following master keying table is an example of the setting of six locks which are operable by a master key.

	A	B	C	D	E	F	G
1	2	2	2	2	2	2	2
2	2	2	2	2	2	2	0
3	3	0	3	3	3	3	0
4	2	0	0	2	2	2	2
5	1	1	0	0	1	1	1
6	1	1	1	0	0	1	1
7	3	3	3	3	0	0	3
8	3	3	3	3	3	0	3

In the table, the first column represents the 8 actuator members of a key numbered 1 to 8, inclusive as indicated in Fig. 17 where the numerals appear on the exterior of the sleeve 77. Column A represents the set positions of the actuator members of the master key, that is, numeral 2 indicates that actuator member No. 1 set in the No. 2 position, which corresponds to the axially adjusted position 53^2 of Fig. 22. The second numeral 2 of column A indicates that actuator member No. 2 occupies the same relative axially adjusted position as member No. 1. The table represents that member No. 3 is set in the No. 3 position corresponding to the axial position 53^3 of Fig. 22. Elements 4 to 8 are set in positions 2, 1, 1, 3, 4 respectively.

Columns B, C, D, E, F, and G indicate the settings of the locking elements of six locks. For example, column B indicates that the first locking element of that lock is correlatively set for actuation to unlocking position by the first actuator element of the key in column A, which said position corresponds to the position 34^2 in Fig. 12. The next locking element of lock B is also set in the number 2 position. In the number 3 position of the lock there is no locking element as indicated by a zero in column B. The same is true of the number 4 position, but locking element number 5 of column B is set in the number 1 position as is also locking element 6. Locking elements 7 and 8 of column B are set in number 3 positions.

The positions of the remaining locks C to G, inclusive, will now be understood. It will be seen that the master key having the setting indicated in column A will operate all the locks having the settings indicated in columns B to G but that any key having its actuator members 53 set particularly to operate any one of the locks B to G will not operate any lock having the setting indicated by any other column in the table.

Likewise, it is possible to arrange the locking elements of a group of locks so that the keys for each of said locks will operate only the one lock in the group for which that key combination is set, but all such keys will operate another lock not in the group. For example, the improved locks may be fitted to a number of apartment doors, each lock having a key that will operate that lock only of that group but the lock of the outer door of the apartment building may have its locking elements so set that that particular lock may be unlocked by each of the group of keys.

The following table illustrates the master locking arrangement mentioned.

	A	B	C	D	E	F
1	2	2	2	2	2	2
2	0	2	3	4	3	1
3	1	1	1	1	1	1
4	3	3	3	3	3	3
5	0	4	2	1	3	2
6	3	3	3	3	3	3
7	2	2	2	2	2	2
8	0	1	4	3	2	3

The left hand column of numerals 1 to 8 designate the respective locking elements of the various locks. Column A indicates a setting of the locking elements of the outer door of the apartment. The zeros in column A indicate that in positions 2, 5 and 8 there are no locking elements in the outside door of the apartment. Column B indicates a setting of the locking elements of the lock on apartment B. Likewise columns C, D, E, and F indicate the settings of locking elements in the respective apartments C to F, inclusive. A key having its actuator elements set to unlock apartment door B will not unlock the doors of apartments C, D, E, or F but as will be seen, it will unlock the outer apartment door A. The same is true of the keys set to operate the doors of the apartments C, D, E, and F that is, each such key will operate only each lock of apartments C, D, E, and F respectively but will also unlock the lock of outer door A.

While in the drawings a locking unit provided with eight locking elements is shown, it will be apparent that locks embodying the principles of the invention may be made having more or less than eight locking elements. Likewise it will be apparent that while the locking elements shown and described are identical and thus are adapted for economical machine production, special locking elements may be used in conjunction with the other elements to provide different locking combinations if desired. For example, it may be desirable in a master locking arrangement to utilize in certain positions in such locks special locking elements having notches of greater length than that of the notches 33 and 34 shown in Figs. 14 and 15 whereby a key actuator pin set in any one of the four above described positions will shift such element to an unlocked position. Likewise it will be apparent that the locking elements may be made in various designated series, as for example a series wherein all the notches of the elements are off-set from the transverse

center line of the elements as in the elements disclosed in the drawings while other series of elements may have the notches off-set distances greater or less than those illustrated. Actuator pins for the keys for such various lock series will of course be modified accordingly. Hence while I have shown and described a particular structure that is illustrative of the improvements various changes may be made in the structure within the spirit of the invention.

I claim:

1. In a lock, a lock casing provided with a cylindrical chamber provided with a plurality of inwardly directed co-planar spaced apart locking lugs, a rotatable locking unit in said chamber provided with a plurality of radially disposed passages for receiving slidable locking elements, and locking elements slidable within said passages and each provided with two locking portions on each of the opposed longitudinal edges and each having a transverse slot in each longitudinal edge, the slots of each element being off-set dissimilarly from the transverse center line of the elements to provide locking portions of different length, said locking elements being insertable in a said passage in any one of four positions in each of which positions one of said locking portions on the outer-most edge of the element normally extends between adjacent lugs of said chamber for locking said unit against rotation, each of said transverse slots being of a width to accommodate said lugs whereby upon sliding movement of said elements to positions wherein the slots in the outer-most edges of said elements are disposed in the plane of said lugs said unit is rotatable in the casing from said locked position.

2. In a permutation lock, a lock casing provided with a cylindrical chamber having a plurality of inwardly directed co-planar locking lugs, a rotatable locking unit in said chamber provided with radially disposed passages and a plurality of slidable locking elements in said passages each provided with two locking portions on each longitudinal edge, all of said locking portions being of different length, each of said elements being insertable in a said passage in any one of four positions for rendering a selected locking portion of the respective element operable to extend into locking relation between adjacent lugs whereby the range of movement required to slide any locking element out of locking relation with respect to said lugs is correlated to the length of the selected locking portion of the respective element.

3. In a lock, a locking unit provided with a plurality of longitudinal passages therein each for receiving a locking element, and a plurality of identical locking elements slidably positioned in said passages and each comprising four locking portions of different length, each of said elements being insertable in a said passage in any one of four positions for disposing a selected locking portion of the respective element in locking relation with respect to a cooperating locking member in a lock casing and requiring sliding movement of the element a distance correlative to the length of said selected locking portion in moving the same out of the respective locking relation.

4. In a lock, a lock casing provided with a cylindrical lock chamber provided with an annular row of spaced apart inwardly directed locking lugs, a key operable locking unit in the chamber comprising carrier means for a plurality of axially slidable locking elements, and a plurality of similar locking elements disposable in the carrier in any one of four different relative positions for cooperation in any of said positions with an adjacent pair of said lugs for preventing rotation of the unit from a given position and each element being provided with a transverse slot positionally correlated to the selected operative position of the respective element for requiring axial adjustment of the element a distance peculiar to the selected position for effecting alignment of the respective transverse slot in the plane of said lugs for releasing said unit for movement from said given position.

5. In a lock, a rotatable locking unit comprising a locking element carrier and a spring carrier in axial alignment, a plurality of longitudinally disposed complementary slots in said carriers providing passages for slidable locking elements, locking elements in said passages, a plurality of spring chambers in said spring carrier, a spring in each spring chamber engaging one of said locking elements for biasing the same forwardly of the unit, said locking elements each being shaped to enable the same to be positioned in a said passage in any one of four positions in setting up selected locking combinations, and means releasably securing said carriers together for movement in unison and enabling separation of the carriers for releasing said locking elements from the respective passages to enable alteration of a selected combination.

6. In a lock, a casing open at its forward end, a rotatable locking unit insertable into said casing through said open forward end and comprising a locking element carrier and a spring carrier in axial alignment, a plurality of longitudinally disposed complementary slots in said carriers providing passages for slidable locking elements, locking elements in said passages, a plurality of spring chambers in said spring carrier, a spring in each spring chamber engaging one of said locking elements for biasing the same forwardly of the unit, said locking elements each being shaped to enable the same to be positioned in a said passage in any one of more than two operative positions in setting up selected locking combinations, and means releasably securing said carriers together for movement in unison into and out of said casing through the open forward end thereof and enabling separation of the carriers for releasing said locking elements from the respective passages to enable alteration of a selected combination.

7. In a lock, a locking unit comprising a forward and a rear carrier each provided with a plurality of complementary slots adapted to provide composite slots for retaining locking elements therein when said carriers are secured in axial alignment, a plurality of locking elements each provided with a pair of locking portions of different lengths on two opposed edges thereof, said elements being slidably disposed within said slots with any one selected locking portion of each arranged in cooperative locking relation with respect to other selected locking portions of the other elements, and means for releasably securing said carriers in axial alignment.

8. A locking element comprising a member having locking edge portions on two opposed side edges thereof, said locking edge portions being provided each with a transverse slot dissimilarly offset with respect to the transverse center line of the element to define four locking edge portions of unequal length.

9. A locking element comprising a pair of

parallel bars and a common web portion connecting said bars, said bars projecting beyond the ends of the web portion and having transverse slots off-set unequal distances from the transverse center line of the element to divide each bar into a plurality of locking portions of different length and each differing in length from the length of the locking portions of the other bar.

10. A rotatable locking unit comprising a front and a rear carrier for locking elements, said carriers being provided with aligned slots extending longitudinally through the carriers and disposed in a diametrical plane thereof, a bar disposed in said slots and projecting through the rear carrier, a groove in the exterior surface of the forward carrier intersecting said slot at opposed portions of the carrier and providing apertures through which portions of said bar extend into said slot, a resilient retainer member disposed in said groove and engaging said portions of said bar for securing said forward carrier in assembled relation with respect to the bar, and means at the projecting end of said bar for securing said rear carrier thereto.

11. A locking unit comprising forward and rear carriers, slots open at the adjacent ends of the carriers for cooperation in receiving locking elements when the carriers are separated and for retaining said elements in the slots when said carriers are assembled in abutting axial relation, each of said carriers having a passage therethrough disposed within a diametrical plane of the carrier, a member extending through the passage of each carrier and projecting from the rear carrier to provide a latch operating member, means securing said forward carrier to said member, and means releasably securing said rear carrier to said member in abutting axial relation with respect to said forward carrier.

12. A lock comprising a casing provided with a cylindrical chamber, said chamber being provided with an annular groove in the wall thereof and with inwardly directed spaced apart lugs, a key-rotatable locking unit provided with a key-receiving recess in the forward end thereof and provided with an outwardly directed lug adapted to be passed between a pair of adjacent inwardly directed chamber lugs upon insertion of said unit into the chamber in a given assembling position of relative rotation with respect to a locking position of the unit, said outwardly directed lug on said unit being arranged to cooperate with said chamber lugs for restraining removal of the unit from the chamber in any relative position of rotation of the unit removed from said given assembling position, locking elements carried by said unit for locking cooperation with said chamber lugs for restraining rotative movement of the unit from said locking position, said locking elements having key-operable means actuatable by a proper key inserted in said recess for moving said elements from positions of locking cooperation with said chamber lugs, and key engageable means in said unit for preventing insertion of a key into or removal from said recess when said unit is out of said locking position, said key engageable means being displaceable in latching cooperation with said groove in the chamber wall for preventing removal of said unit from said chamber upon movement of the unit by said key to said assembling position.

LEO E. DEUTSCH.

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