

KEY DUPLICATING METHOD AND APPARATUS**Field of the Invention**

This invention relates to duplication of keys for locks such as cylinder
5 tumbler locks. The invention will be hereinafter described with particular
reference to a key intended for use with a cylinder lock of the kind having
tumbler plates or discs which are movable about a pivotal or rotational axis, but
it is to be understood that the invention is applicable to keys for use with other
types of locks.

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Background of the Invention

An example rotatable disc tumbler lock is disclosed by the specification
of Australian Patent 550647 (86467/82), and a key for use with that lock is also
disclosed. The blade of the key is basically of cylindrical form and tumbler
indexing surfaces are produced on the blade at various locations. The
15 indexing surfaces are usually formed by a material removal process, and the
location of those surfaces varies longitudinal of the blade and also in terms of
angular disposition around the longitudinal axis of the blade. Ramp surfaces
interconnect adjacent indexing surfaces and function to cause rotation of the
tumbler discs as the key blade is moved longitudinally into the lock keyway.

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Keys of the foregoing kind are difficult to duplicate, largely because of
the varying angular disposition of the indexing surfaces. Prior to the present
invention it has not been possible to duplicate such keys by automated
apparatus, and, as a result, key duplication has been time consuming and
expensive.

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It is an object of the present invention to provide an improved method
and apparatus for duplicating keys of the kind having tumbler indexing surfaces
which are located at different angular positions around the longitudinal axis of
the key blade. It is a further object of the invention to provide such a method
and apparatus for duplicating a key of the kind in which tumbler indexing
30 surfaces are spaced apart longitudinally of the blade and are relatively
arranged at different angular positions around the longitudinal axis of the
blade. It is yet another object of the invention to provide a method and

apparatus which enables automatic duplication of a key of the foregoing kind.

Summary of the Invention

The method and apparatus hereinafter described are both intended for duplicating a key of the kind having an elongate blade, and at least two tumbler
5 indexing surfaces formed on the blade at respective positions spaced apart in the longitudinal direction of the blade. Each of the two indexing surfaces has a different angular position relative to a reference plane containing the longitudinal axis of the blade.

More than two indexing surfaces may be provided along the length of
10 the blade, in which event it is generally preferred that no two indexing surfaces have the same angular disposition relative to the reference plane. It is to be understood however, that the present invention is applicable to situations in which no more than two of a group of three or more indexing surfaces have a different angular disposition.

15 A method according to the invention is characterised in that a duplicate of each of a first and a second indexing surface of the key is formed on the blade of a key blank and the duplicate of the second indexing surface is formed after the blank blade is rotated about its longitudinal axis through an angular distance from the position at which the first duplicate is formed. That angular
20 distance is determined by the relative angular dispositions of the first and second indexing surfaces of the key being duplicated. In some circumstances, the blade of the key blank may not be rotated about its longitudinal axis during formation of an indexing surface on that blade. That may depend on the form of the key being duplicated and/or the nature of the means used to form the
25 indexing surfaces.

The key and the key blank are each releasably attached to a respective one of two rotatable devices that are connected in a manner such that rotation of one causes rotation of the other. It is preferred that the two devices rotate in unison in response to interaction between the key blade and coacting means,
30 and that such interaction occurs during relative movement between the key blade and the coacting means in the axial direction of the key blade.

Apparatus according to the invention includes first and second rotatable

devices for releasably holding a key and a key blank respectively so that the key and the key blank are rotatable about the longitudinal axis of their respective blades, forming means engageable with the blade of the key blank so as to form an indexing surface thereon, the forming means and the key
5 blank being relatively movable in the axial direction of the key blank blade, synchronising means causing the two devices to rotate in unison during at least part of the relative movement in the axial direction of the key blank blade so that the key blank is rotated through an angle the same as the relative angular disposition of two adjacent indexing surfaces of the key, and said
10 synchronising means controls the position of the forming means such that each time the forming means is operative to form a said indexing surface the position of the forming means relative to the longitudinal axis of the key blank blade is substantially the same as the position of an indexing surface of the key blade relative to the longitudinal axis of the key blade.

15 In a preferred arrangement, the two devices are drivably interconnected so that rotation of one causes rotation of the other.

Rotation of the key holding device may be achieved by coaction between the key blade and a relatively movable cam. In one such arrangement, the cam has an opening having a shape which is substantially
20 complementary to the cross-sectional shape of the key blade. When the key blade is located within that opening, relative axial movement of the cam and the key blade results in coaction between the cam and the blade such that the key is caused to rotate. The extent and direction of that rotation will be dictated by the configuration of the blade surfaces, and both the extent and
25 direction of rotation may change in the course of relative axial movement between the blade and the cam.

Any suitable means may be adopted to form the blade of the key blank so as to have a configuration duplicating that of the original key. In one arrangement, a blade forming head is connected with the aforementioned cam
30 so as to move along the length of the blank blade in synchronism with movement of the cam along the length of the key blade. The blade forming head includes at least one forming tool or device of any suitable type. It is

generally preferred however, to use a rotatable tool which removes material by cutting or grinding, for example. In one particular arrangement, the blade forming head includes two rotatable forming tools, each of which removes material from a respective one of two opposite sides of the blank blade during a blade forming operation. The or each tool may be in the form of a disc, but other forms such as one similar to an end milling cutter could be used.

Relative movement between the cam and the key blade as referred to above could involve movement of either the cam or the key blade while the other remains stationary, or could involve movement of both the cam and the key blade. Similarly, relative movement of the key blank blade and the blade forming head could involve movement of either the key blank blade or the blade forming head while the other remains stationary, or could involve movement of both the key blank blade and the blade forming head.

Apparatus according to another aspect of the invention is characterised in that it includes separate holding devices for an original key and a key blank respectively. Each holding device is operable to turn the key or the key blank respectively about the longitudinal axis of the blade thereof and is capable of turning the key or the key blank respectively through 360°. In a preferred arrangement, each holding device is mounted on a carrier which is movable in the axial direction of the key and blank blades relative to a blade forming head.

A method according to yet another aspect of the invention is characterised in that an original key and a key blank are arranged with the longitudinal axis of the respective blades thereof substantially coincident, and both the key and the blank are rotatable through substantially 360° while the blade of the key blank is moved longitudinally relative to a blade cutter or other forming device.

Brief Description of the Drawings

Embodiments of the invention are described in detail in the following passages of the specification which refer to the accompanying drawings. The drawings, however, are merely illustrative of how the invention might be put into effect, so that the specific form and arrangement of the various features as shown is not to be understood as limiting on the invention.

In the drawings:

Figure 1 is a perspective view of one form of key capable of being duplicated by the method and apparatus of the present invention.

Figure 2 is an enlarged cross-sectional view taken along line II-II of
5 Figure 1.

Figure 3 is a diagrammatic illustration of key duplicating apparatus according to one embodiment of the invention.

Figure 4 is an end view of key duplicating apparatus according to another embodiment of the invention.

10 Figure 5 is a diagrammatic plan view of the apparatus shown by Figure 4.

The apparatus hereinafter particularly described is intended to duplicate a key 1 of the kind shown by Figure 1 of the accompanying drawings. That key 1 has an elongate blade 2 which, in the example shown, is initially in the form of a straight cylinder. When the blade 2 is formed to suit a particular lock,
15 material is removed from each of two opposite sides of the blade 2 so as to form on each of those sides a series of tumbler indexing surfaces 3 and intervening sloping ramp surfaces 4. As shown by Figure 1, it is usual to vary the angular disposition of the indexing surfaces 3 along the length of the blade 2 so that in its final form the blade 2 has a somewhat twisted configuration. It is also usual to arrange the indexing surfaces 3 in pairs so that surfaces 3 of the same pair are located at respective opposite sides of the blade 2. A section of the blade 2 which has a pair of indexing surface 3 formed thereon will be hereinafter referred to as an indexing section. A part 5 of the original
20 cylindrical surface of the blade 2 may be left extending between each two oppositely located surfaces 3, of an indexing section.

It is a feature of a key of the foregoing kind that the cross-sectional shape of the blade 2 is substantially uniform throughout that part of the blade length which is formed with indexing and ramp surfaces 3 and 4. One such
30 cross-sectional shape is shown by Figure 2. Other shapes could be adopted.

As previously stated, the angular disposition of the indexing surfaces 3 may be varied along the length of the blade 2. In Figure 2, the line 6

represents the angular disposition of the indexing surfaces 3 of the indexing section shown cross-hatched in that Figure. The angular disposition of another pair of indexing surfaces 3 is represented by the line 6a. A third line 6b shown in Figure 2 represents a reference plane containing the longitudinal axis of the blade 2, and which is included as a convenient way of providing a reference for the angular disposition of a surface 3.

Figure 3 shows, in diagrammatic form, example apparatus which is suitable for duplicating a key of the kind shown by Figure 1. The apparatus includes two holding devices or chucks 7 and 8 which are mounted for rotation about a common axis 9. Any appropriate support (not shown) may be employed to hold the chucks 7 and 8 in proper association with other parts of the apparatus. It is to be understood that the chucks 7 and 8 could be arranged to rotate about respective axes which are not coincident and which are not necessarily parallel to one another. In the arrangement shown, the chuck 7 is adapted to releasably hold a key 10 so that the longitudinal axis of the key blade 11 is coincident with the axis 9, and the chuck 8 is adapted to releasably hold a key blank 12 so that the longitudinal axis of the blank blade 13 is coincident with the axis 9.

It is preferred that the chucks 7 and 8 are drivably interconnected so that rotation of one causes rotation of the other. In the particular arrangement shown, that interconnection includes a group of mitre gears which comprises a drive gear 14, a driven gear 15 and at least one idler gear 16. The drive gear 14 is secured to the chuck 7 for rotation therewith, and the driven gear 15 is secured to the chuck 8 for rotation therewith. The preferred arrangement shown includes two idler gears 16, and they transfer drive from the gear 14 to the gear 15 in such a way that the gears 14 and 15 rotate in opposite directions. Such opposite rotation is necessary for the particular apparatus shown, but may not be necessary or appropriate in other situations.

It will be appreciated that gear arrangements different to that described above could be adopted.

The apparatus includes means for driving the chuck 7 so that it rotates or oscillates in a manner consistent with the twisted character of the key blade

11. One suitable form of blade driving means is shown by Figure 3, and includes a cam member 17 having an opening 18 formed therethrough. The opening 18 has a shape which is substantially complementary to the cross-sectional shape of the key blade 11, an example of which is shown by Figure 5 2.

In the arrangement shown, the cam member 17 is attached to a carrier 19 so as to be held against movement relative to that carrier. If desired, the cam member 17 may be removably attached to the carrier 19 so as to permit replacement by another cam member which is adapted to coact with a key blade of different cross-sectional shape. 10

The carrier 19 is mounted for movement in the direction of the axis 9 so as to permit the key blade 11 to be located within the opening 18 of the cam member 17. When the blade 11 is so located, movement of the cam member 17 along the length of the blade 11 causes the blade 11 to rotate or oscillate as a consequence of coaction between the ramp surfaces 4 (Figure 1) of the blade 11 and sloping cam surfaces 20 of the cam member 17. That rotation of the blade 11 will be interrupted each time the cam member 17 reaches and moves across an indexing section of the blade 11, and may occasionally reverse due to the twisted configuration of the blade 11. 15

It will be appreciated that the chuck 8 will rotate in response to rotation of the key blade 11 because of the drive connection 14, 15 and 16. For reasons previously explained, rotation of the chuck 8 will be in a direction opposite to that of the corresponding phase of rotation of the blade 11, but will otherwise follow the pattern and sequence of rotational movement of the blade 11. 20 25

Any suitable means may be used to treat the key blank blade 13 so that it has a configuration the same as that of the key blade 11. In the arrangement shown, the blade forming means includes a tool head 21 which carries two rotatable forming tools 22. By way of example, each forming tool 22 may be a circular or disc-like cutting or grinding tool. It is preferred that the two tools 22 are laterally aligned as shown by Figure 3. A space 23 provided between the outer peripheries of the tools 22 has a width equal to the spacing between two 30

oppositely located indexing surfaces 3 of the key blade 11, and means (not shown) may be provided to enable adjustment of the space 23 to suit different key blades. Any suitable means (not shown) may be used to rotate the tools 22, and the direction of rotation of the tools 22 may be the same or different according to requirements.

In the arrangement shown, the tool head 21 is mounted for movement in the direction of the axis 9, and that movement enables the blank blade 13 to be received within the tool space 23. The apparatus includes means whereby continued movement of the tool head 21 in the direction of the axis 9 is synchronised with movement of the key blade 11 through the cam opening 18. The arrangement is such that movement of the tools 22 along the length of the blade 13 while that blade is being rotated (oscillated) through the drive means 14, 15 and 16, results in the blade 13 being formed to have a configuration (pattern of surfaces 3 and 4) corresponding to the configuration of the blade 11. Figure 3 shows the blade 13 after that forming process has been completed.

It will be appreciated from the foregoing that two movements need to be synchronised. One is the axial movement of the cam member 17 and the tools 22 along the length of the blades 11 and 13 respectively. The other is the rotary, or oscillatory, movement of the blades 11 and 13. In the particular arrangement shown, synchronisation of the rotary, or oscillatory, movement is achieved through the drive means 14, 15 and 16. Synchronisation of the axial movement is achieved in the manner described below.

In the particular arrangement shown, the tool head 21 is mounted on a carrier 24 which is drivably connected to the cam carrier 19. That drive connection can be of any suitable form such as to cause simultaneous, but opposite, movement of the two carriers 19 and 24. In the example shown, the drive connection includes a rotatable gear 25 which engages with each of two gear racks 26 and 27. The rack 26 is connected to or formed integral with the carrier 19, and the rack 27 is connected to or formed integral with the carrier 24.

With the foregoing arrangement, rotation of the gear 25 causes the

carriers 19 and 24 to move simultaneously in reverse directions. Rotation of the gear 25 in one direction draws the cam member 17 over the key blade 11 and simultaneously draws the tools 22 over the blank blade 13. Any suitable reversible drive system (not shown) can be employed to cause rotation of the gear 25.

It is to be understood that the reverse direction movement of the carriers 19 and 24 referred to above may not be required in other forms of the apparatus. It is to be also understood that the axial movements referred to can be synchronised in a manner quite different to that particularly described above.

In a modified form of the apparatus particularly described, a single blade forming tool may be used rather than two as described. Such modified apparatus may be controlled so that the forming tool treats the blade blank to form each of two series of indexing surfaces 3 and associated ramp surfaces 4. The tool may be controlled to alternate between forming part of one series and then part of another, until formation of both series is complete. It is preferred however, to form one series completely before commencing to form the other series.

Another form of key duplicating apparatus is diagrammatically illustrated by Figures 4 and 5. That apparatus includes a blade forming head 30 and a carrier assembly 31 which is movable relative to the head 30. In the arrangement shown, the forming head 30 includes a stylus 32 and a circular cutter 33 which is rotatable about an axis 34. Both the stylus 32 and the cutter 33 are mounted on a fixed member 35 in a manner such that there is no change in their relationship in the direction of the axis 34. The assembly 31 includes an arm 36 which carries two chucks 37 and 38 (Figure 5), or other holding devices, and which is mounted on a support 39 for relative pivotal movement about an axis 40. The support 39 is arranged for movement relative to the head 30 in the direction of the axis 40.

Each of chucks 37 and 38 is rotatable about a common axis of rotation 41 which is substantially parallel to the axis 34. Any appropriate drive means (not shown) can be operable to cause rotation of the chucks 37 and 38, and

any suitable means can be adopted to cause simultaneous and corresponding rotation of each chuck 37 and 38. In one arrangement there is no drive means as such and the chucks 37 and 38 are freely rotatable, but are interconnected to effect simultaneous and corresponding rotation. That interconnection, and the aforementioned interconnection between the styles and the cutter 33, form respective parts of synchronising means as previously discussed. Rotation of the chucks 37 and 38 occurs in response to interaction between a key 1 and the stylus 32 which results from longitudinal movement of the key 1 relative to the stylus 32 while the two members are in engagement. The chuck 37 is adapted to releasably hold an original key 1 so that the longitudinal axis of the blade thereof is substantially coincident with the axis 41. The chuck 38 is adapted to releasably hold a key blank 42 with the longitudinal axis of the blade thereof substantially coincident with the axis 41.

For the purpose of the following description it will be assumed that the apparatus is intended to duplicate a key 1 of the general kind shown by Figure 1. In order to duplicate a key 1 as shown by Figure 1 the stylus 32 is arranged so that the nose 43 thereof (Figure 5) is able to engage with and accurately trace the contour and/or angular disposition of each surface 3 and 4 of the key 1. In operation of the apparatus described, the arm 36 moves backwards and forwards as the blade of the key 1 moves over the stylus 32 and the arm 36 reacts to engagement by the stylus 32. That movement of the arm 36 enables the cutter 33 to cut surfaces in the blank 42 which correspond to the surfaces 3 and 4 of the key 1.

The carrier 39 is moved, by any appropriate means, in the direction of the axis 41 during the surface cutting operation, and that movement may temporarily cease while a surface 3 is being formed. Rotational movement of the chuck 38 may also temporarily cease at that time. The key 1 and the blank 42 may be rotated through 360° in the course of the complete key duplicating operation. In some cases the rotation may be greater or less than 360°. Furthermore, the direction of rotation may reverse on one or more occasions in the course of the duplicating operation.

Apparatus as described above provides a relatively simple and effective

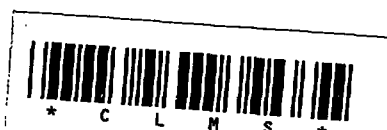
means of duplicating keys of complex configuration.

Various alterations, modifications and/or additions may be introduced into the constructions and arrangements of parts previously described without departing from the spirit or ambit of the invention as defined by the appended

5 claims.

CLAIMS

1. A method of duplicating a key having an elongate blade and at least two
tumbler indexing surfaces formed on the blade at respective positions spaced
apart in the longitudinal direction of the blade, each of said two indexing
5 surfaces having a different angular disposition relative to a reference plane
containing the longitudinal axis of the blade, said method including the steps
of, releasably attaching a said key to a first rotatable device so that the key is
rotatable about the longitudinal axis of the blade thereof, releasably attaching a
key blank to a second rotatable device so that the key blank is rotatable about
10 the longitudinal axis of the blade thereof, forming a duplicate of a first of said
indexing surfaces on the blade of said blank, rotating said two devices in
unison through an angle determined by the relative angular dispositions of said
first indexing surface and a second of said indexing surfaces, and forming a
duplicate of said second indexing surface on said blank blade, each said
15 duplicate surface being formed on the blank blade at an axial position
substantially the same as the axial position at which the indexing surface it
duplicates is located on said key blade.
2. A method according to claim 1, wherein neither said device rotates
during formation of a said duplicate surface.
- 20 3. A method according to claim 1 or 2, wherein said devices are caused to
rotate in response to interaction between said key blade and blade coacting
means, and said interaction occurs during relative movement between the key
blade and the coacting means in the axial direction of the key blade.
4. A method according to claim 3, wherein said duplicate of an indexing
25 surface is formed by forming means connected to said coacting means so that
the position of said key forming means relative to said blank blade in the
longitudinal direction thereof changes in accordance with changes in the
position of said coacting means relative to the key blade in the longitudinal
direction thereof.
- 30 5. A method according to any preceding claim, wherein said duplicate of
the first indexing surface is formed while said blank blade is at a first rotational
position, and said first rotational position is established by the rotational



position of the key blade existing at the time said duplicate of the first indexing surface is being formed.

6. A method according to any preceding claim, wherein said key and said key blank are both rotated through substantially 360° during duplication of the key.

7. A method according to any preceding claim, wherein a sloping ramp surface is formed on the blank blade after said first indexing surface has been formed and before said second indexing surface duplicate is formed, and said ramp surface extends between the two said duplicates.

8. Apparatus for duplicating a key having an elongate blade and at least two tumbler indexing surfaces formed on the blade at respective positions spaced apart in the longitudinal direction of the blade, each of said two indexing surfaces having a different angular disposition relative to a reference plane containing the longitudinal axis of the blade, said apparatus including first and second rotatable devices for releasably holding a said key and a key blank respectively so that the key and the key blank are rotatable about the longitudinal axis of their respective blades, forming means engageable with the blade of said key blank so as to form an indexing surface thereon, said forming means and said key blank being relatively movable in the axial direction of the key blank blade, synchronising means causing said devices to rotate in unison during at least part of said relative movement in the axial direction of said key blank blade so that the key blank is rotated through an angle the same as the relative angular disposition of two adjacent said indexing surfaces of the key, and said synchronising means controls the position of said forming means such that each time the forming means is operative to form a said indexing surface the position of said forming means relative to the longitudinal axis of the key blank blade is substantially the same as the position of a said indexing surface of the key blade relative to the longitudinal axis of that key blade.

9. Apparatus according to claim 8, wherein said synchronising means causes said devices to cease rotation during formation of a said indexing surface by said forming means.

10. Apparatus according to claim 8 or 9, wherein said synchronising means



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includes a drive connection between the two said devices whereby said second device is caused to rotate in response to rotation of said first device.

11. Apparatus according to any one of claims 8 to 10, including blade coacting means arranged to be engaged by said key blade and coacting therewith so as to cause rotation of the key blade in response to relative movement of the coacting means and the key blade in the axial direction of the key blade.

12. Apparatus according to claim 11, wherein said first device rotates in response to said rotation of the key blade.

13. Apparatus according to claim 11 or 12, wherein said coacting means includes a cam member having an opening therethrough, said opening having a shape substantially complementary to the cross-sectional shape of the key blade, and said coaction results from said relative movement in the axial direction of the key blade while said key blade is located within said opening.

14. Apparatus according to claim 13, wherein said cam member is releasably attached to a carrier to permit removal and replacement by a cam member of different configuration.

15. Apparatus according to claim 13, wherein said cam member and said forming means are mounted on separate carriers arranged for relative movement in the longitudinal direction of the key blade, and said synchronising means includes drive means interconnecting the two carriers so that they move in unison in said longitudinal direction.

16. Apparatus according to claim 15, wherein said drive means includes two gear racks, each of which is connected to a respective one of said carriers, and a rotatable gear engaging each of said racks.

17. Apparatus according to claim 11 or 12, wherein said coacting means includes a stylus adapted to bear against the key blade.

18. Apparatus according to any one of claims 11 to 14, wherein said synchronising means includes an interconnection between said coacting means and said forming means such that said forming means and said key blank are caused to move relative to one another in the axial direction of the key blank blade in response to said relative movement between the coacting



means and the key.

19. Apparatus according to any one of claims 8 to 18, wherein said forming means includes at least one rotatable forming tool.

20. Apparatus according to claim 19, wherein two said forming tools are
5 provided, and said key blade is located between said forming tools and is treated by each said tool during the said indexing surface forming operation. -

