

Cylinder lock and key with side bar

FIELD OF THE INVENTION

The present invention relates to a cylinder lock and key
5 combination, including

a cylinder lock, comprising

- a housing having a cylindrical bore accommodating a rotatable key plug,

- said key plug having a longitudinally extending keyway for
10 receiving a key blade,

- a row of tumbler pins arranged for elevational and rotational movement in corresponding cylindrical chambers in said key plug for engagement with coded V-cut bittings on an upper edge of an associated key upon insertion thereof into
15 said keyway, and

- a longitudinal side bar which is slidably journaled for transversal movement in said key plug,

- said side bar having an outer, longitudinal ridge portion fitting into an associated groove in said housing, so as to
20 normally prevent rotation of said key plug in said cylindrical bore of the housing,

- said side bar also having a row of inner projecting lugs each selectively registering with one or more recesses in said tumbler pins when said key has been inserted into said keyway,

- said side bar being movable sideways by turning of a
25 correctly cut key, while said projecting lugs enter into said associated tumbler pin recesses so that said longitudinal ridge portion is released from said groove and the key plug is permitted to rotate relative to said housing, and

30 a key, comprising said key blade having

- an upper edge provided with said coded V-cut bittings.

BACKGROUND OF THE INVENTION AND PRIOR ART

Cylinder lock and key combinations of this kind are previously known, e.g. from the US patent specifications 3,722,240, 3,499,302, 4,635,455, 4,723,427 and 4,732,022 (all assigned to
5 Medeco Security Locks, Inc.). They provide well functioning and secure mechanisms. Because of the dual lock feature (tumbler pins as well as a side bar locking mechanism), these locks are difficult to manipulate, in particular by picking and/or so called "bumping".

10 However, for certain geometrical configurations, it may be possible to inspect an empty lock (without any key in the keyway) and find out the codes relating to the rotational positions of the "gates" or slots which should register with
15 projections on the side bar. If such inspection is successful, it may be less difficult to bypass or open the lock.

In particular, when the keyway is relatively high, to accommodate a key blade with a large height, such as a key
20 blade extending above the rotational axis of the key plug, some of the tumbler pins may be exposed from the inside of the keyway, so that the "gates" or slots (or other recesses or holes) can be identified or sensed, and their relative locations may be determined.

OBJECT OF THE INVENTION

Against this background, a primary object of the present invention is to provide a cylinder lock and key combination,
30 of the kind stated above, where the lower portions of the tumbler pins, even when these pins are located in their lowermost positions in an empty lock, do not reveal the

locations of the recesses or "gates" that cooperate with the projections on the side bar.

Further objects are to ensure that the side bar slides back
5 and forth without overdue resistance when the key is turned either way to operate the lock, and to provide a large variety of tumbler pins so as to increase the number of possible codes.

10 Another object is to increase the security of the lock even more as compared to prior art locks of this kind.

A still further object is to provide improved key profiles and key bittings cooperating with the lowermost end portions of
15 the tumbler pins.

SUMMARY OF THE INVENTION

These objects are achieved by a combination of features of the tumbler pins, the side bar and the key blade, as follows:

- 20 - each of the lugs in said row of inner projecting lugs of said side bar is located at a relatively high level, above a rotary axis of the key plug, when being moved sideways with the side bar into the respective tumbler pin recesses, whereas the outer longitudinal ridge portion of the side bar
25 is located at a substantially lower vertical level than the inner projecting lugs, namely at substantially a same vertical level as the rotary axis of the key plug, seen in a central vertical plane in the keyway, when the outer longitudinal ridge portion engages with the associated
30 groove in the housing, and
- said tumbler pins are configured so that each of said pin recesses is located entirely above the rotary axis of the key plug and also entirely above a lowermost end portion of

the tumbler pin in a cylindrical outer surface of the tumbler pin and is covered by a cylindrical wall part of an associated one of said cylindrical chambers, without communicating downwardly with the keyway,

- 5 - whereby each pin recess is concealed and invisible from an inside of said keyway, even when the keyway is empty.

As will be explained further below, by providing extra recesses in the cylindrical outer surface of the tumbler pins the security of the lock can be improved even further, as
10 compared to prior art locks of this kind.

Furthermore, each of the tumbler pins may have a lower portion with two oppositely located, inclined planar surface portions (like a "chisel" configuration) forming between them a linear,
15 relatively narrow guiding portion fitting into a corresponding V-cut code bitting in the associated key blade, each pin recess being located at a cylindrical outer surface portion at a distance from any of said inclined surface portions.

20 According to another aspect of the invention, there is provided a side bar for a cylinder lock having a key plug which is rotatable in a housing, the side bar being slidable sideways in the key plug and having an outer ridge portion which is normally seated in a groove in the housing, and inner
25 projecting lugs dimensioned to be seated in associated recesses in tumbler pins, which are movable in said key plug, wherein:

- said projecting lugs are located at a substantially higher level than said outer ridge portion of the side
30 bar and said axis of said key plug, and

- the side bar is guided by means of opposite guiding surfaces located at a mutual distance being substantially smaller than an overall thickness of the side bar.

Preferably, the side bar will have an overall thickness which is at least as large as half of a radius of the key plug, or even larger. Even so, with such a relatively large thickness, it is possible to achieve a good sliding movement of the side bar, e.g., by providing each longitudinal end portion, or intermediate portions, of the side bar with transversally extending guiding surfaces which secure a precise lateral guiding of the side bar in the key plug. Preferably, these transversally extending guiding surfaces should be located opposite to each other at a mutual distance which is smaller than the overall thickness of the side bar.

According to a further aspect of the invention, there is provided a key for a lock, comprising:

- a key blade having a single upper edge with V-cut bittings, each V-cut bitting standing at a respective one of a first number of angles relative to a transverse vertical plane, each being perpendicular to a longitudinal direction of the key blade, and each being located at a respective one of a second number of vertical levels in relation to an opposite lower edge of the key blade, wherein the V-cut bittings at the upper edge of the key blade are irregularly arranged in two ways:

- a linear bottom portion of at least some V-cut bittings is displaced in the longitudinal direction of the key blade in relation to a vertical plane extending transversely and centrally through a position corresponding to the central axis of an

associated one of tumbler pins of the lock when the key is fully inserted into the lock,

- the linear bottom portion of the at least some V-cut bittings is inclined in relation to a horizontal plane extending along the key blade, so that the at least some V-cut bittings are deeper at one side of the key blade than at another side of the key blade, said horizontal plane extending along the key blade being normal to central axes of the associated tumbler pins of the lock when the key is fully inserted into the lock, and the at least some V-cut bittings of the key blade are configured to cooperate with the associated tumbler pins, and

wherein each of the tumbler pins includes:

a projecting V-formed end portion having a shape that is substantially complementary to the associated V-cut bittings, and a lowermost edge portion that is generally offset in the longitudinal direction of a keyway in relation to a central, longitudinal axis of the tumbler pins, so that the lowermost edge portion is also inclined in relation to a plane that is perpendicular to the central, longitudinal axes of the tumbler pins.

There are a number of possible, advantageous geometrical configurations of the tumbler pins, the side bar and the key, as will be apparent from the appended claims and the detailed description below.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be further explained with reference to the appended drawings, in which

Fig. 1 illustrates, in a perspective view, a cylinder lock and key combination according to the invention;

Fig. 2 shows an exploded, perspective view of the lock and key combination of fig. 1, with the most important components being separated from each other;

Fig. 3 shows a longitudinal vertical section through the lock and key of fig. 1;

Fig. 4 shows a corresponding vertical section through the lock only, the key being retracted and not shown in this figure;

Fig. 5 shows a cross-section along the line V-V in fig. 3, at a larger scale and illustrating the interacting components of the lock and key combination of the invention;

Fig. 6 shows a perspective view of the key plug (with inserted key) of the lock of figs. 1, 2, 3, and 5, the lock housing and the upper pins being taken away;

Fig. 6a shows, at a larger scale, a detail of fig. 6;

Fig. 7 shows, in a perspective view, the side bar which is slidably journaled in the key plug shown in fig. 6;

Fig. 7a shows, at a larger scale, a detail of fig. 7;

Fig. 7b shows, also in a perspective view, a modified side bar with intermediate guiding surfaces between each pair of adjacent lugs;

Fig. 8 shows, in a side view, a first embodiment of a tumbler pin included in the cylinder lock of fig. 5;

5 Figs. 8a, 8b, 8c, 8d, 8e and 8f are views from underneath of the tumbler pin of fig. 8, in different angular positions and having varying locations of the recesses in the outer cylindrical surface of the pin, the geometrical configuration of the pins shown in figs. 8d, 8e, 8f being "mirrored" in relation to the configuration of the pins shown in figs. 8a,
10 8b and 8c;

Figs. 9a, 9b, 9c, 9d, 9e and 9f are corresponding side views of the pins of figs. 8a through 8f;

15 Fig. 10 shows, in a side view, a second embodiment of a tumbler pin having an inclined lower guiding portion;

Figs. 10a, 10b, 10c, 10d, 10e, and 10f are views from underneath (corresponding to figs. 8a through 8f) of the pin
20 of fig.10, with various locations of the side recesses;

Figs. 11a, 11b, 11c, 11d, 11e, and 11f are corresponding side views of the pins of figs. 10a through 10f;

25 Fig. 12 shows, in a side view, a third embodiment of a tumbler pin being similar to the second embodiment and having a lower guiding portion which is inclined only along a limited portion of the lower end;

30 Figs. 12a, 12b, 12c, 12d, 12e, and 12f are views from underneath (corresponding to figs. 8a through 8f) of the pin of fig. 12, with various locations of the side recesses;

Figs. 13a, 13b, 13c, 13d, 13e, and 13f are corresponding side views of the pins of figs. 12a through 12f.

Fig. 14 shows, in a side view, a fourth embodiment of a tumbler pin, having a lower end with a part-cylindrical portion and an adjoining chisel portion;

Figs. 14a, 14b, 14c, 14d, 14e, and 14f are views from underneath the pin of fig. 14, corresponding to those of figs. 8a through 8f, with various locations of the side recesses;

Figs. 15a, 15b, 15c, 15d, 15e, and 15f are corresponding side views of the pins of figs. 14a through 14f;

Figs. 16a, 16b, 16c, 16d, 16e and 17a, 17b, 17c, 17d, 17e illustrate (in views from underneath and side views, respectively) similar tumbler pins having three different kinds of side recesses in the outer cylindrical portion of the pin, the continuous recesses in the form of grooves in figs. 17d and 17e being extended almost to the lowermost end of the pin.

Fig. 18 shows a cross-section through the key plug of the lock with an inserted key blade, similar to fig. 5, illustrating a further embodiment of the tumbler pins;

Figs. 18a, 18b and 18c show the key blade in fig. 18 in a perspective view, a side view and in a cross-sectional view, respectively;

Fig. 18d shows the same key blade in a top view;

Fig. 18e shows an enlarged part of fig. 18d;

Fig. 18f shows the same key blade in longitudinal, sectional view;

5 Fig. 19 shows a cross-section, corresponding to that of fig. 18, of an embodiment where the upper part of the key blade is offset in relation a to a central plane of the tumbler pin and the keyway and where the tumbler pin is somewhat different from the previous embodiments;

10 Fig. 20 shows the tumbler pin included in the embodiment of fig. 19, in a perspective view;

15 Fig. 20a shows the tumbler pin of fig. 20, in a view from underneath; and

Figs. 20b, 20c and 20d show the tumbler pin of fig. 20 in three different perspective views.

20 DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The cylinder lock and key combination illustrated in figs. 1,2,3 and 5 includes a cylinder lock 100 and an associated key 200 with a grip 201 and a key blade 202. The key blade 202 can be inserted into a longitudinal keyway 101 in a cylindrical key plug 102, which is rotatable in a cylindrical bore 103 in a housing 104 of the lock 100.

25 The key plug 102 is normally held in a locked rotational position by way of two interacting lock mechanisms, comprising a set of cylindrical, lower tumbler pins 111, 112, 113, 114, 115, 116, which are fitted slidingly in vertically oriented cylindrical chambers 111a, 112a, 113a, 114a, 115a, 116a and which are aligned with a corresponding set of upper tumbler

pins 121, 122, 123, 124, 125, 126 in associated cylindrical holes 121a, 122a, 123a, 124a, 125a, 126a, and a side bar 150 which is movable sideways and has a radially outer ridge portion 160 which is normally accommodated in a longitudinal groove 105 (see fig. 5) in the lock housing 104 so as to prevent rotation or turning of the key plug 102 in relation to the housing 104.

When the key plug is located in the rotational position shown in fig. 5, the lower and upper pins 111-116 and 121-126 are pair-wise aligned with each other and are movable vertically along a vertical axis in a central vertical plane P through the housing 104.

In this specification, all references to "vertical", "upper" and "down", etc. are related to the vertical plane P in fig. 5. It is understood, however, that this plane may be oriented differently in a particular embodiment of a lock and key combination according to the invention.

Each pair of upper and lower pins, such as the pins 113 and 123 visible in fig. 5, are urged downwards by a set of helical springs 127 acting between the respective upper pin 121-126 and a top end closure member 128 secured at the upper end of the respective cylindrical chambers or holes 121a-126a.

When a correctly cut key blade 202 is fully inserted into the keyway 101, each pair of lower and upper tumbler pins 111 and 121, etc. will be positioned with their abutting upper and lower contact surfaces located at a shear line 110 (fig. 5) between the rotatable key plug 102 and the stationary housing 104, so as to enable a turning motion of the key plug 102 in relation to the housing 104. When the key plug is turned, by

means of the key blade 202 (operated with the grip 201), the outer ridge portion 160 will be forced to move sideways inwardly towards the keyway 101 and the central plane P of the housing 104, against the action of springs 107 (visible in
5 fig. 2 and fig. 5), so that the side bar is released from its engagement with the groove 105 and makes it possible to turn the key plug 102 further in relation to the housing 104. In this way, the lock can be opened by means of the key 200.

10 Each lower tumbler pin 111-116 has a recess or hole 111h, 112h, 113h, 114h, 115h, 116h in its cylindrical outer surface (possibly in the form of a slot extending vertically, i.e. in parallel to the vertical plane P). As will be described further below, each lower tumbler pin can be positioned
15 vertically as well as in its rotational location, by interaction with V-cuts in the upper edge portion of the key blade. These V-cuts 211, 212, 213, 214, 215, 216 (see fig. 2) each have a certain vertical position as well as a predetermined angular orientation of its bottom portion, so
20 that the tumbler pins 111, 112, 113, 114, 115, 116, with corresponding chisel end portions, will be positioned in predetermined positions, as shown in fig. 3, where the holes 111h, 112h, 113h, 114h, 115h, 116h are aligned at the same vertical level and are all oriented in a direction pointing in
25 a transversal direction towards the side bar. In this way, these holes or recesses will form accommodating seats for inner projecting lugs 151, 152, 153, 154, 155, 156 on the side bar. Thus, the projecting lugs 151 etc. can be moved into the holes 111h, etc. so that the sideward movement of the side bar
30 will not be hindered.

The structure of the cylinder lock and key combination 100,200 described so far is previously known as such, e.g. from the US

patent specifications mentioned above, and constitutes a well-functioning and very secure locking device, with the two interacting locking mechanisms involving the tumbler pins 111, etc. and the side bar 150.

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However, according to the present invention, the configuration of the side bar 150 and the lower tumbler pins 111-116 is especially adapted in a way that significantly increases the security of the lock and makes it very difficult to manipulate the lock by determining the relative rotational positions of the lower tumbler pins 111-116.

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More particularly, the recesses or holes 111h-116h are located at a high vertical level in relation to the rotational axis A of the key plug 102, and the holes 111h, etc. are also located entirely in the outer cylindrical surface of the respective pin 111, etc., so that the walls of the associated cylindrical holes or recesses 111a, 112a, 113a, 114a, 115a, 116a will cover the respective recess or hole 111h, etc. even when the pins are located in the their lowermost positions after retracting the key blade 202 from the keyway 101, and the lock 100 is empty, as shown in fig. 4. Moreover, the recesses or holes 111h, etc. do not communicate with the lowermost, downwardly exposed surface of the tumbler pin. Therefore, even with sophisticated optical or mechanical equipment, it is virtually impossible to determine the relative location of the respective hole 111h, etc. It should be noted that, in a typical, normal case of an empty lock 100, the recesses or holes 111h, etc. are not oriented in exactly the same way. When retracting the key blade 202, the various V-cuts 211, 212, 213, 214, 215, 216 will cause the lower tumbler pins 111, etc. to rotate somewhat in either direction and the rotational positions will be different from that shown in fig. 4.

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More precisely, the row of inner, projecting lugs 151,152,153, 154,155,156 is located entirely above the top biting level of the key blade, i.e. above the uppermost V-cut or biting 213.

5 The corresponding, shortest lower tumbler pin 113 will thus have its hole 113h located entirely above its lower end. So, the hole 113h will be completely covered by the cylindrical surface of the associated cylindrical chamber 113a, even when the tumbler pin 113 is located in its lowermost position as

10 shown in fig. 4. It is also important that the recess or hole 113h (and also each hole in the other lower tumbler pins 111,112,114,115,116) does not communicate with any part of the lower end portion being exposed downwardly to the keyway. Accordingly, it will not be possible to identify the relative

15 location of the recess or hole 111h, etc. by inspecting the empty keyway 101 by mechanical or optical means.

In order to place the holes 111h, etc. at such high levels relative to the keyway and the uppermost biting levels of the

20 key blade, and also the corresponding projecting lugs 151, 152, 153, 154, 155, 156 at such a high vertical level, the side bar is designed with a large thickness such that the row of inner lugs 151, etc. is located at a higher vertical level than the outer ridge 160 cooperating with the groove 105 in

25 the housing 104. This is most clearly apparent from fig. 5. It is an advantage to have the outer ridge 160 located at the same vertical level as the rotational axis A of the key plug 102. With such a location, the key plug 102 can be turned in either rotational direction with a smooth interaction between

30 the adjoining oblique guiding surfaces of the ridge 160 and the groove 105, without any undue resistance or blocking action. It is also an advantage to have the sliding direction of the side bar oriented perpendicularly to a vertical plane P

through the key plug 102. Accordingly, with these constraints, the side bar must be rather thick in the vertical dimension, as seen in fig. 5.

5 Preferably, the thickness t of the side bar 150 is about the same as (or greater than) half of the radius of the key plug 102. In the illustrated example, the thickness t is about 3,4 mm and the radius of the key plug is about 6.5 mm.

10 Normally, it would be difficult to ensure a smooth and well-functioning guidance of the sliding lateral movement of the side bar 150, but this difficulty is resolved in that the longitudinal end portions 170,180 of the side bar 150 (see
15 figs. 6,6a,7,7a) are provided with laterally extending guiding surfaces 171, 172 and 181,182, respectively. Each pair of such guiding surfaces 171,172 and 181,182 are located opposite to each other at a mutual distance which is smaller than the overall thickness of the side bar. From fig. 6, it is evident that the respective end portions 170, 180 are fitted into
20 respective end parts of a key plug cavity or recess 106 (see fig. 5). One of these end parts, namely 106a, is visible in fig. 5, which cooperates and guides the end portion 180 of the side bar 150.

25 Preferably, the mutual distance of the opposite guiding surfaces 171,172 and 181,182 is about half of the overall vertical thickness or height t of the side bar, or may be even less.

30 A modified embodiment of the side bar 150' is shown in fig. 7b. It has approximately the same height as the one shown in fig. 7. However, between each pair of adjacent projecting lugs, here in the form of tongues rather than pins, there are

additional upper guiding surface portions 172', 173', 174', 175', 176', in addition to the upper guiding portions 171 and 182. These additional upper guiding surface portions 172', etc. will provide an even smoother guiding of the side bar.

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The relatively large thickness t of the side bar 150 (or 150') permits a high positioning of the row of inner projecting lugs 151, 152, 153, 154, 155, 156. As appears from fig. 5, the projecting lug 153 (and also each of the other lugs in the row) is located entirely above the uppermost part of the keyway and, as is important according to the invention, also above the top bitting level B of the key being inserted into the keyway (compare figs. 5 and 3). This top bitting level B is also located vertically above the level C of the rotational axis A of the key plug 102.

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In the example shown in figs. 1 through 7 (see especially figs. 3 and 5), the diameter D of the rotatable key plug is about 13 mm, and the height H of the key blade 202 is about 8 mm (the height of the keyway being about the same, with just a small play permitting a sliding movement). The top bitting level B is located about 0.8 mm below the level T of the upper edge of the key blade. The increments I between the various bitting levels (six in total) are each 0.64 mm, so the total bitting range R is about 3.2 mm (see Fig. 3). This bitting range R is almost of the same order as the height (or length) of the shortest tumbler pin 103, this height being about 5.5 mm.

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The lowest bitting level is located slightly above the level E of the lower ends of the cylindrical chambers 111a, etc. accommodating the lower pins 111, etc., so as to guarantee that, in the empty lock as shown in fig. 4, the lower end

portions of all the lower pins 111, etc. are located slightly above a relatively wide lower portion W (fig. 5) of the keyway. Above this lower portion W, the keyway and the key blade inserted therein, are narrower and forms a relatively narrow keyway portion N, which is also extended in a zig-zag manner upwards to the top end level T (fig. 5).

As will be seen from fig. 5, the lower tumbler pin 113 (and the other pins 111,112,114,115,116 as well) is provided with an upper fin 113b which projects radially outwardly into an associated cavity 190 having a limited circumferential extension outside the associated cylindrical chamber 113a. In this way, the tumbler pin 113 is retained within a limited angular range, which will ensure a well-functioning interaction with the upper edge of the key blade 202 and its coded V-cuts. The underside of each fin may be placed at the same distance from the lower end of the pin, irrespective of the pin length. The vertical thickness may be the same, thus allowing the upper ends of the longer pins to be provided with anti-pick grooves (not shown).

As an optional feature, at least one or some of the fins 113b may be extended vertically downwards, as indicated in fig. 5 by dotted lines for an extended fin 113b'. Then, the respective tumbler pin having such an extended fin will be hanging at a slightly higher vertical level, above the lowermost level E of the cylindrical chamber 111a,...,116a, when the key blade 202 is retracted and the keyway 101 is empty (compare fig. 4 showing all tumbler pins at the same lowermost positions). The advantage with such an arrangement is that it will make it even more difficult to manipulate the lock.

As stated above, the recesses or holes 111h, 112h, 113h, 114h, 115h, 116h should be located entirely above the top biting level B, and therefore also above the lowermost end portions of the tumbler pins, so that these recesses or holes 111h, etc
5 are open sideways, towards the cylindrical surface of the associated cylindrical chamber 111 a, etc. (whereby they will be covered by these cylindrical surfaces) but not downwardly towards the keyway.

10 In the following, a number of embodiments of the lower tumbler pins will be described with reference to the drawing figures 8 to 20. In all the embodiments, each tumbler pin has a chisel end portion with a lowermost guiding element which will guide the tumbler pin so that it is rotated into an angular position
15 which ensures that a side recess is directed so as to register with one of the projecting lugs of the side bar, after full insertion of a correctly cut key into the keyway of the lock.

In fig. 8, there is shown a first embodiment of a tumbler pin
20 11 forming a part of the lock according to the invention. The pin 11 is substantially cylindrical, with a top end portion 11a having a central, elevated circular contact portion 11a, and a fin 11b projecting radially outwards from the cylindrical surface adjacent to the upper end. This fin 11b is
25 accommodated in a cavity 190 (see fig. 5) forming a radial extension of the associated chamber 111a, 112a, 113a, 114a, 115a, 116a within a limited angular region that will ensure that the tumbler pin 11 (113 in fig. 5) will always be
30 oriented within a limited rotational range in the chamber 111a, etc. when the key blade 202 is inserted into the keyway 101.

At the lower end portion, the tumbler pin 11 has a chisel configuration, with two inclined planar portions 11c, 11d (see fig. 9b) having the same inclinational angle and ending on each side of a guiding portion 11e, the lower surface of which extends in a horizontal plane that is perpendicular to the vertical axis of the tumbler pin 11. As is previously known *per se*, one (11d) of the inclined planar portions is larger than the other one 11c, so that the guiding portion 11e is located somewhat offset from the central axis L of the pin 11 (fig.8b).

As will be seen from the views from underneath 8a through 8f and the side views 9a through 9f, the tumbler pin 11 can be varied into six different modified versions by changing the angular location of the side recess or hole 11h in relation to the fin 11b, in three different locations, see figs. 8a, 8b and 8c, and by placing the fin 11b on either side of the guiding portion 11e, compare figs. 8b and 8e.

In accordance with the invention, in all these modified versions, each of the holes 11h in the cylindrical surface of the tumbler pin is located at a distance from the parts of the lower end portion being exposed downwards towards the keyway.

It also appears from figs. 9a through 9f that there is also a second hole 11 h' at the same angular position, but located very close to the upper end. This makes it possible to provide further codes or a master key system, as is known *per se* in this technological field. A further development to provide a master key system would be to add another hole 11h located at a different vertical level and/or at a different angular position.

A second embodiment of the tumbler pin, denoted 21, is shown in figs. 10, 10a through 10f, and 11a through 11f, the difference to the tumbler pin 11 in fig. 8 being that the lower guiding portion 21e is inclined so as to rise from left to right in fig. 10. This will affect the geometrical shape of the V-cut bittings of the key blade, but the various locations of the holes 21h are the same as for the first embodiment (compare the figs. 9a through 9f and figs. 11a through 11f). Also, of course, the inclination of the guiding portion 21e may be reversed, i.e. the guiding portion may rise from right to left in fig. 10 (for a slightly longer pin). So, the inclination may also be used for master keying. Thus, a master key may have a bitting with two inclined portions corresponding to two different locks.

A still further, third embodiment of the tumbler pin, denoted 31, is shown in figs. 12, 12a through 12f, and 13a through 13f. Again, the various locations of the holes 31h are the same as in the first embodiment, but the lower end portion of the pin 31 is slightly different, with a lower guiding portion 31e which is inclined only along a limited portion of the lower end. Of course, the key blade V-cut bittings have to be adjusted accordingly.

A fourth embodiment is shown in figs. 14, 14a through 14f, and 15a through 15f, where the tumbler pin 41 has a lower end with a part-cylindrical, skirt-like portion 41f and a chisel portion 41f' with a guiding portion 41e' extending along a part of the lowermost, horizontal end surface. In this case, the V-cut bittings of the key blade have to be adapted so as to accommodate the pin 41 with its special lower end portion. Again, the locations of the holes 41h may be varied in the

same way as in the first embodiment (figs. 8 and 9a through 9f).

In figs. 16a through 16e and 17a through 17e, three different kinds of recesses in the cylindrical surface portion of the tumbler pin are shown.

In figs. 16a and 17a, the recess 51h in the outer cylindrical surface of the tumbler pin 51 is formed by a number of mutually adjacent radial bores. The lowermost bore 51h' is located at a distance from the inclined chisel surface 51d. Accordingly, the lower pin surface portions being exposed downwards towards the keyway 101 are unaffected by the bores forming the recess 51h. Therefore, it is not possible to identify the angular location of the recess 51h.

In figs. 16b and 17b, the holes 61h and 61h' in the pin 61 are individual and separate bores just like the ones in the fourth embodiment shown in figs. 14a and 15a.

As a third example, the recess 71h in the pin 71 (the embodiment of the pin being identical to the one shown in figs. 14d and 15d) shown in figs. 16c and 17c is a continuous slot ending at a point 71h' located at some distance from the lowermost end of the part-cylindrical skirt portion 71f.

Because of the this skirt portion, it is possible to extend the slot further downwards, as shown in figs. 16d, 17d and 16e, 17e for two different angular positions of the elongated recess 81h which ends at a point 81h' very close to the lower end surface of the pin. Still, the recess 81h will be concealed and will not be visible from underneath when mounted in the lock. As in the other embodiments, there are further possibilities to locate the elongated recess 81h at a number

of different positions in the circumferential or angular direction.

In fig. 18, there is shown a cross-section, corresponding to
5 fig. 5, of an embodiment with a lower tumbler pin 21' similar
to the one (21) shown in fig. 10, but having an elongated side
recess 21'h in its cylindrical outer surface. Here, the coded
V-cut forming the bitting 213' of the key blade 202 is
inclined, relative to a horizontal plane being perpendicular
10 to a central axis of the tumbler pin (the central axis being
located in a central plane P through the keyway and the
inserted key blade 202), with the same inclinational angle as
the bottom guiding portion 21e' of the tumbler pin. This will
ensure a well-functioning contact between the V-cut and the
15 tumbler pin.

If the pin 21' is slightly longer, it can have its
inclinational angle of the guiding portion 21e' reversed, i.e.
rising from left to right instead of from right to left, as
20 indicated in fig. 18 with dotted lines. These dotted lines
correspond to two different pins of two different locks. By
forming the V-cut with corresponding V-cut portions, having
opposite inclinational angles, meeting each other at a mid-
point M, a master key is obtained. This master key can operate
25 the two different locks.

The key 202 in fig. 18 is shown more fully in figs. 18a (in a
perspective view), 18b (in a side view) and in fig. 18c (in a
cross-sectional view), the scale being somewhat smaller than
30 in fig. 18. The same key 202 is also shown in a top view in
fig. 18d, an enlarged part within a circle being shown in fig.
18e, and in a longitudinal sectional view in fig. 18f, along
the line B-B in fig. 18d.

The bittings 213,214,215,216,217 are irregularly arranged in two ways:

- 5 First, a linear bottom portion LB1, LB2, LB3 of each of the bittings 214, 215, 216 (see fig. 18e) is displaced in the longitudinal direction D1 in relation to a vertical plane P extending transversely and centrally through a position corresponding to the central axis of an associated one of the
10 lower tumbler pins 21' of the lock (see fig. 18), the displacement being denoted d1, d2, d3, respectively, in fig. 18e. Here it is assumed that the key blade is inserted fully into the lock.
- 15 Secondly, these linear bottom portions LB1, LB2, LB3 of the bittings 214, 215, 216 are generally inclined at an angle $\alpha_1, \alpha_2, \alpha_3$ to said transversal plane P, but also at an angle β in relation to a horizontal plane HP (fig. 18c) extending along the key blade, so that at least some of the V-cut
20 bittings are deeper at one side of the key blade than at another side of the key blade. This horizontal plane HP is normal to the central axes of the tumbler pins 21' of the lock shown in fig. 18.
- 25 Of course, the bottom bottom portions LB1, LB2, etc. of the bittings should be conformed or complementary to the particular configuration of the tumbler pins of the associated lock, e.g. as shown in figs. 10, 12, 14 etc. The linear bottom portion of at least one of the V-cut bittings may be inclined
30 upwardly from one side of the key blade at a first part of the thickness of the key blade and be inclined downwardly at a second part of the thickness of the key blade, so that the bitting is deeper at one side of the key blade than at the

opposite side of the key blade. As an alternative, a first portion may be inclined in relation to a horizontal plane (HP in fig. 18c) and a second portion may be parallel to the horizontal plane. Still the V-cut bitting will be deeper at one side of the key blade than at the second side of the key blade.

Also, the key should have a key blade which, in case at least one tumbler pin has a V-formed end portion including a lowermost edge portion that is at least partially inclined in relation to the plane that is perpendicular to the central, longitudinal axis of the tumbler pin, is configured such that the key has an upper single edge portion on each of the V-cut bittings having two opposite sloping surfaces which merge at the linear bottom portion, and each of the V-cut bittings is located at a respective one of a number of vertical levels (L1, L2, L3, L4, L5, L6, fig. 18f) in relation to an opposite lower edge LE (fig. 18f) of the key blade, as shown in figs. 18a through 18f.

Fig. 19 shows a further embodiment, in a cross-section similar to the one in fig. 18, with a tumbler pin 41' of the same kind as in fig. 14, i.e. a tumbler pin having a skirt portion reaching all the way down to the end surface of the pin. In this skirt portion, there is an elongated recess 41'h in the outer cylindrical surface, which cooperates with a projecting lug 153' on the side bar 150'. The projecting lug 153' has a larger height than in the previous embodiments, the lug being formed like a tongue, rather than a cylindrical pin, as on the modified side bar 150' of fig. 7b.

Here, the recess 41'h reaches very far down to a point very close to the bottom surface of the pin. The chisel portion of

the pin, with two inclined, flat surface portions 41'c and 41'd (see fig. 20a) are located at an opposite side of the pin, to the left in fig. 19. Also, the upper, narrow part N of the key blade 202' is offset (to the left in fig. 19) in
5 relation to the central plane P, leaving about half of the associated cylindrical chamber 113'a empty, at the right hand side of the keyway.

In this embodiment, the tumbler pin 41' is optionally provided
10 with an extra recess 41'h', which is illustrated in figs. 20, 20b, and 20d. The extra recess is not as deep as the "real" recess 41'h and is actually a "false" recess intended to make it even more difficult for those who try to manipulate and open the lock, without a correctly cut key. Thus, if the
15 projecting lug or tongue 153' finds it way into the extra or false recess 41'h', the side bar 150' will get stuck in a position where it does not release the ridge portion 160' from its associated groove in the housing 104. Of course, such extra or false recesses may be provided even for all other
20 embodiments described above.

It will be apparent from fig. 19 that it is very difficult to identify or reach the side recess 41'h when the keyway is located at an opposite side in relation to the location of the
25 side bar 150' and the side recess 41'h.

It will be understood that the various embodiments of the pins and their recesses shown in figs. 8, 10, 12, 14, 16a through 17e, 18, 19 and 20 will all satisfy the criteria set up
30 according to the present invention, namely to be completely concealed by the associated cylindrical chamber in the key plug and to have no communication at all with the lower end

surface portions of the pin being exposed downwardly towards the keyway.

5 The invention also relates to a side bar, as described above and defined specifically in the claims, and a special key having a chisel end portion being inclined from one side of the key to the other, as described above. The key may have a lower, relatively wide part (W) and an upper, relatively narrow part (N) being offset in relation to a central vertical
10 plane P, as shown in fig. 3.

The lock and key combination according to the invention may be modified in various ways within the scope of the claims. One modification would be that there is another locking mechanism,
15 in addition to the one described above. An example of such a locking mechanism is a code pattern at one or two sides of the key blade, cooperating with side locking tumblers in the key plug, e.g. as disclosed in the US patent specifications 5,715,717, 7,159,424, 7,665,337, and 8,448,485 (all in the
20 name of Widén). Another modification would be to have pins with two tips fitting fully into some, but not necessarily all adjacent bittings in the key blade, as disclosed in the US patent specification 7,958,760 (Widén).

CLAIMS

1. A cylinder lock and key combination, including a cylinder lock (100), comprising:

- 5 - a housing (104) having a cylindrical bore (103) accommodating a rotatable key plug (102),
- said key plug (102) having a longitudinally extending keyway (101) for receiving a key blade (202),
- a row of tumbler pins (111,..., 116) arranged for
10 elevational and rotational movement in corresponding cylindrical chambers (111a,..., 116a) in said key plug (102) for engagement with coded V-cut bittings (211,..., 216) on an upper edge of an associated key upon insertion thereof into said keyway (101), and
- 15 - a longitudinal side bar (150) which is slidably journaled for transversal movement in said key plug (102),
- said side bar having an outer, longitudinal ridge portion (160) fitting into an associated groove (105) in said
20 housing, so as to normally prevent rotation of said key plug (102) in said cylindrical bore of the housing,
- said side bar (150) also having a row of inner projecting lugs (151,..., 156) each selectively registering with one or more recesses (111h,..., 116h) in said tumbler pins when
25 said key has been inserted into the keyway (101),
- said side bar (150) being movable sideways by turning of a correctly cut key, while said projecting lugs enter into an one of associated tumbler pin recesses so that said longitudinal ridge portion (160) is released from
30 said groove and the key plug (102) is permitted to rotate relative to said housing (104), and
- a key (200), comprising said key blade (202) having:

- an upper edge provided with said coded V-cut bittings (211,..., 216),

wherein:

- 5 - each of the lugs in said row of inner projecting lugs (151,..., 156) of said side bar (150) is located at a relatively high level, above a rotary axis (A) of the key plug (102), when being moved sideways with the side bar (150) into the respective tumbler pin recesses (111h,..., 116h), whereas the outer longitudinal ridge portion (160) of the side bar
10 (150) is located at a substantially lower vertical level than the inner projecting lugs (151,..., 156), namely at substantially a same vertical level as the rotary axis (A) of the key plug (102), seen in
15 a central vertical plane (P) in the keyway (101), when the outer longitudinal ridge portion (160) engages with the associated groove (105) in the housing (104), and
- 20 - said tumbler pins (111,..., 116) are configured so that each of said pin recesses (111h,..., 116h) is located entirely above the rotary axis (A) of the key plug (102) and also entirely above a lowermost end portion of the tumbler pin (111, ..., 116) in a cylindrical outer surface of the tumbler pin and is covered by a cylindrical wall part of an associated
25 one of said cylindrical chambers (111a,..., 116a), without communicating downwardly with the keyway (101),
- 30 - whereby each pin recess is concealed and invisible from an inside of said keyway, even when the keyway (101) is empty.

2. The cylinder lock and key combination as defined in claim 1, wherein each of inner projecting lugs (151,..., 156) in the row is located above the keyway (101).

5 3. The cylinder lock and key combination as defined in claim 1, wherein when the key blade (200) is inserted into the keyway (101), the key blade (200) has a top biting level (B) located above the rotary axis (A) of the key blade (200), and each of the inner projecting lugs (151,..., 156) in the row of
10 the inner projecting lugs (151,..., 156) is located above the top biting level (B) of the key blade (200).

4. The cylinder lock and key combination as defined in claim 1, wherein said side bar (150), at each longitudinal end
15 portion (170, 180) thereof, has transversally extending guiding surfaces (171, 172, 181, 182) which secure a precise lateral guiding of the side bar (150) in said key plug.

5. The cylinder lock and key combination as defined in claim
20 4, wherein said transversally extending guiding surfaces (171, 172, 181, 182) are located opposite to each other at a mutual distance which is smaller than an overall thickness (t) of the side bar (150).

25 6. The cylinder lock and key combination as defined in claim 1, wherein said side bar (150') has transversally extending upper guiding surfaces (172', etc.) between at least some of said inner projecting lugs (151', etc.), and a mutual distance between the upper guiding surfaces (172', etc.) and
30 opposite lower guiding surfaces (172, 182) being smaller than an overall thickness (t) of the side bar (150).

7. The cylinder lock and key combination as defined in claim 1, wherein at least some of the tumbler pins (11) have pin recesses (11h, 11h') located at at least two different locations, so as to enable forming of a master key system, said different locations being at least one of different vertical levels and different circumferential locations.

8. The cylinder lock and key combination as defined in claim 1, wherein all of said cylindrical chambers (111a, ..., 116a) reach down to a same vertical level (E), below which said keyway (101), is wider than an upper part of said keyway (101), corresponding to a lower, relatively wide part (W) of the key blade (202) of said key (200), and wherein the V-cut code bittings (211,..., 216) are all located in an upper, relatively narrow part (N) of said key blade (202).

9. The cylinder lock and key combination as defined in claim 8, wherein said narrow part (N) of said key blade (202') is offset in relation to a central vertical plane (P) through said keyway and said key blade (202') upon insertion of the key blade into the keyway.

10. The cylinder lock and key combination as defined in claim 1, wherein each of said tumbler pins (11) has a lower portion with two oppositely located inclined planar surface portions (11c, 11d) forming between them a linear, relatively narrow guiding portion (11e) fitting into a corresponding one of the coded V-cut bittings (B), and wherein each pin recess (11h) is located at a cylindrical outer surface portion at a distance from any of said inclined surface portions.

11. The cylinder lock and key combination as defined in claim 10, wherein said two oppositely located inclined planar surfaces portions (11c, 11d) have a same inclinational angle, and

5 wherein said relatively narrow guiding portion (11e) is offset from a central axis (L) of the tumbler pin (11).

12. The cylinder lock and key combination as defined in claim 10, wherein said two oppositely located inclined planar surface portions occupy only a part of a circumference of the tumbler pin (41), leaving a massive, part-cylindrical skirt portion (41f) at a lower end of the pin, said skirt portion ending at substantially a same vertical level as said relatively narrow guiding portion (41e').

13. The cylinder lock and key combination as defined in claim 12, wherein said pin recess (41h, 81h) on at least one of the tumbler pins is located at an outer cylindrical surface of said skirt portion, without communicating with a lowermost end surface or any of the two oppositely located inclined planar surface portions,

whereby said pin recess (81h) may be located relatively close (81h') to the lowermost end of the tumbler pin, without being visible from an inside of a key slot, and enabling a shortest one of the tumbler pins to have a relatively short length which is only slightly longer than a vertical biting range (R) of the key blade (202).

14. The cylinder lock and key combination as defined in claim 10, wherein said relatively narrow guiding portion (21e) is inclined at an angle relative to a horizontal plane which is perpendicular to a longitudinal axis of the tumbler pin (21).

15. The cylinder lock and key combination as defined in claim 14, wherein said V-cut bittings (211',..., 216') on the key blade are also inclined at said angle relative to said horizontal plane, so as to provide a linear contact with said guiding portions (21e) of the associated pins (21).

16. The cylinder lock and key combination as defined in claim 1, wherein each of said tumbler pins (111,..., 116) is provided with a guiding fin (113b) projecting radially outwardly and being accommodated in a cavity (190), which forms a radial extension of an associated chamber (113a) within a limited angular region, whereby the tumbler pins (111,..., 116) are always adapted to be oriented within a limited rotational range in said associated chamber.

17. The cylinder lock and key combination as defined in claim 16, wherein said radial fins (113b) have different vertical lengths, in parallel to a vertical axis of the associated pin (113), so that the tumbler pins (111,..., 116) are adapted to be urged downwards with lower ends thereof, and are adapted to be located at different vertical levels when the key blade (202) is retracted from the keyway (101).

18. The cylinder lock and key combination as defined in claim 1, wherein the outer cylindrical surface of at least one of said tumbler pins (41') is provided with an extra recess (41'h') which is deliberately configured or located so as to retain the pin (41') and/or the side bar (150'), when the associated projecting lug (151,..., 156) is seated in said extra recess, in a position which does not permit rotation of the key plug (102) relative to the housing (104) of the lock (100).

19. The cylinder lock and key combination as defined in claim 1, wherein the side bar (150) has an overall thickness (t), measured in a vertical direction in parallel to the central vertical plane (P), which is at least half of a radius of the cylindrical bore (103).

20. The cylinder lock and key combination as defined in claim 1, wherein each V-cut bitting (211, ..., 216) in the upper edge of the key blade (202) of the key (200) stands at respective one of a first number of angles relative to a transverse direction, and is located at a respective one of a second number of vertical levels in relation to an opposite lower edge of the key blade (202).

21. A side bar for a cylinder lock having a key plug (102) which is rotatable in a housing (104), the side bar (150) being slidable sideways in the key plug (102) and having an outer ridge portion (160) which is normally seated in a groove (105) in the housing, and inner projecting lugs (151,..., 156) dimensioned to be seated in associated recesses (111h,..., 116h) in tumbler pins, which are movable in said key plug, wherein:

- said projecting lugs (151,..., 156) are located at a substantially higher level than said outer ridge portion (160) of the side bar (150) and said axis (A) of said key plug (102), and
- the side bar (150) is guided by means of opposite guiding surfaces (171, 172, 181, 182, 172', ... 176') located at a mutual distance being substantially smaller than an overall thickness (t) of the side bar (150).

22. The side bar as defined in claim 21, wherein the overall thickness (t) of the side bar (150) is at least as large as half of a radius (D/2) of said key plug (102).

23. A key (200) for a lock (100), comprising:

- a key blade (202) having a single upper edge with V-cut bittings (213, ...), each V-cut bitting (213, ...) standing at a respective one of a first number of angles relative to a transverse vertical plane, each being perpendicular to a longitudinal direction of the key blade (202), and each being located at a respective one of a second number of vertical levels in relation to an opposite lower edge of the key blade (202),

wherein the V-cut bittings (213, ...) at the upper edge of the key blade (202) are irregularly arranged in two ways:

- a linear bottom portion of at least some V-cut bittings (213, ... , 216, is displaced in the longitudinal direction of the key blade (202) in relation to a vertical plane extending transversely and centrally through a position corresponding to the central axis of an associated one (21) of tumbler pins (111 ...) of the lock when the key (200) is fully inserted into the lock (100), and

- the linear bottom portion of the at least some V-cut bittings (213, ...) is inclined in relation to a horizontal plane extending along the key blade (202), so that the at least some V-cut bittings (213, ... , 216) are deeper at one side of the key blade (202) than at another side of the key blade (202), said horizontal plane extending along the key blade (202) being normal to central axes of the associated tumbler pins of the lock (100) when the key is fully inserted into the lock, and the at least some V-cut bittings (213, ...) of the key blade (202) are configured to cooperate with the associated tumbler pins (111 ...), and

wherein each of the tumbler pins (111 ...) includes:

a projecting V-formed end portion having a shape that is substantially complementary to the associated V-cut bittings, and a lowermost edge portion (21e) that is generally offset in the longitudinal direction of a keyway in relation to a central, longitudinal axis of the tumbler pins (111 ...), so that the lowermost edge portion (21e) is also inclined in relation to a plane that is perpendicular to the central, longitudinal axes of the tumbler pins (111 ...).

24. A key as defined in claim 23, wherein the linear bottom portion of at least one of the V-cut bittings (213, ...) is inclined upwardly from one side of the key blade (202) to an opposite side at a first part of a thickness of the key blade (202), and is inclined downwardly at a second part of the thickness of the key blade (202), so that the at least one of the V-cut bittings (213, ...) is deeper at the one side of the key blade (202) than at the opposite side of the key blade (202) .

25. A key as defined in claim 21, wherein the linear bottom portion of the at least one of the V-cut bittings (213, ...) includes:

- a first portion that is inclined in relation to the horizontal plane, and
- a second portion that is parallel to said horizontal plane,

so that the at least one of the V-cut bittings (213, ...) is deeper at the one side of the key blade than at the second side of the key blade (202).

26. A key as defined in claim 21, wherein at least one of the tumbler pins (111, ...) having the V-formed end portion

includes a lowermost edge portion that is at least partially inclined in relation to the plane that is perpendicular to the central, longitudinal axis of the tumbler pin (21), and

- the key (200) has an upper single edge portion on each of the V-cut bittings (213, ...) having two opposite sloping surfaces which merge at the linear bottom portion, and
- each of the V-cut bittings (213, ...) stands at a respective one of the first number of angles relative to the transverse vertical plane, that is perpendicular to the longitudinal direction of the key blade, and
- each of the V-cut bittings (213, ...) is located at a respective one of the second number of vertical levels in relation to an opposite lower edge of the key blade (202),

wherein the linear bottom portion of the at least one of the V-cut bittings (213, ...) is inclined in relation to the horizontal plane extending along the key blade (202), so that the at least one of the V-cut bittings (213, ...) is deeper at the one side of the key blade (202) than at the opposite side of the key blade (202), and

- the V-formed end portion of the at least one of the tumbler pins (111, ...) and the associated one of the V-cut bittings (213, ...) of the key blade (202) have substantially complementary geometrical configurations,

whereby the at least one of the tumbler pins (111, ...) is elevated and rotated into a predetermined position upon fully inserting the key (200) into the lock (100).

27. A key as defined in claim 23, comprising an elongated key blade having a lower, relatively wide part (W) and an upper, relatively narrow part (N) provided with a number of bittings, wherein said relatively narrow part (N) of said key blade

(202) is offset in relation to a central vertical plane (P) through said lower, relatively wide part (W), and wherein there is an inclined transition region of the key, extending obliquely upwards from one side of said relatively wide part (W) to a position above the other side of said relatively wide part (W).

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