Oct. 31, 1967 E. KELLER 3,349,587

METHOD OF INCREASING THE NUMBER OF DIFFERENT LOCKING COMBINATIONS

Filed June 28, 1965

2 Sheets-Sheet 1

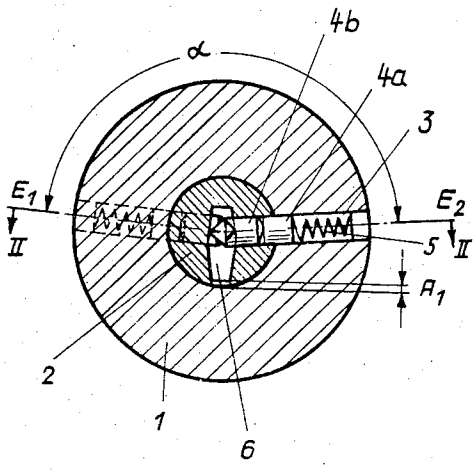

Fig. 1

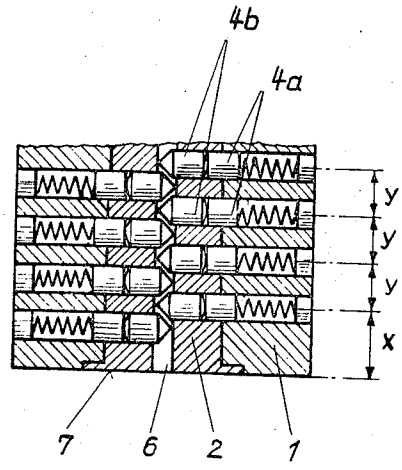

Fig. 2

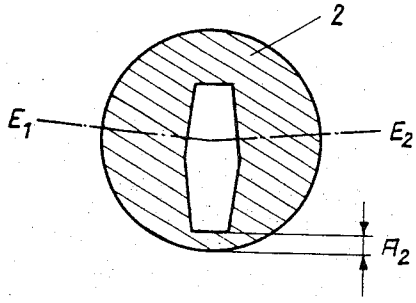

Fig. 3

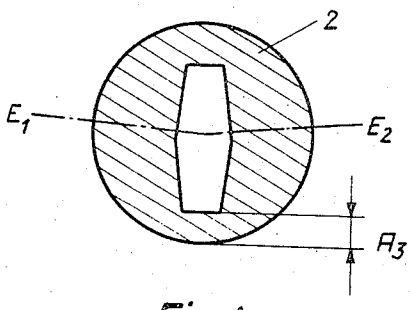

Fig. 4

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2 Sheets-Sheet 2

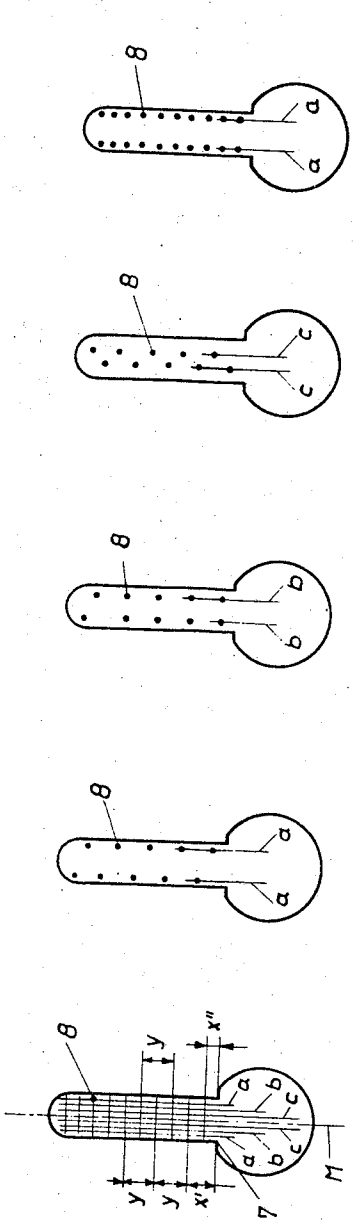

Fig.9 Fig.8 Fig.7 Fig.6 Fig.5

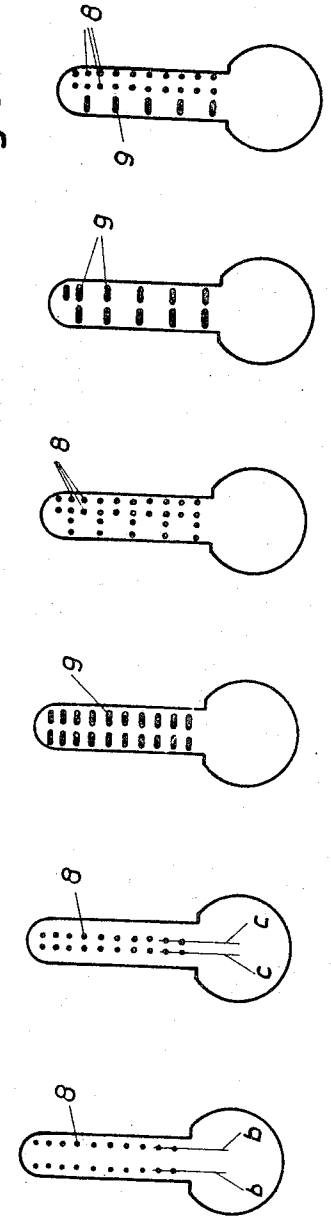

Fig.15 Fig.14 Fig.13 Fig.12 Fig.11 Fig.10

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METHOD OF INCREASING THE NUMBER OF DIFFERENT LOCKING COMBINATIONS

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ABSTRACT OF THE DISCLOSURE

A system of cylinder type locks employing two sets of locking pins of equal length in two planes offset slightly less than 180° and keys provided with countersinks of uniform depth matching the pins, the necessary number of lock combinations being achieved by varying the position of the key channel in an axial plane bisecting the angle of the planes in which the pins are normally located, and by varying the spacing of the pins from each other and from the abutment face of the cylinder for an inserted key.

The invention relates to a method of increasing the number of different locking combinations that can be provided in key-operated safety locks in which a rotatable inner cylinder is contained in a stationary outer cylinder and radial bores extending from the outer into the inner cylinder slidably contain two-part locking pins which prevent rotation of the inner cylinder unless they are displaced into particular positions by a key insertable into a passage for its reception in the inner cylinder and provided with recesses in its side faces for displacing the locking pins into said positions.

In safety locks of the specified kind it has been the practice in the past to provide the two-part locking pins with head portions of different lengths and the side faces of the key with recesses in the form of countersinks of correspondingly different depths. Variation of the lengths of the locking pins and corresponding variation of the depth of the countersinks in the sides of the key thus provide the different locking combinations that can be made available in such locks. The number of theoretically possible locking combinations V in such locks can be calculated from the formula $V=s^z$, where s is the number of possible different lengths of the pin heads and z the number of two-part pins contained in the lock. In practice the number of different locking combinations in such a lock is limited to about 100,000 because the prescribed dimensions of the two cylinders and manufacturing tolerances that must be observed permit only a fraction of the theoretically possible combinations to be actually utilised.

When in a safety lock of such a kind as hitherto known to the part the different possible combinations have been exhausted, a completely new type of lock must be designed involving costly changes in manufacturing plant or the cross section of the key and the corresponding cross section of the passage for the reception of the key must be changed. In locks of the specified kind in which the keys are provided with countersinks in their side faces the possibilities of changing the section are likewise limited. Moreover, such changes affect the safety of the entire range of locks because keys of smaller cross section could be used to open locks with a larger section channel for the reception of the key.

The object of the present invention is to provide a substantial increase in the number of locking combinations that can be made available in such a lock without

substantially increasing the cross section of the key and that of the channel for the reception of the key. The method proposed by the present invention consists in not only varying the relative spacing y of the locking pins axially along the length of the inner cylinder and the axial distance x of the first locking pin of a row of locking pins from the abutment face **7** for the key on the end face of the inner cylinder, but also the radial distance A of the channel for the key from the circumferential surface of the inner cylinder.

In the equipment of say factories, banks or the like with locks, of which the majority can be opened by a master key and individual groups of locks and/or single locks can be opened by a master key and by supplementary keys that differ from one another, the master key and possibly the supplementary keys can be provided on lines extending across the longitudinal axis of the key on at least one side of its centre line M with at least two countersinks or with a groove for the purpose of operating the locking pins in different locks in which the distance A of the channel for the insertion of the key from the circumferential surface of the inner cylinder differs.

The invention also relates to safety locks and keys for performing the method according to the invention.

The invention will be more particularly described by reference to embodiments shown in the accompanying drawings in which

FIG. 1 is a cross section of the cylinder of a lock of the invention having a channel of rhombic cross section for the reception of the key and two-part locking pins located in two different radial planes,

FIG. 2 is a longitudinal section of the cylinder taken on the line II—II in FIG. 1,

FIG. 3 is a cross section of the inner cylinder on a larger scale in which the channel for the reception of the key is spaced radially further away from the circumferential surface of the cylinder,

FIG. 4 is a cross section analogous to FIG. 3 in which the said radial distance has been further increased,

FIG. 5 is a side view of a key that fits into any one of the channels in FIGS. 1, 2 or 3 and upon which the centres of all the countersinks it is possible to provide are marked, and

FIGS. 6 to 15 are embodiments of different types of key.

The cylinder **1** illustrated in FIGS. 1 and 2 is similar to that described in Swiss patent specification 344,637. This outer cylinder **1** contains a rotatable inner cylinder **2**. The two cylinders **1** and **2** are each provided with radial bores **3** located in two planes E_1 and E_2 placed at a relative angle α slightly less than 180°. The bores **3** contain two-part locking pins comprising an outer portion **4***a* and an inner head portion **4***b*. The pins **4***a*, **4***b* are each urged inwards by a spring **5**. The channel **6** for the reception of the key is of rhombic cross section and corresponds to the cross section of the key that fits into the cylinder. Channel **6** is completely contained inside the inner cylinder **2**. In the cylinders of locks already known to the art the inner head portions **4***b* of the different locking pins are of different lengths, whereas the sides of the corresponding key are provided with countersinks of different depths for cooperation with the points of the pins. The insertion of the key into the lock therefore displaces the locking pins in such a way that the division between the two parts **4***a*, **4***b* of the pins is shifted into alignment with the peripheral surface of the inner cylinder **2** when the head portions have engaged their associated countersinks in the key, thus permitting the inner cylinder to be turned inside the outer cylinder **1**.

In the locks of the invention, the inner head portions **4***b* of all the locks comprised in a set are of equal length

and the corresponding countersinks in the key are all of correspondingly equal depth. Variation of the lock is achieved by varying the relative axial spacing *y* of the locking pins *4a*, *4b* in a manner as such already known to the art, as well as the axial distance *x* of the first locking pin of a row of locking pins from the abutment face **7** for the key on the end face of the inner cylinder **2** and by also varying the radial distance A_1, A_2, A_3 (FIGS. 1, 3 and 4) of the channel **6** for the key from the circumferential surface of the inner cylinder.

In locking installations in which a plurality or a set of different locks can all be unlocked with a master key and groups of different locks can be opened by supplementary keys and/or individual locks that differ in their respective locking combinations can be opened with individual keys, the above described method is particularly useful. This will be explained in greater detail by reference to FIG. 5. This drawing is a side view of a key upon which the intersections of longitudinal and transverse lines indicate the positions of every possible countersink which can be combined in different patterns. The key shown in FIG. 5 is intended for a cylinder containing two rows of 5 locking pins which are relatively spaced at intervals *y*, whereas the distance of the first pair of pins from the abutment face **7** may be X' or X''. The selected countersinks **8** may then be located on each half of the side face of the key on one of the lines *a*, *b* or *c* at intervals *y*.

Single keys, that is to say keys which will open only one particular lock may be provided for instance with patterns of countersinks on the lines *a*, as in FIG. 6, or on the lines *b* as in FIG. 7 or on the lines *c* as in FIG. 8. Naturally these patterns may be selectively varied. A group key which is capable of opening all the locks in which the patterns of countersinks are on the lines *a* as in FIG. 6 is illustrated in FIG. 9. The key shown in FIG. 10 analogously opens all locks in which the pattern of countersinks is on the lines *b* and the key in FIG. 11 opens all locks with patterns of countersinks on the lines *c*. However, the master key according to FIG. 12 opens every lock in the entire installation. This key is not provided with separate countersinks **8** but with grooves **9** extending across its longitudinal axis, the depth of the grooves being the same as the depth of the countersinks **8** in the individual and group keys.

It is also possible to provide additional supplementary keys which permit some of the locks having patterns on the lines *a* and/or *b* and/or *c* to be opened. Such keys are provided on lines across their longitudinal axis on at least one side of their centre line M with at least two countersinks **8** (cf. FIG. 13) or they are provided with grooves **9** (cf. FIG. 14). Finally, keys of the kind shown in FIG. 15 can be provided which have grooves **9** on transverse lines as well as individual countersinks **8**.

I claim:

1. In a locking installation, in combination:

(A) a plurality of locks, each lock having

(a) outer stationary cylinder means;

(b) inner cylinder means conformingly received in said outer cylinder means for rotation about an axis,

(1) said outer and inner cylinder means being each formed with a plurality of radial bores extending in a common plane substantially parallel to said axis, the bores of said inner cylinder means being simultaneously radially alignable with the bores of the outer cylinder means by said rotation,

(2) said inner cylinder means being formed with an axial channel communicating with each of said bores therein; and

(c) locking pin means including an outer pin and an inner pin conformingly movable in each bore between an unlocking position in which a portion of the inner pin extends into said channel, the remainder of the inner pin is contained in said inner cylinder means, and the outer pin is contained in said outer cylinder means, and a locking position in which respective integral portions of said outer pin extend in corresponding bore portions in each cylinder means,

(1) the inner cylinder means, pins, and channels in the several locks being substantially identical, and the position of each channel relative to the associated axis along another plane defining a fixed angle with said common plane being different from the corresponding position of the channel in each other lock, said other plane being substantially parallel to said axis; and

(B) a plurality of keys conformingly axially insertable in each of said channels,

(a) each key having a face portion transversely intersecting said common plane in each of said locks in the inserted position of said key,

(1) said face portion being formed with a row of recesses therein, said recesses being simultaneously radially alignable with the bores of one of said locks in the associated channel while being out of radial alignment at least one of the pin means of at least one other lock, when the key is inserted in the channel of said other lock, whereby said one pin means is held in the locking position thereof when said key is inserted in the channel of said other lock.

2. In an installation as set forth in claim **1**, said recesses being of equal depth.

3. In an installation as set forth in claim **1**, a supplementary key conformingly axially insertable in each of said channels and having a face portio intersecting said common plane in each of said locks in the inserted position of said supplementary key, said face portion being formed with a plurality of groups of recesses, respective groups of said recesses being simultaneously radially alignable with the bores of at least two of said locks in the associated channels, and said recesses being out of alignment with at least one of the pin means of a third one of said locks, whereby said one pin means of said third lock is held in the locking position thereof when said supplementary key is inserted in the channel of said third lock, said groups of recesses extending in respective axial rows.

4. In an installation as set forth in claim **3**, respective recesses in two of said axial rows being transversely aligned and jointly constituting a groove in the face portion of the supplementary key.

5. In an installation as set forth in claim **1**, a master key conformingly axially insertable in each of said channels and having a face portion intersecting said common plane in each of said locks in the inserted position of said master key, said face portion being formed with a plurality of groups of recesses, respective groups of said recesses being simultaneously radially alignable with said bores of each lock in the associated channel, said groups of recesses extending in respective axial rows.

6. In an installation as set forth in claim **5**, respective recesses in two of said axial rows being transversely aligned and jointly constituting a groove in said face portion of said master key.

7. In an installation as set forth in claim **5**, the recesses of each axial row being transversely aligned with corresponding recesses in another axial row in said face portion of said master key and constituting therewith respective grooves in said face portion.

8. In an installation as set forth in claim **1**, each inner cylinder means of said plurality of locks having a radial end face, respective ones of said locks differing in the axial spacing of said end face from the nearest one of said

pin means, said channel passing through said end face, and cooperating abutment means on said end face and on each of said keys for limiting axial insertion of said key into said channel.

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