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(54) CYLINDER LOCK AND KEY SYSTEM

(57) A cylinder lock and key system including cylinder locks and keys. The locks comprises a housing having a cylindrical bore; and
a cylindrical plug (200, 600) which is rotatably journaled in the housing about a rotational axis and which exhibits a front end and a keyway (206, 606), which extends axially from an entrance opening at the front end. The keys (100, 300, 400, 500, 700) comprises a key bow (102, 302, 402, 502); and a key blade (104, 304,404, 504) extending forwardly from the key bow to a key tip. the key blade is insertable in a forward longitudinal direction to a fully inserted position in the keyway of corresponding locks and rotatable about the rotational axis when inserted. The plugs and keys are provided with cooperating stop surfaces for defining the fully inserted position of the keys in the keyways. The cooperating stop surfaces comprise at least two first stop surfaces (120a, 120b, 320a, 320b, 420a, 420b, 420c, 520a, 520b) arranged at the key blade (104, 304, 404, 504) of each key, each first stop surface facing forward in the insertion direction and being positioned at a selected one of a predetermined number of selectable axial positions. At least two second stop (220a, 220b, 620a, 620c) surfaces are arranged in the keyway (206, 606) of each plug, each second stop surface being positioned at a selected one of the predetermined number of selectable axial positions. The first and second stop surfaces are arranged such that at least one first stop surface is in contact with a corresponding second stop surfaces when a correct key is fully inserted in the keyway of a corresponding lock. Each first stop surfaces (120a, 120b, 320a, 320b, 420a, 420b, 420c, 520a, 520b) is defined by a respective forwardly open, through penetrating recess (122a, 122b, 422a, 422b) arranged at the key tip (105, 305,405, 505). Each second stop surface (220a, 220b, 620a, 620c) is defined by a respective stop member (222a, 222b, 622a, 622c) which is arranged in the keyway and extends laterally over the entire cross section of the keyway.

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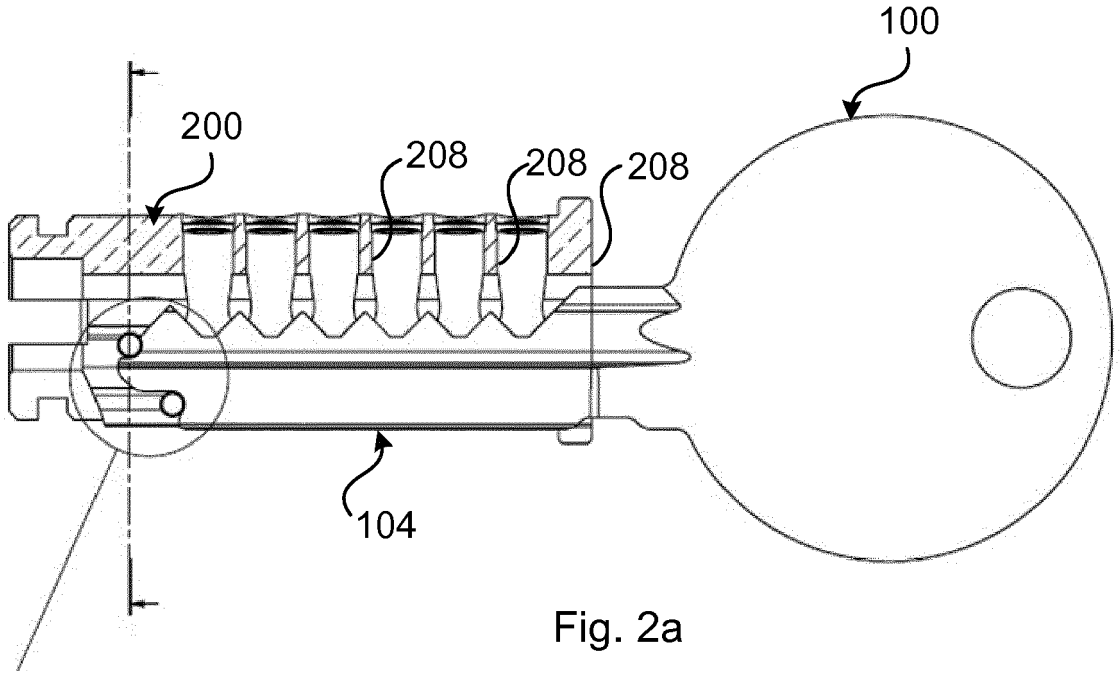

Fig. 2a

Description

Background

[0001] The invention concerns a cylinder lock and key system comprising a plurality of cylinder locks and a plurality of keys, each key being arranged for operating at least one of the cylinder locks. Particularly, the invention concerns a master key system wherein at least one key is arranged to operate several of the locks comprised in the system. The invention also concerns a cylinder lock and key combination for such a system as well as a key and a key blank for producing a key for such a system.

[0002] Cylinder locks comprise a housing or stator with a cylindrical axial bore housing a cylindrical rotatable plug, core or rotor. The plug exhibits an axial keyway for insertion of a key provided with a code. The plug is further provided with code sensing members which detect the code of the inserted key and which allows rotation of the plug in the housing only when a key having a correct code, which corresponds to the lock in question, is fully inserted into the keyway.

[0003] There exist several general types of cylinder locks, such as pin tumbler locks and disc tumbler locks. The pin tumbler locks comprise radially displaceable pin tumblers which are arranged in the plug and housing, to sense or detect a code arranged at an edge and/or a side of the key blade. Keys where the code is formed as axially spaced code surfaces arranged at different heights or radial positions along the edge of the key blade normally exhibits a saw teeth like shape and are sometimes referred to as cut keys or conventional notched keys. Another type of keys is the so called dimpled keys, where the code is formed of a number of normally conical recesses formed in the sides and/or edges of the key blade. These and other general types of cylinder locks and corresponding keys are well known in the art and are not further described here.

[0004] In order for the code sensing members to be able to correctly detect the code of the key, the key needs to be inserted to a well defined position in the keyway when detection is made. This position is normally referred to as the fully inserted position of the key in the keyway. Traditionally, the fully inserted position is defined by a collar or shoulder arranged at the key, at the junction between the key blade and the key bow. The shoulder exhibits a stop surface which is facing the front end of the plug and the front end of the plug exhibits a corresponding stop surface. Alternatively the fully inserted position may be defined by a stop surface arranged at the tip of the key, which surface makes contact with a stop member arranged at a rear portion of the keyway For operating the lock from its locked to its unlocked mode, the key is inserted until the two stop surfaces make mutual contact and prevent further insertion of the key. The key has then reached the fully inserted position, at which the code sensing members of the plug are radially aligned with the respective intended code surfaces of the key. If the key is a correct key, i.e. a key having the correct code for the lock in question, the code surfaces of the key, at this key position, are arranged such that the code sensing members will release the plug from the housing. Thereby the plug may be rotated relative to the housing, e.g. by means of the key bow, for manoeuvring the lock to its unlocked mode.

[0005] Lock and key systems referred to as master key systems are systems comprising a plurality of locks and keys which are arranged in a hierarchic order. For example, some keys may be configured to operate only one respective lock, whereas other keys may be configured to operate several different locks and one or several yet other keys, so called grand master keys, may be configured to operate all locks in the system. Correspondingly, some locks may be configured to be operated by only one key at each hierarchic level, whereas other locks may be configured to be operated by several keys at each hierarchic level. Such master key systems find great use e.g. in office buildings, hospitals, within companies and the like, where it is desirable to control the access to certain doors for each key holder. However, less complicated master key systems are also frequently used at e.g. apartment blocks where e.g. tenants should have access to only one or a few doors, whereas landlords and service personnel should have access to several and in some instances all doors in the building.

[0006] Especially at comparatively complicated master key systems involving great numbers of locks and keys as well as many hierarchic levels and sophisticated access combinations it is of great importance that the possible number of permutations for the correct lock and key code combinations are high. One way of increasing the number of possible permutations in a system is to increase the number of pin or disc tumblers in the plugs and the corresponding number of axial code surface positions at the keys. Another way is to increase the number of selectable code heights at each axial code surface position at the keys, i.e. to decrease the pitch between the possible code heights for each pin or disc tumbler. Yet another way to increase the number of permutations in a system is to vary the profiles, i.e. the cross sectional shapes of the keyway and the key blades. However, these ways of increasing the number of possible permutations of a system are limited and, in practice, suffer from some disadvantages. It would therefor be advantageous to find another simple, reliable and readily applicable way to increase the number of possible permutations in master key systems.

Prior art

[0007] EP o 637 663 B1 discloses a key and lock combination wherein the key is provided with a first stop surfaces for defining the fully inserted position when inserting the key into the lock and a further stop surface for defining the fully inserted position when the key is inserted into a key copying machine. By separating the two

stop surfaces axially from each other it is achieved that unauthorized persons can not produce a true copy of an original key by means of fully inserting a key blank into a regular key copying machine.

[0008] EP 1523 603 B1 discloses a lock and key combination wherein a reversible key is provided with two shoulders arranged at a respective edge of the key blade. Each shoulder exhibits a forwardly facing stop surface and is provided with a recess forming a laterally facing additional control surface. The lock comprises a plug provided with a keyway and a recess formed in the front end of the plug. The recess defines a forwardly facing stop surface interacting with one of the stop surfaces of the key and a laterally facing additional control surface interacting with a corresponding one of the lateral control surface of the key. By this means, it is possible to increase possible variations of the cross sectional profiles of the corresponding keyways and key blades.

[0009] US 2,065,294 discloses a lock and key combination wherein a non-reversible key is provided with two stop surfaces arranged at opposite edges of the key blade. One of the stop surfaces is arranged at the coded edge of the key blade and the other stop surface is arranged at the spine edge of the key blade. The core is provided with two corresponding stop surfaces each cooperating with a respective one of the key's stop surfaces. By utilizing two pairs of stop surfaces the number of permutations may be increased.

[0010] EP 1048 804 A1 discloses a locking system comprising a key and a lock cylinder with a keyway. The lock and the key are provided with stop elements for defining the maximum insertion depth of the key. The stop elements are arranged such that they are positioned in the keyway spaced apart from the key tip and from the ends of the cylinder when the key is fully inserted in the keyway. The key further comprises a reference element for defining a correct position of the key during the milling process for producing the key from a key blank. The reference element is arranged to lie outside of the key way and spaced apart from the ends of the cylinder when the key is fully inserted in the keyway.

Summary of the invention

[0011] It is an object of the present invention to provide an enhanced cylinder lock and key system.

[0012] Another object is to provide such a system which exhibits a high degree of security and which renders it difficult to wrongfully produce unauthorized keys.

[0013] A further object is to provide such a system at which a comparatively high number of possible permutations may readily be achieved.

[0014] Yet another object is to provide such a system which is reliable in use.

[0015] Still an object is to provide such a system at which the cylinder locks and the keys are backward compatible such that cylinder locks and keys according to the invention may be utilized in already existing systems.

[0016] A still further object is to provide such a system at which the cylinder locks may be of the modern type having plugs in which the keyway extends radially in one direction all the way to the periphery of the plug, thereby forming a keyway which is open in one radial direction.

[0017] These and other objects are achieved by a cylinder lock and key system as defined in the preamble of claim 1 and which exhibits the special technical features defined in the characterizing portion of that claim.

[0018] A cylinder lock and key system includes cylinder locks and keys. The cylinder locks are of the kind comprising a housing having a cylindrical bore; and a cylindrical plug which is rotatably journaled in the housing about a rotational axis and which exhibits a front end and a keyway, which extends axially from an entrance opening at the front end. The keys are of the kind comprising a key bow and a key blade extending forwardly from the key bow to a key tip. The key blade is insertable in a forward longitudinal direction to a fully inserted position in the keyway of corresponding locks and rotatable about the rotational axis when inserted. The plugs and keys are provided with cooperating stop surfaces for defining the fully inserted position of the keys in the keyways. The cooperating stop surfaces comprise at least two first stop surfaces arranged at the key blade of each key, each first stop surface facing forward in the insertion direction and being positioned at a selected one of a predetermined number of selectable axial positions, and at least two second stop surfaces arranged in the keyway of each plug, and being positioned at a selected one of the predetermined number of selectable axial positions. The first and second stop surfaces are arranged such that at least one first stop surface is in contact with a corresponding second stop surfaces when a correct key is fully inserted in the keyway of a corresponding lock. Each first stop surfaces is defined by a respective forwardly open, through penetrating recess arranged at the key tip; and each second stop surface is defined by a respective stop member which is arranged in the keyway and which extends laterally over the entire cross section of the keyway.

[0019] By arranging at least two forwardly facing first stop surfaces at axially selectable positions at the key blade and a corresponding number of oppositely facing second stop surfaces at a corresponding number of selectable positions in the keyway, it is possible to require that any key and lock combination exhibits a correct configuration of the first and second stop surfaces for allowing the key to be inserted into the fully inserted position. By this means it is possible to define a number of possible permutations for the system merely by arranging the stop surfaces at different axial positions.

[0020] It is for example possible to provide the keys with two first stop surfaces which each may be positioned at any one of three different selectable axial positions and the plugs with two corresponding second stop surface which also may be positioned at any one of three corresponding selectable positions.

[0021] Hereby it is possible to achieve $3^2 = 9$ possible combinations merely by means of the cooperating stop surfaces. The system may also be given permutations in a traditional manner by the arrangement of the tumblers and the code surfaces on the keys as well as by variation of the keyway and key blade profiles. At this example, the total number of possible system permutations equals the number of traditionally accomplished permutations multiplied by 9. The cooperating first and second stop surfaces thus provides for that the total number of system permutations may be manifold increased in a simple and yet reliable manner. By varying the stop surface combinations it is also possible distinguish different groups of lock and key combinations e.g. within a master key system. For example the stop surface combinations may be used to differentiate lock and key combinations that are intended for different countries, different retailers or different customers and the like.

[0022] The arrangement of the first stop surfaces being defined by a respective forwardly open, through penetrating recess arranged at the key tip further allows for that the keys and key blanks comprising the first stop surfaces may readily be produced by simple cutting operations, such as by means of stamping or punching. The arrangement of the second stop surfaces being defined by a respective stop member which is arranged laterally in the keyway, from one side to the other further allows for a comparatively easy way to fix the second stop surfaces at the desired positions in the key way. The fact that the second stop surfaces are arranged inside the keyway also renders it difficult to observe or detect the positions of the second stop surfaces. This in turn makes it more difficult for unauthorized persons to produce keys which may be used for operating the lock in question.

[0023] At least one first stop surface may be curved and at least one stop member may exhibit a correspondingly curved surface forming a second stop surface At least one curved first stop surface may exhibit a constant radius of curvature and the at least one second stop surface may exhibit a radius of curvature which is essentially equal to the radius of curvature of the at least one first stop surface.

[0024] The at least one stop member may be cylindrical.

[0025] The keys may be provided with a number of code surfaces arranged one after the other in the longitudinal direction of the key blade; and the plugs may be provided with radially displaceable pin tumblers, each code surface being arranged to cooperate with a corresponding pin tumbler when the key blade is fully inserted in the keyway, and at least one first stop surface may be positioned longitudinally in front of the front most code surface.

[0026] Each first stop surface may be positioned axially in front of the front most code surface.

[0027] The keys may be dimpled flat keys at which the code surfaces are arranged as depressions formed in at least one key blade side and aligned along a longitudinal code line and the key tip may exhibit a slanting guide surface arranged at the code line for guiding pin tumblers onto said key blade side, which guide surface is free of through penetrating recesses defining a first stop surface.

[0028] The guide surface may be arranged between two first stop surfaces.

[0029] The key tip may be pointed with a front most apex and at least one first stop surface may be arranged at each side of the apex.

[0030] The key tip may exhibit a forwardly facing front edge and at least two first stop surfaces may be formed as depressions in the front edge, which depressions extend through the cross section of the key blade and in the longitudinal direction of the key blade..

[0031] At least one key may be a reversible key, the key blade of which exhibits at least two primary first stop surfaces and at least two secondary first stop surface; and the primary and secondary first stop surfaces may be arranged symmetrically with regard to a longitudinal centre axis of the key blade.

[0032] At least one first stop surface may be arranged at the longitudinal centre axis of the key blade and may constitute both a primary and a secondary first stop surface.

[0033] The keys may be provided with a code arranged at the key blade for cooperating with corresponding pin tumblers of the plugs, which code exhibits a code cut angle α and code surfaces which are radially separated by an integer multiple of a code surface pitch, p, and wherein the selectable axial positions for the first and second stop surfaces are axially separated by a stop separation distance q, wherein $q \geq 0{,}5 * p * \tan \alpha$.

[0034] The invention also relates to a cylinder loch and key combination, a key for a cylinder loch and key system, a key blank for producing such a key and a cylinder lock for a cylinder lock and key system which exhibits the same objects and advantages as the system. The cylinder lock and key combination, the key, the key blank and the cylinder lock exhibit objectives, features and advantages corresponding to those of the system.

[0035] The first and second stop surfaces may thus be applied to cylinder lock and key combinations comprising merely one cylinder lock and one or a few keys. At such cases, the concealed arrangement of the second stop surfaces will make unauthorized key production difficult. Additionally, the possible first and second stop surface combinations may be used for differentiating several lock and key combinations one from the others. Correspondingly, when the first stop surfaces are applied to keys and key blanks, unauthorized key production and key copying is prevented or made difficult.

[0036] Further objects and advantages of the invention appear from the description of embodiments below and from the appended claims.

[0037] Generally, all terms used in the claims are to be interpreted according to their ordinary meaning in the technical field, unless explicitly defined otherwise herein.

All references to "a/an/the element, apparatus, component, means, step, etc." are to be interpreted openly as referring to at least one instance of the element, apparatus, component, means, step, etc., unless explicitly stated otherwise. The steps of any method disclosed herein do not have to be performed in the exact order disclosed, unless explicitly stated. If not specified differently, a radial direction of a key is to be understood as a direction which is radial to the axis of rotation when the key is inserted in a plug and rotated therewith.

Brief description of the drawings

[0038] In the following detailed descriptions of exemplifying embodiments will be given with reference to the figures, in which:

Fig. 1a is a side view of a key comprised in a cylinder lock and key system according to one embodiment of the inversion and fig. 1b shows a detail thereof in enlarged scale. Fig. 1c is a perspective view of the key shown in fig. 1a. Fig 1d shows a detail thereof in enlarged scale.

Fig. 2a is a longitudinal section showing the key shown in fig. 1a when inserted into a plug. Fig 2b is a front view of the key inserted into the plug. Fig. 2c is a cross section through fig. 2a. Fig 2d shows a detail in enlarged scale of fig 2a.

Fig. 3a is a side view of the key shown in fig 1a and fig 3b shows a detail thereof, in enlarged scale.

Fig. 4a is a side view of another key and fig. 4b shows a detail thereof in enlarged scale. Fig. 4c is an opposite side view of the key shown in fig 4a.

Fig. 5a is a side view of a further key and fig. 5b shows a detail thereof in enlarged scale. Fig. 5c is an opposite side view of the key shown in fig. 5a. Fig. 5d is a perspective view of the key shown in fig 5a and fig. 5e shows a detail in enlarged scale thereof.

Fig. 6a is a side view of yet another key and fig. b is a perspective view thereof. Fig. 6c shows a detail in enlarged scale of fig. 6b and fig. 6d is a side view of the detail shown in fig. 6c.

Fig. 7a is a perspective view showing the key of fig 6a inserted into a plug. Fig 7b is a side view of the key and plug of fig. 7a and fig 7c shows a detail in enlarged scale thereof. Fig. 7d is a perspective view of the detail shown in fig. 7c.

Fig. 8a is a longitudinal section showing a detail of a key inserted into a plug and fig. 8b is a corresponding section showing the same key inserted into another plug,

Detailed description of embodiments

[0039] Figs. 1a-d illustrates a key 100 comprised in a cylinder lock and key system according to an embodiment of the invention. The key 100 comprises a key bow 102 and a key blade 104 which protrudes in a forward longitudinal direction from the key bow 102 to a key tip 105 of the key blade 104. The key tip 105 constitutes a front most portion of the key blade 104. The key blade 104 exhibits a profiled cross section as seen in fig. 1d. The key blade 104 further exhibits a first key blade side 106 and a second key blade side 108 which is arranged in parallel with and opposite to the first key blade side 106. The key blade sides 106, 108 are joined by a lower key blade edge 110 and an upper key blade edge 112. The upper key blade edge 112 is provided with a code 114 which has been cut into the upper edge 112. The key 100 is thus a so called swan or cut key. The key is further insertable into the plug 200 shown in figs. 2a-d.

[0040] The key blade 104 exhibits a height direction which is parallel with the key blade sides 106, 108 and perpendicular to the longitudinal direction of the key blade 104. The height increases in the direction from the lower key blade edge 110 towards the upper key blade edge 112.

[0041] The code 114 comprises several code surfaces 116', 116" arranged one after the other at positions which are fixed in the longitudinal direction. As best seen in figs 1a-b, the code surface 116' is arranged at a front most code position whereas the other code surfaces 116" are arranged at code positions being further spaced apart from the key tip 105.

[0042] At this embodiment, the key tip 105 is constituted by the portion of the key blade 104 which is arranged longitudinally in front of the front most code position, i.e. in front of the axial code position where code surface 116' is situated. Further, at this example the key tip 105 is pointed and comprises a front most apex 105a.

[0043] Each code surface 116', 116" is arranged to be aligned with and come in contact with a respective tumbler pin (not shown) when the key 100 is inserted in the plug of a cylinder lock for which the key is intended. The code surfaces 116', 116" are arranged at different possible code surface depths which may be measured as the code surface distance from the lower edge 110 of the key blade 104. The possible code surface depths are separated in the height direction by a code pitch which is the smallest distance in the height direction by which the code surfaces may be separated.

[0044] The key 100 is provided with two first stop surfaces 120a, 120b. The first stop surfaces 120a are arranged for defining a fully inserted position when the key blade 104 is inserted into the plug 200. In the example shown in figs. 1a-d the first key stop surfaces 120a, 120b are defined by a respective through penetrating recess 122a, 122b which are formed in the in a front edge of the

key blade 104. The recesses 122a, 122b are open forwardly such that the first stop surfaces 120a, 120b faces in the forward direction. The first stop surfaces 120a, 120b are arranged at a respective side of the key tips' 105 apex 105a. One of the first stop surfaces 120a is arranged above the apex 105a and forms an upper first stop surface, whereas the other first stop surface 120b is arranged below the apex 105b and forms a lower first stop surface.

[0045] Both the upper 120a and the lower 120b first stop surface are concavely curved with a constant radius of curvature. The radius of curvature is the same for both first stop surfaces 120a, 120b.

[0046] In the example shown in figs. 1a-d the recesses 122a, 122b have been formed a punching operation when forming the key blank. It is however also possible to form the recess in many other ways such as by a milling operation using a cylindrical cutter. The first stop surfaces 120a, 120b which are formed by the rear edges of the respective recesses 122a, 122b are thus formed as respective forwardly facing segments of a cylindrical inner envelope surface.

[0047] In the example shown in figs. 1a-d, both first stop surfaces 120a, 120b are arranged longitudinally in front of the front most code position where code surface 116' is arranged. Arranging the first stop surfaces 120a, 120b in front of the front most code position allows for a greater possibility to freely choose the vertical position of the first stop surfaces 120a, 120b since there is no risk that the first stop surfaces 120a, 120b will interfere with any of the code positions. This advantage especially applies to the upper first stop surface 120a which may be arranged above the greatest possible code depth.

[0048] Figs. 2a-d illustrate the key 100 when it has been fully inserted into a plug 200 of a cylinder lock which forms part of the cylinder lock and key system in which the key shown in figs. 1a-d forms part. The plug 200 is intended to be rotationally received in a cylindrical bore of a lock housing as is well known in the art. The plug 200 exhibits a front end 202 and a rear end 204. A keyway 206 extends axially from the front end 202 toward the rear end 204 and exhibits a keyway opening at the front end 202. The keyway 106 further extends in one radial direction to the envelope surface of the plug 200 such that the keyway 106 forms a slit in the plug 200. A number of pin tumbler channels 208 are arranged radially in the plug 200 such that they debouch in the keyway 206, one after the other in the axial direction of the plug 200. Each pin tumbler channel 208 receives a radially displaceable pin tumbler (not shown). By insertion of the key blade 104 in the keyway 206, the coded upper key blade edge 112 will contact the inner ends of the pin tumblers and displace the pin tumblers radially in the pin tumbler channels 208. If a correct key blade 104 is fully inserted into the key channel 206 all pin tumblers will be displace to a position where their outer ends are in level with the outer envelope surface 212 of the plug 200 such that the plug may be rotated in the housing (not shown). This functioning of a cylinder lock is well known in the art and is not further described here.

[0049] As seen in figs 2a-d, the plug is provided with stop members 222a and 222b defining a respective second stop surface 220a, 220b. As best seen in fig. 2c the stop members 222a, 222b are each formed of a cylindrical pin which extends transversely through the keyway 206. In fig. 2c only the upper stop member 222a is shown. The stop members 222a, 222b are received in a respective bore 224a which extends transversely through the plug 200. The bore 224a is through penetrating the plug 200 and intersects the keyway 106. The stop members 222a, 222b thus extend laterally over the entire cross section of the keyway 106. In the shown example the stop members 222a, 222b are fixed in position by being press fitted in their respective bore 224a.

[0050] The two stop members 222a, 222b are cylindrical with essentially the same but preferably somewhat smaller radius as the radius of curvature of the first stop surfaces 120a, 120b. The curvature of the second stop surfaces 220a, 220b are thus essentially the same as the curvature of the first stop surfaces 120a, 120b on the key 100. Each stop member 222a, 222b exhibits a forwardly facing surface formed as a segment of a cylindrical outer envelop surface. These surfaces constitute the second stop surfaces 220a, 220b for defining the fully inserted position of a key in the keyway 206.

[0051] The key 100 shown in figs. 1a-d is a correct key for the plug 200 shown in figs. 2a-d. When the key 100 in inserted into the keyway 206 it may be advanced until the first stop surfaces 120a, 120b make contact with a respective second stop surface 220a, 220b in the keyway 206. By making the radius of curvature somewhat smaller for the second stop surfaces than the radius of curvature of the first stop surfaces, it is assured that the second stop surfaces may make contact the first stop surfaces without the risk that the stop members 222a, 222b will be squeezed or jammed by the first stop surfaces 120a, 120b.

[0052] The key 100 has then assumed the correct fully inserted position whereby code surfaces of the coded edge 112 are correctly aligned with corresponding pin tumblers (not shown) of the plug 200. The pin tumblers are then lifted to a position where their outer ends are in level with the outer envelope surface 212 of the plug 200 and thereby at the shear line between the plug 200 and the housing (not shown). The plug may then be rotated relative to the housing, e.g, by means of turning the key 100.

[0053] In the example shown in figs. 1a-d and 2a-d, both pairs of first 120a, 120b and second 220a, 220b stop surfaces are arranged to be in simultaneous contact when defining the fully inserted position. It should however be noted that it is sufficient that only one pair of first and second stop surfaces, e.g. 120a and 220a or 120b and 220b are arranged to be in contact for defining the fully inserted position. In cases where the key and plug are provided with more than two first and second stop

surface any number of pairs of stop surfaces, from one to the number of first and second stop surfaces may be arranged to be in contact for defining the fully inserted position.

[0054] As readily understood, insertion of a key having no first stop surfaces or where the positons of the first stop surfaces do not correctly correspond to the positions of the second stop surfaces of the plug in question, will result in that the key is not correctly positioned in the keyway, when the key blade is stopped by some key blade portion coming in stopping contact with a portion of the plug.

[0055] In the cylinder lock and key system, each of the first stop surfaces 120a, 120b on each key comprised in the system may be axially positioned at any one of a predetermined number of possible first stop surface positions. Figs. 3a and b show the key 100 and indicate that, at the system in which the key 100 is comprised, one of the first stop surfaces may be positioned at either of two possible axial positions 120a or 120a'. The other first stop surface may be positioned at any one of two possible axial positions 120b or 120b'. Even though not illustrated in the drawing, plugs comprised in this system are arranged such that each second stop surfaces may be positioned at any one of two corresponding possible second stop surface positions.

[0056] With the shown example it is thus possible to increase the number of system permutations simply by varying the positions of the first 120a, 120b and the second 220a, 220b stop surfaces.

[0057] Figs. 4a-e illustrate a key 300 which forms part of another cylinder lock and key system according to the invention. The key 300 is a sawn flat key with a key bow 302 and a key blade which extends forwardly to a key tip 305. The key tip 305 is pointed with a front most apex 305a. The key blade 304 exhibits opposing key blade sides 306, 308 and an upper key blade edge 312 comprising a cut code 314 with a front most code surface 316' and a number of code surfaces 316" arranged rearward of the front most code surface.

[0058] The key blade 304 is provided with two first stop surfaces 320a, 320b. One first stop surface is arranged above the apex 305a, and the other first stop surface 120b is arranged below the apex 305a. Both stop surfaces 320a, 320b are defined by a respective cut through the key tip 305. At this example the first stop surfaces are formed as forward facing planar surfaces. The planar surfaces extend perpendicular to the longitudinal axis of the key blade 304.

[0059] Even though not illustrated it is realized that a cylinder plug comprised in this system could be of the type shown in figs. 2a-d having cylindrical stop members defining convex second stop surfaces which in contact with either or both first stop surfaces 320a, 320b define the fully inserted position for the key blade 305 in the keyway. However, it would be preferable to form the stop members extending through the key way of pins having square, rectangular, triangular or other non-circular cross sections. By this means one of the outer side surfaces of the stop members could be planar and could be oriented facing forward in the keyway such as to achieve a greater contact surface between the respective first and second stop surfaces. By this means a better definition of the fully inserted position is achieved at the same time as wear of the first and second stop surfaces is reduced.

[0060] Figs 5a-e illustrate a key 400 comprised in a further cylinder lock and key system according to the invention. This key 400 is a reversible dimpled flat key. The key comprises a key bow 402 and a key blade 404 which extends forwardly from the key bow to a key tip 405. The key blade 404 exhibits a first key blade side 406 and an opposite second key blade side 408. A lower 410 and an upper 412 key blade edge connects the key blade sides 406, 408.

[0061] A first code 414a is formed in the left hand key blade side 406, as seen in the forward direction of the key blade. A second code 414b is formed in the opposite, right hand key blade side 408. Both codes 414a, 414b comprise a number of cavities or dimples 416a', 416a", 416b', 416b" which are recessed into the respective key blade side 406, 408. Each dimple defines, at its bottom, a code surface which may be positioned at any one of e predetermined number of possible code depths. The code surfaces are arranged to cooperate with pin tumblers (not shown) of the plug in a manner which is well known in the art. The dimples 416a', 416a", 416b', 416b" are aligned, one after the other, along a respective code line 425a, 425b, which are parallel to the longitudinal direction of the key blade 404, at the respective key blade side 406, 408.

[0062] In the region of the key tip 405, the key blade 404 exhibits a forwardly facing front edge 405a. Each key blade side 406, 408 exhibits a slanting guide surface 430a, 430b. The slanting guide surfaces 430a, 430b are aligned with the respective code line 425a, 425b and tappers in the forward direction. The slanting guide surfaces 430a 430b are so arranged for allowing the pin tumblers (not shown) of the plug to be guided upon to the respective key blade side 406, 408 when the key blade 404 is inserted to the keyway and the front edge 405a makes contact, one by one, with the pin tumblers protruding into the keyway.

[0063] At this example, the key blade 404 is provided with three first stop surfaces 420a, 420b, 420c. Each first stop surface is defined by a respective forwardly open recess 422a, 422b, 422c which is formed in the front edge 405a and which penetrates the entire thickness of the key blade 404. One of the first stop surfaces 420c is arranged at the longitudinal centre line of the key blade 404. This first stop surface 420c may thus make contact with a second stop surface (not sown) which is arranged vertically centred in the keyway of a corresponding plug. The other first stop surfaces 420a, 420b are arranged symmetrically with respect to the longitudinal centreline of the key blade 404. Thus, they are positioned at the same distance from the longitudinal centreline of the key

blade 404 and at the same axial position. By this means the key blade 404 may be inserted into the keyway in any of two rotational orientations separated by 180° about the longitudinal centre axis of the key blade with the effect that the same first stop surface configuration will be presented to a plug having two second stop surface. Expressed differently, the key blade 404 shown in figs. 5a-e comprises two primary first stop surfaces 420a, 420c and two secondary first stop surfaces 420b, 420c which are arranged symmetrically with respect to the longitudinal centre axis of the key blade 404. The centre first stop surface 420c constitutes both at primary and a secondary stop surface and may make contact with a corresponding centrally positioned second stop surface, irrespective of at which rotational orientation the reversible key is inserted into the keyway of the plug.

[0064] As best seen in fig 5b the slanting guide surfaces 430a, 430b are free of any recesses defining at first stop surface. By this means it is achieved that the first stop surfaces 420a, 420b, 420c will not interfere with the guiding of the pin tumblers up to the key blade sides 406, 408 comprising the dimples. Instead, at least one first stop surface is arranged at each side of the code lines 425a, 425b and slanting guide surface 430a, 430b. By this means the available space for forming the first stop surfaces 420a, 420b, 420c at the key tip 405 is efficiently utilized. While not shown, the same advantage of arranging at least one first stop surface at each vertical side of a slanting guide surface applies also to dimpled keys which are not reversible and where the first stop surfaces need not to be arranged symmetrically with respect to the longitudinal centre axis of the key blade.

[0065] Figs. 6a-d show a further example of a key 500 comprised in a cylinder lock and key system. The key 500 is a revisable dimpled key with a key blade 504, a key tip 505 and a forwardly facing front edge 505a. The key blade 504 exhibits two primary first stop surfaces 520a, 520c. One of the primary stop surfaces 520a may be positioned at any one axial position of a first set comprising three selectable axial positions, illustrated in the drawings as a=+1, a=o and a=-1. The selectable axial positions of the first set are equidistantly separated by the axial distance q. The other primary first stop surface 320c is positioned at one of a second set of selectable axial positions b=+i, b=o and b=-1. Also these selectable axial positions are separated by the same axial distance q. The first set of selectable axial positions a is axially offset the second set of selectable axial positions b. At an embodiment which is not shown, the first set may be axially of set the second set by a distance q/2.

[0066] Even though not illustrated in fig. 6d, it is understood that, since the key 500 is reversible, also the secondary first code surface 520b may be positioned at any one of the three selectable positions of the first set and that the selected position for secondary first stop surface 520b should be the same as the position selected for primary stop surface 520a.

[0067] The same principle of positioning the at least two first stop surfaces at different sets of selectable axial positions may be applied also to keys which are not reversible, such as to the key 100 shown in figs. 1a-d, the key 300 shown in figs. 4a-e and also to the reversible key 400 shown in figs. 5a-e.

[0068] The plugs intended for receiving keys with first stop surfaces arranged at selectable axial positions as described above have second stop surfaces which may be positioned at corresponding selectable axial positions.

[0069] Figs. 7a-d show the key 500 when it has been fully inserted into a plug 600. As best seen in figs. 7c and 7d the plug comprises two stop members 622a, 622c which define a respective second stop surface 620a, 620c. In the fully inserted position of the key blade 504 into the keyway 606, the primary first stop surface 520a makes contact with one of the second stop surfaces 620a and the other primary first stop surface makes contact with the other second stop surface 620c. As readily understood, if the key was inserted in a reversed rotational orientation first contact surface 520c would still make contact with second stop surface 620c whereas secondary first contact surface 520b would make contact with second contact surface 620a, thereby defining the same fully inserted position as shown in fig 7c.

[0070] From fig. 7c it is also seen that the recess 522c defining the first stop surface 520c extends longer from the front edge 505a than the diameter of the stop member 622c defining the second stop surface 620c. The longitudinal depth of the forwardly open recess 522c from is thus greater than the dimension of the stop member 622 in the same longitudinal direction. By this means a portion of the key tip 505 protrudes in front of the stop member 622c when the key has reached is fully inserted position. This allows for that the portion of the key tip 505 which, in the fully inserted position, protrudes in front of at least one stop member 622c may be utilized for making contact with a movable auxiliary control or latch means (not shown) which may be arranged in the plug 600 for providing additional security.

[0071] The same principle of dimensioning at least one forwardly open, first stop surface defining, recess in relation to the dimensions of a second stop surface defining stop member, such that a portion of the key blade, in the fully inserted position, extends in front of said stop member may also be applied also other embodiments of the invention. For example, this principle has been applied at the embodiment shown in fig. 2d where the apex 105a and a further a portion of the key tip 105 protrudes in front of the entire stop member 22b.

[0072] The above described arrangement of the selectable axial positons for the first and second stop surfaces enhances the security of the system since the offset configuration of the selectable axial positions renders it more difficult for unauthorised persons to predict the correct axial positions and reproduce the first stop surfaces correctly at an unauthorized attempt to copy the key.

[0073] A particular advantage is achieved if the equi-

distant axial stop separation distance q between the selectable axial positions is chosen with respect to the geometry of the code arranged on the key. Fig. 8a shows in enlarged scale a portion of a key blade 704 of a conventional notched correct key 700 inserted into the plug 800 of a pin tumbler lock. The key blade 704 is provided with a number of code surfaces 751, 752, 753 which are separated axially along the coded edge 712 of the key blade 704. The plug 800 is provided with a corresponding number of code sensing pin tumblers 851, 852, 853 which are axially separated by the same distance as the code surfaces, such that each code surface 751, 752, 753 is radially aligned with a corresponding pin tumbler 851, 852, 853 when the correct key is fully inserted. Each code surface is radially positioned at a certain radial position or code height which is selected out of a number of possible radial positions. These selectable radial positions for the code surfaces are radially separated by an equidistant pitch p. In fig. 8a the pitch (p) is indicated as the radial distance between code surface 751 and 753. These two code surfaces 751, 752 are thus positioned at the smallest possible radial distance between any code surfaces that are not on the same code height. The code surfaces 751, 752, 753 are further arranged as the respective top of a generally truncated equilateral triangular code cut 755. Both sides of the triangular cut 755 exhibits an angle α to the radial direction. This angle α constitutes a code cut angle of the code and is equal for all code surfaces.

[0074] Now, it has proven advantageous to set the stop separation distance q as shown in figs. 6d and discussed above to a certain value with regard to the above described geometry of the key code. In the shown example it is advantageous to set the stop separation distance q to a value which is equal to or greater than half of the pitch p multiplied by tan α, i.e.;

$$q \geq 0{,}5\ p \tan \alpha$$

[0075] By this means it is assured that the code surfaces of a key comprised in the system but intended not to open this particular lock of the same system will not coincidentally be aligned with any pin tumbler when a key not having the correct first stop surfaces positions in relation to the plug in question is inserted into the plug. Such an incorrect combination is shown in fig. 8b which illustrates the key 700 shown in fig. 8a, when it has been fully inserted into a different cylinder lock 800' of the same system. Also this cylinder lock 800' is provided with pin tumblers 851', 552', 853". However, at this incorrect combination, at least one of the first stop surfaces has made contact with a second stop surface which is displaced axially one stop surface separation distance q from the position at which the second stop surface should be positioned at the plug (e.g. plug 800) for which the key 700 is intended. This stop surface separation distance q is equal to 0,5 * p * tan α.

[0076] A seen in fig 8b, this incorrect combination results in a misalignment between the code surfaces 751, 752, 753 of the key 700 and the corresponding pin tumblers 851', 852', 853' which causes the pin tumblers to be radially displaced out of their releasing position between the plug 800' and the cylinder housing 850'. All shown pin tumblers 851', 852', 853, intersect the shear line S' whereby rotation of the plug 800' is not possible. By selecting the stop surface separation distance q, sufficiently large in relation to the code cut angle α and the pitch p, it is assured that the radial displacement of the pin tumblers 851', 852', 853' is large enough to ensure that the pin tumblers are positioned in an interlocking position between the plug 800' and housing 850' , i.e. a position where the pin tumblers 851', 852', 853' securely intersect the shear line S' between the plug 800'and the housing 850'.

[0077] If e.g. the code cut angle α is 45° and the stop surface separation distance q is larger than 0,5 * p * tan α, the resulting radial displacement of the pin tumbler will be larger than half the pitch. A too small radial displacement could prevent a secure interlocking between the plug and the housing. In particular, manufacturing tolerances and pin tumbler end chamfers or crowning may result in that the pin tumblers, upon rotation of the plug, are forced away from the shear line such that they do not intersect the shear line, thereby incorrectly allowing continued rotation of the plug relative to the housing. With the chosen smallest stop separation distance it is however assured that the pin tumblers will be radially displaced long enough not to allow the pin tumblers to be forced away from the shear line by rotating the key.

[0078] Preferably, the stop surface separation distance q should also be smaller than a certain value to assure that the pin tumblers are not coincidently displace to the next code level. Advantageous q is chosen smaller than or equal to 0,8 * p * tanα. By this means it is assured that using a key with incorrect first stop surfaces does not run the risk of the pin tumblers to be radially displaced a full pitch distance where it could coincidently be positioned such that the pin tumbler does not intersect the shear line. If e.g. the code cut angle α is 45° and the code separation distance q is smaller than or equal to 0,8 * p * tan α, the pin tumblers will be radially displaced a distance which is smaller than or equal to 0,8 * p. At such a limited radial displacement the risk of an end portion of the pin tumblers to be coincidently positioned in proximity to the shear line is eliminated.

[0079] Also at dimpled keys, the same principle for setting the stop separation distance q in relation to the code geometry may advantageously be utilized. In such instances the code cut angle α is the angle between the conically sloping code dimple walls and the central axis of the dimpled code recess.

[0080] In practice, the code cut angle α is, both at sawn or cut keys and at dimpled keys, set within the interval of 40° - 60°.

[0081] It is to be understood that the invention is not limited to the exemplifying embodiments shown in the drawings and described above. Instead the invention may freely be varied within the scope of the appended claims. For instance, in the examples given above the keys and plugs are provided with two first stop surfaces and two second stop surface respectively. Naturally, the keys and plugs may be provided with a higher number of first and second stop surfaces. For each compatible key and plug combination the number of first stop surfaces should preferably correspond to the number of second stop surfaces. The invention may also be varied by varying the predetermined number of selectable axial positions for the first and second stop surfaces. It is also foreseeable that the first stop surfaces may be positioned at any one of a first predetermined number of axial positions whereas the second stop surfaces may be positioned at any one of a second different number of predetermined axial positions. Further more, each of the first stop surfaces may be positioned at any one of a different predetermined number selectable axial positions. Each corresponding second stop surface should then preferably be positioned at any one of a corresponding number of selectable axial positions.

Claims

1. A cylinder lock and key system including,

cylinder locks of the kind comprising

a housing having a cylindrical bore; and
a cylindrical plug (200, 600) which is rotatably journaled in the housing about a rotational axis and which exhibits a front end and a keyway (206, 606), which extends axially from an entrance opening at the front end; and

keys (100, 300, 400, 500, 700) of the kind comprising

a key bow (102, 302, 402, 502); and
a key blade (104, 304, 404, 504) extending forwardly from the key bow to a key tip, which key blade is insertable in a forward longitudinal direction to a fully inserted position in the keyway of corresponding locks and rotatable about the rotational axis when inserted;

wherein the plugs and keys are provided with cooperating stop surfaces for defining the fully inserted position of the keys in the keyways, which cooperating stop surfaces comprise

- at least two first stop surfaces (120a, 120b, 320a, 320b, 420a, 420b, 420c, 520a, 520b) arranged at the key blade (104, 304, 404, 504) of each key, each first stop surface facing forward in the insertion direction and being positioned at a selected one of a predetermined number of selectable axial positions, and
- at least two second stop surfaces (220a, 220b, 620a, 620c) arranged in the keyway (206, 606) of each plug, each second stop surface being positioned at a selected one of the predetermined number of selectable axial positions; and

wherein the first and second stop surfaces are arranged such that at least one first stop surface is in contact with a corresponding second stop surfaces when a correct key is fully inserted in the keyway of a corresponding lock,
characterized in that
each first stop surfaces (120a, 120b, 320a, 320b, 420a, 420b, 420c, 520a, 520b) is defined by a respective forwardly open, through penetrating recess (122a, 122b, 422a, 422b) arranged at the key tip (105, 305, 405, 505) ; and **in that**
each second stop surface (220a, 220b, 620a, 620c) is defined by a respective stop member (222a, 222b, 622a, 622c) which is arranged in the keyway and extends laterally over the entire cross section of the keyway.

2. A cylinder lock and key system according to claim 1, wherein at least one first stop surface (120a, 120b, 420a, 420b, 520a, 520b, 520c) is curved and at least one stop member (222a, 222b, 622a, 622c) exhibits a correspondingly curved surface forming a second stop surface (220a, 220b, 620a, 620c).

3. A cylinder lock and key system according to claim 2, wherein the at least one curved first stop surface (120a, 120b, 420a, 420b, 520a, 520b, 520c) exhibits a constant radius of curvature and the at least one second stop surface (22a, 220b, 620a, 620c) exhibits a radius of curvature which is essentially equal to the radius of curvature of the at least one first stop surface.

4. A cylinder lock and key system according to claim 2 or 3, wherein the at least one stop member (222a, 222b, 622a, 622c) is cylindrical.

5. A cylinder lock and key system according to any of claims 1-4, wherein the keys are provided with a number of code surfaces (116', 116", 316', 316",416a', 416a", 416b', 416b", 516') arranged one after the other in the longitudinal direction of the key blade (104, 304, 404, 504); and the plugs (200, 600) are provided with radially displaceable pin tumblers, each code surface being arranged to cooperate with a corresponding pin tumbler when the key blade

(104, 304, 404, 505) is fully inserted in the keyway, and wherein at least one first stop surface (120a, 120b, 320a, 320b, 420a, 42b, 520a, 520b, 520c) is positioned longitudinally in front of the front most code surface (116', 416a', 416b').

6. A cylinder lock and key system according to claim 5, wherein each first stop surface (120a, 120b, 320a, 320b, 420a, 42b, 520a, 520b, 520c) is positioned longitudinally in front of the front most code surface (116', 416a', 416b').

7. A cylinder lock and key system according to claim 5 or 6, wherein the keys (400, 500) are dimpled flat keys at which the code surfaces (4161, 416", 516') are arranged as depressions formed in at least one key blade side (406, 408, 506) and aligned along a longitudinal code line (425a, 425b) and wherein the key tip (405, 505) exhibits a slanting guide surface (430a, 430b) arranged at the code line (425a, 425b) for guiding pin tumblers onto said key blade side (406, 408), which guide surface is free of through penetrating recesses defining a first stop surface.

8. A cylinder lock and key system according to claim 7, wherein the slanting guide surface (430a, 430b) is arranged between two first stop surfaces (420a, 420c).

9. A cylinder lock and key system according to any of claims 1-8, wherein the key tip (105, 305) is pointed and exhibits a front most apex (105a, 305a) and wherein at least one first stop surface (120a, 120b, 320a, 320b) is arranged at each side of the apex.

10. A cylinder lock and key system according to any of claims 1-8, wherein the key tip (405, 505) exhibits a forwardly facing front edge (405a, 505a) and wherein at least two first stop surfaces (422a, 422b, 520a, 530b, 530c) are formed as depressions in the front edge, which depressions extend through the cross section of the key blade (404, 504) and in the longitudinal direction of the key blade.

11. A cylinder lock and key system according to any of claims 1-10, wherein at least one key (400, 500) is a reversible key, the key blade (404, 504) of which exhibits at least two primary first stop surfaces (420a, 420c, 520a, 530c) and at least two secondary first stop surface (420b, 420c, 520b, 520c) ; and wherein the primary and secondary first stop surfaces are arranged symmetrically with regard to a longitudinal centre axis of the key blade.

12. A cylinder lock and key system according to claim 11, wherein at least one first stop surface (420c, 520c) is arranged at the longitudinal centre axis of the key blade (404, 504) and constitutes both a primary and a secondary first stop surface.

13. A cylinder lock and key system according to any of claims 1-12, wherein the longitudinal depth of at least one through penetrating forwardly open recess (122b, 522c) forming a first stop surface (120b, 520c) is greater than a cross sectional dimension of the stop member (222b, 622c) defining a corresponding second stop surface (220b, 620c), such that at least a portion of the key tip (105, 505) protrudes forwardly beyond said stop member when the key blade (104, 504) is in the fully inserted position.

14. A cylinder lock and key system according to any of claims 1-13, wherein the keys are provided with a code arranged at the key blade (704) for cooperating with corresponding pin tumblers (851, 852, 853) of the plugs (800), which code exhibits a code cut angle α and code surfaces (751, 752, 753) which are radially separated by an integer multiple of a code surface pitch, p, and wherein the selectable axial positions for the first and second stop surfaces are axially separated by a stop separation distance q, wherein $q \geq 0{,}5 * p * \tan \alpha$.

12. A cylinder lock and key combination including,

a cylinder lock comprising

a housing having a cylindrical bore; and
a cylindrical plug (200, 600) which is rotatably journaled in the housing about a rotational axis and which exhibits a front end and a keyway (206, 606) having opposite keyway sides and a height direction which is parallel with the keyway sides and perpendicular to the rotational axis, which keyway extends axially from an entrance opening () at the front end; and

a key (100, 300, 400, 500, 700) comprising

a key bow (102, 302, 402, 502); and
a key blade (104, 304, 404, 504) extending forwardly from the key bow to a key tip which key blade is insertable in a forward longitudinal direction to a fully inserted position in the keyway of corresponding locks and rotatable about the rotational axis when inserted;

wherein the plug and key are provided with cooperating stop surfaces for defining the fully inserted position of the key in the keyway, which cooperating stop surfaces comprise

- at least two first stop surfaces (120a, 120b, 320a, 320b, 420a, 420b, 420c, 520a, 520b) ar-

ranged at the key blade, each first stop surface facing forward in the insertion direction; and
- at least two second stop surfaces (220a, 220b, 620a, 620c) arranged in the keyway of the plug, each second stop surface facing forward relative to the plug; and

wherein the first and second stop surfaces are arranged such that at least one first stop surface is in contact with a corresponding second stop surfaces when the key is fully inserted in the keyway of the lock,
characterized in that
each first stop surfaces (120a, 120b, 320a, 320b, 420a, 420b, 420c, 520a, 520b) is defined by a respective forwardly open, through penetrating recess (122a, 122b, 422a, 422b) arranged at the key tip (105, 305,405, 505); and **in that**
each second stop surface ((220a, 220b, 620a, 620c)) is defined by a respective stop member (222a, 222b, 622a, 622c) which is arranged in the keyway and extends laterally over the entire cross section of the keyway.

13. A key (100, 300, 400, 500, 700) for a cylinder lock and key system according to any of claims 1-11, which key comprises a key bow (102, 302, 402, 502) and a key blade (104, 304, 404, 504) extending forwardly from the key bow to a key tip, which key blade is insertable to a fully inserted position in a keyway of corresponding locks and rotatable about a rotational axis when inserted, which key blade is provided with at least two first stop surfaces (120a, 120b, 320a, 320b, 420a, 420b, 420c, 520a, 520b) which are arranged to define the fully inserted position of the key in the keyway by contacting corresponding second stop surfaces arranged in the keyway of a lock, **characterized in that** each first stop surfaces (120a, 120b, 320a, 320b, 420a, 420b, 420c, 520a, 520b) is defined by a respective forwardly open, through penetrating recess (122a, 122b, 422a, 422b) arranged at the key tip.

14. A key blank for producing a key according to claim 13, which key blank comprises a key bow and a key blade extending forwardly from the key bow to a key tip, wherein at least two first stop surfaces are arranged at the key blade for defining a fully inserted position of a key produced from the key blank in a keyway of a cylinder lock and at least two first stop surfaces, each first stop facing forward, **characterized in that** each first stop surfaces is defined by a respective forwardly open, through penetrating recess arranged at the key tip.

15. A cylinder lock for a system according to any of claims 1-12, which cylinder lock comprises a housing having a cylindrical bore and a cylindrical plug (200, 600) which is rotatably journaled in the housing about a rotational axis and which exhibits a front end (202, 602) and a keyway (206, 606) which extends axially from an entrance opening at the front end and which is arranged to receive a corresponding key which is inseratble to a fully inserted position in the keyway, wherein the plug is provided with at least two second stop surfaces (220a, 220b, 620a, 620c) which are arranged to define the fully inserted position of the key in the keyway by contacting corresponding first stop surfaces arranged at the corresponding key **characterized in that** each second stop surface (220a, 220b, 620a, 620c) is defined by a respective stop member (222a, 222b, 622a, 622c) which is arranged in the keyway and extends laterally over the entire cross section of the keyway.

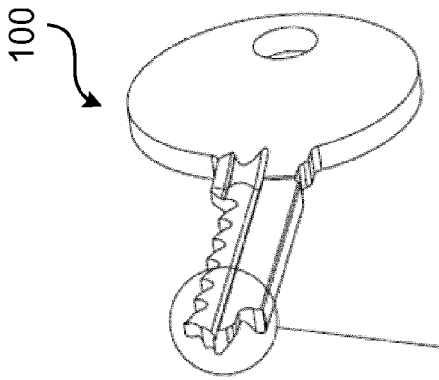

Fig. 1c

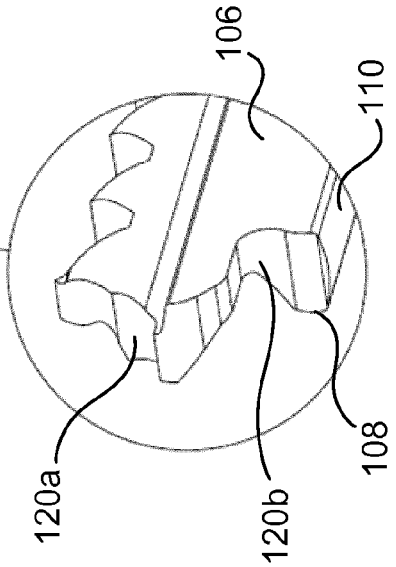

Fig. 1d

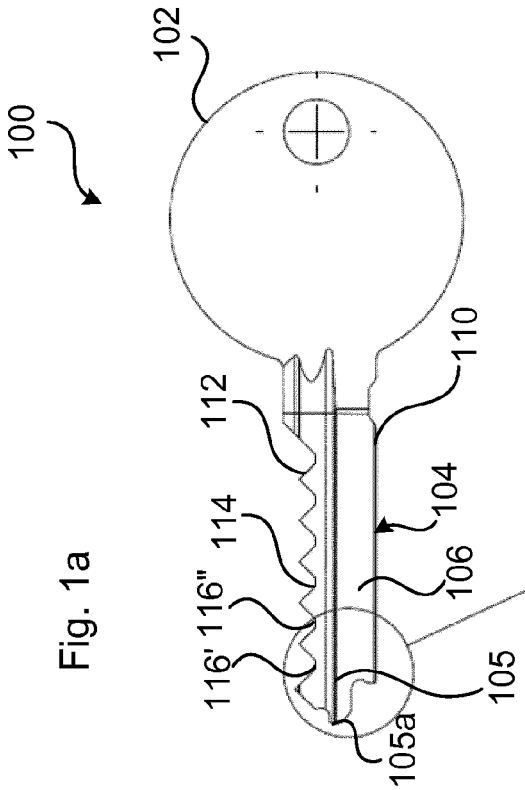

Fig. 1a

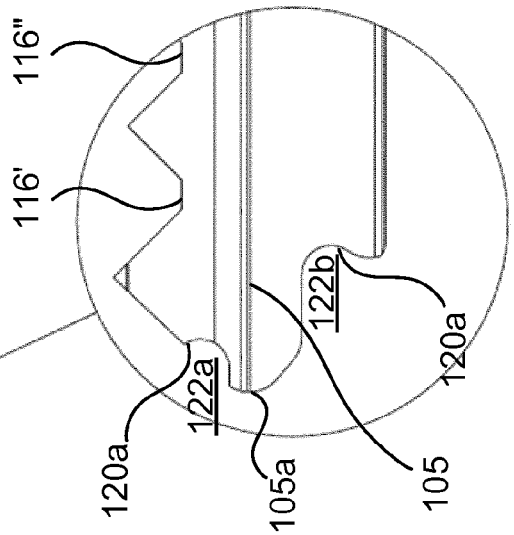

Fig. 1b

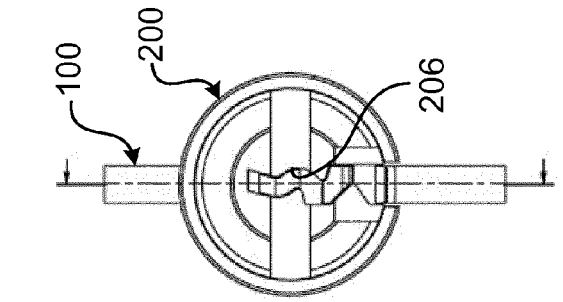

Fig. 2b

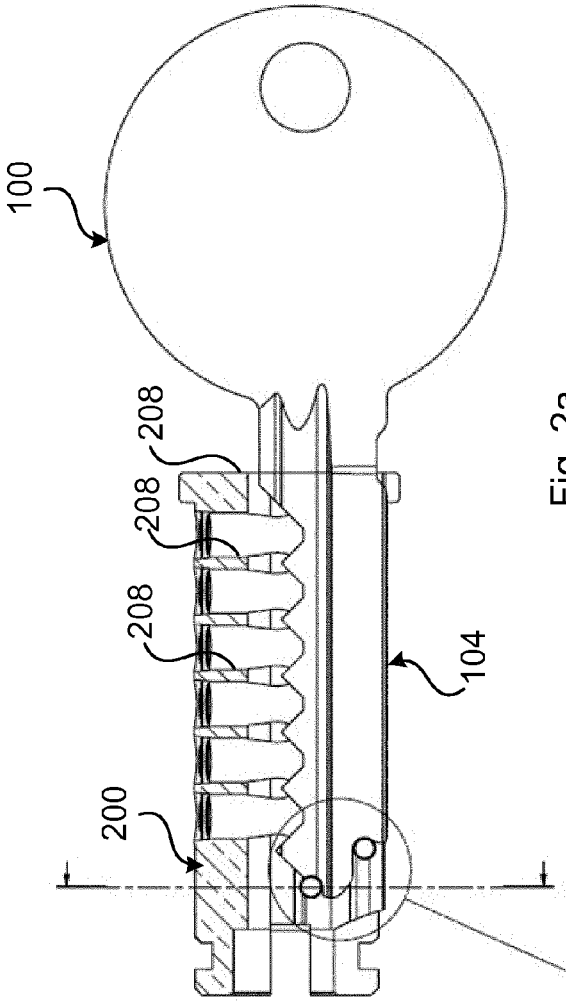

Fig. 2a

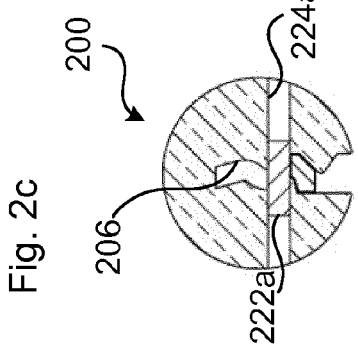

Fig. 2c

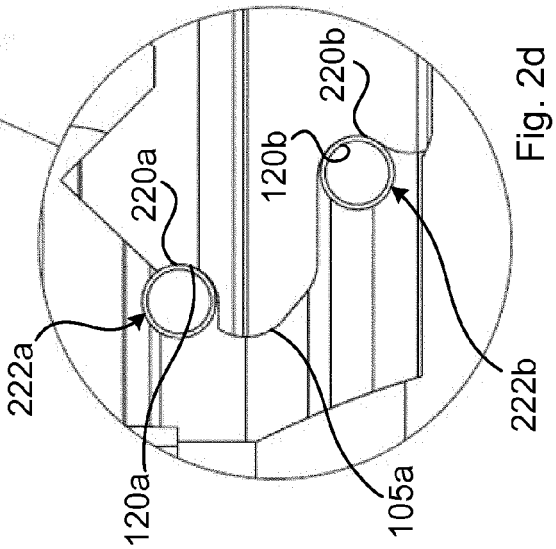

Fig. 2d

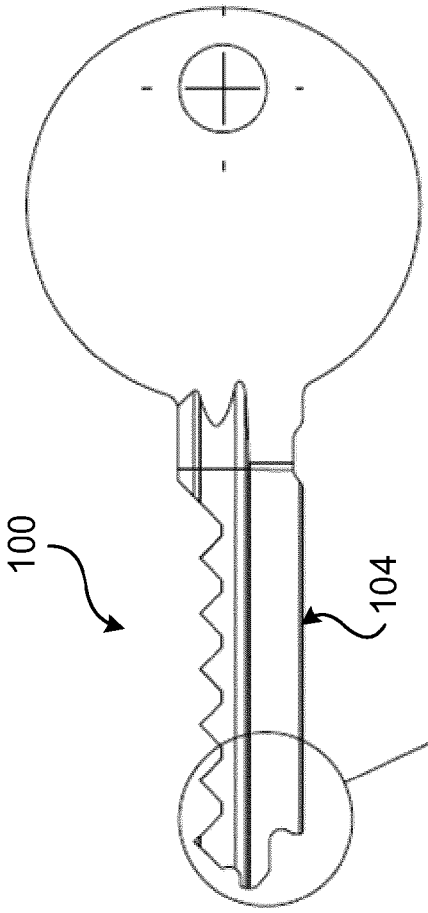

Fig. 3a

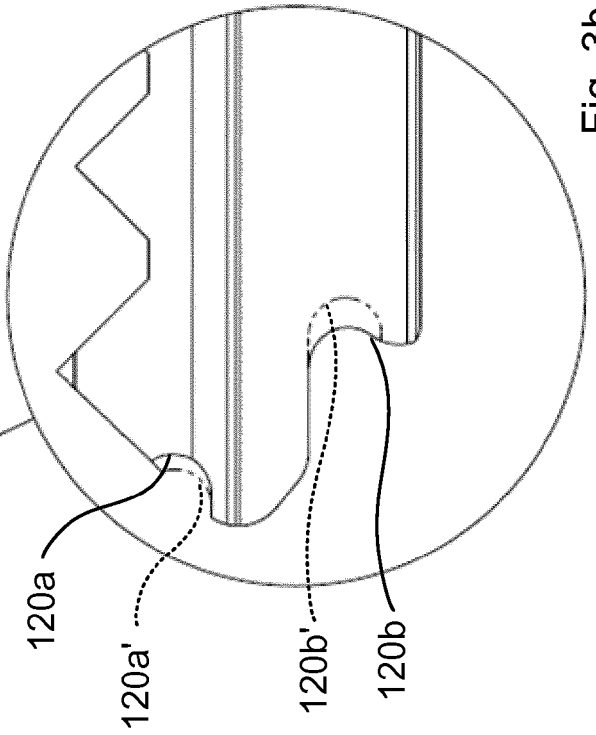

Fig. 3b

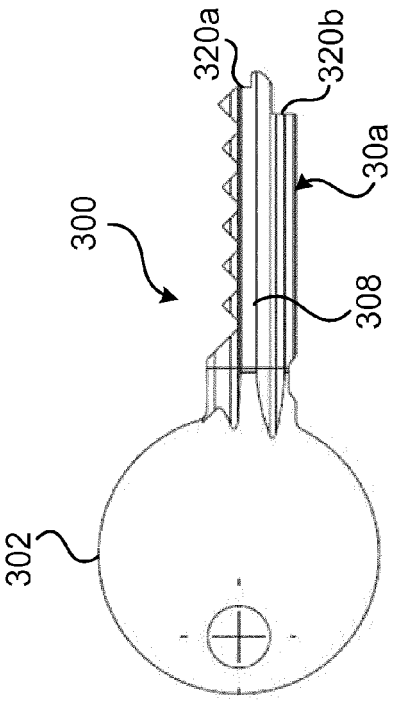

Fig. 4c

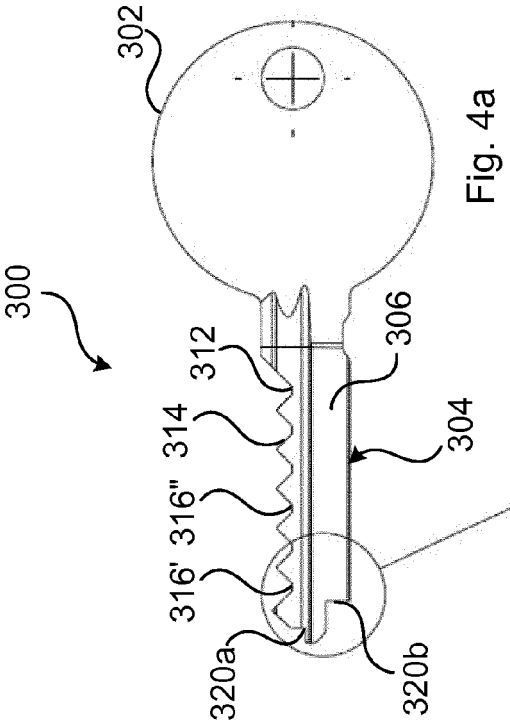

Fig. 4a

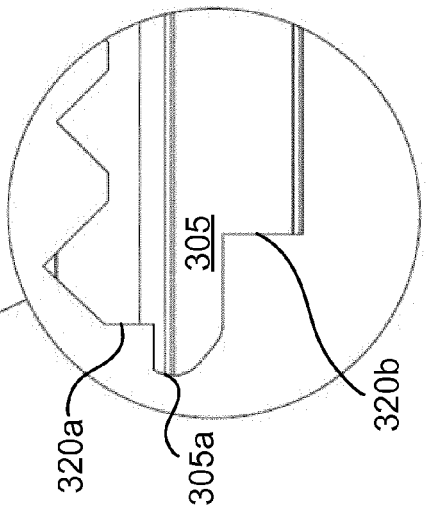

Fig. 4b

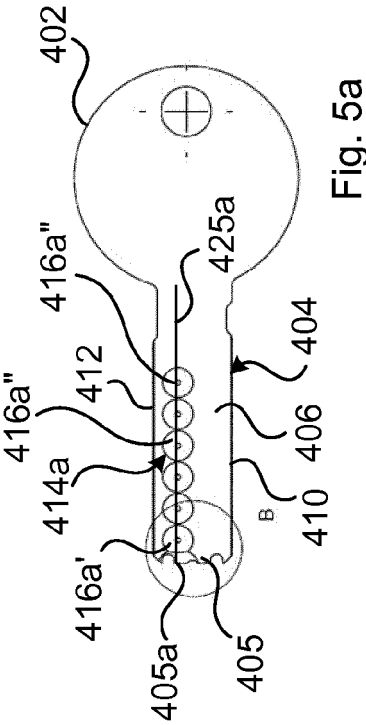

Fig. 5a

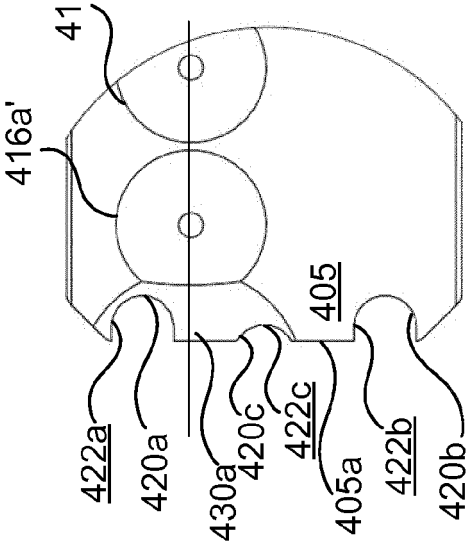

Fig. 5b

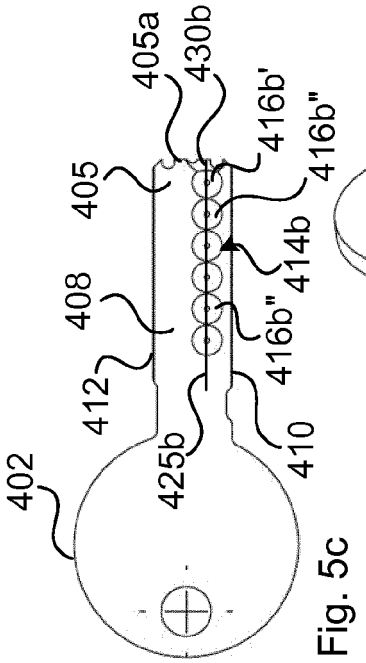

Fig. 5c

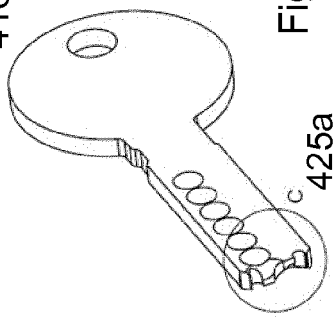

Fig. 5d

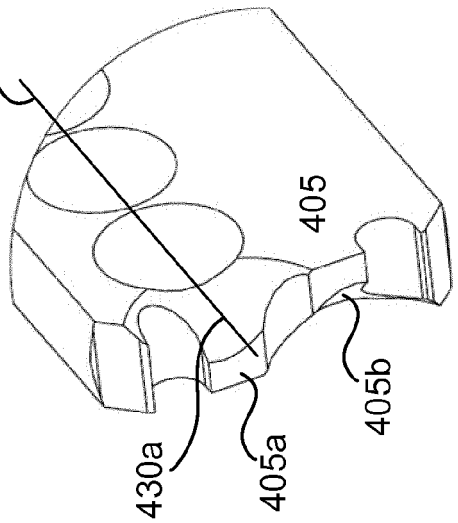

Fig. 5e

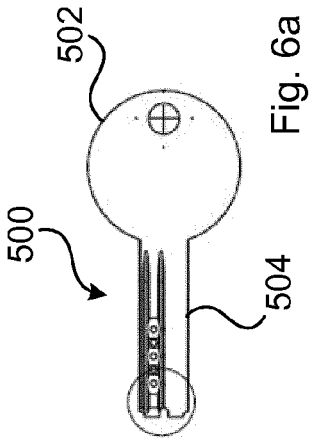

Fig. 6a

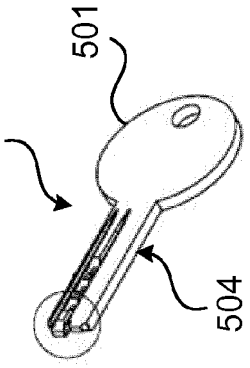

Fig. 6b

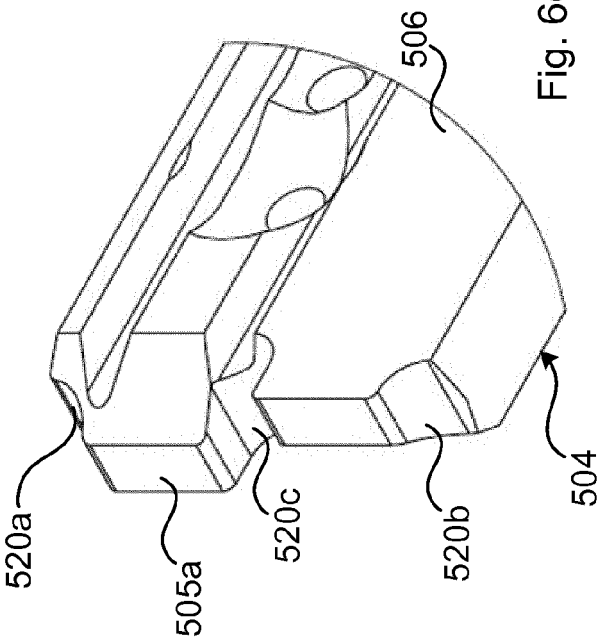

Fig. 6c

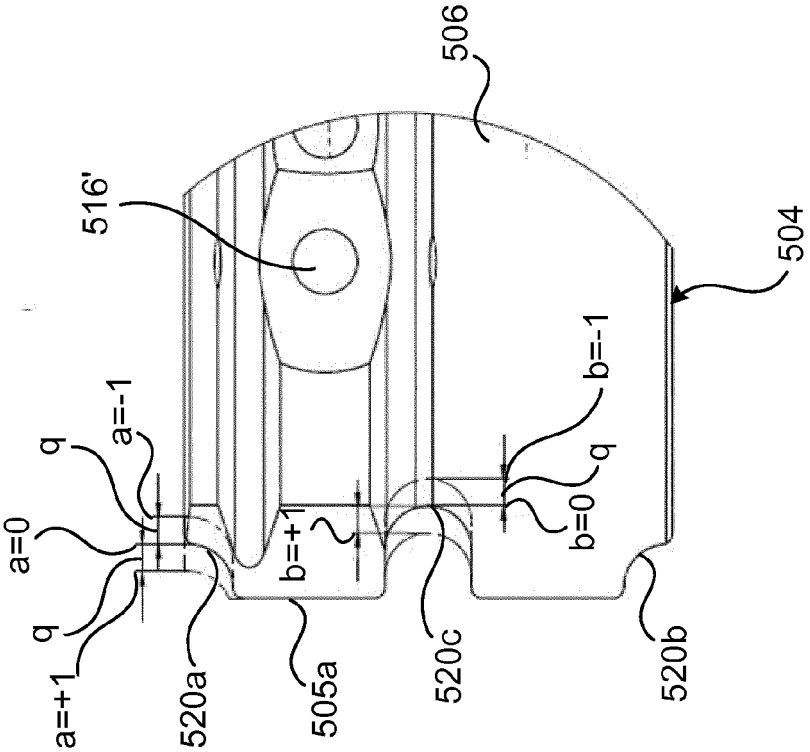

Fig. 6d

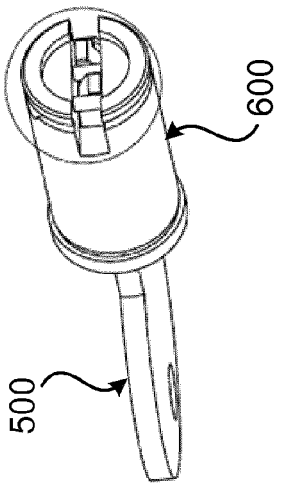

Fig. 7a

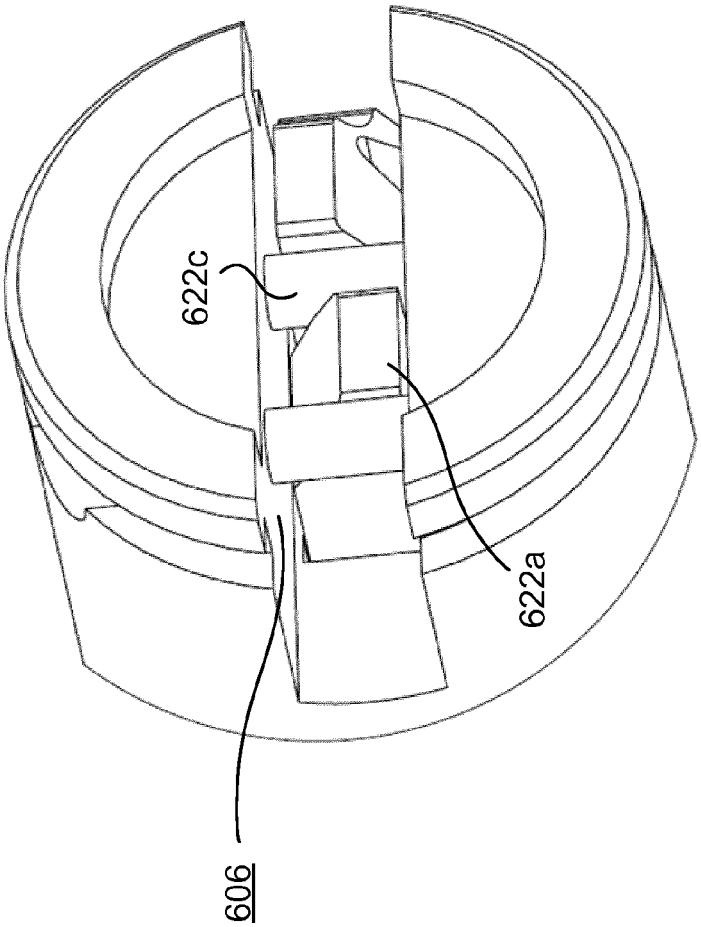

Fig. 7d

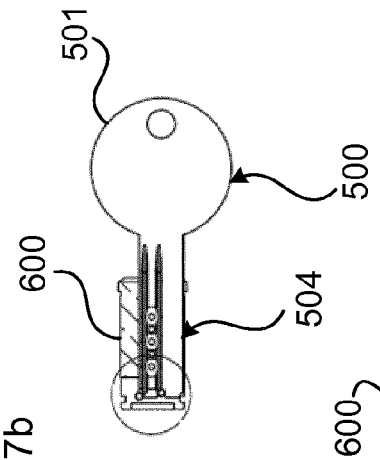

Fig. 7b

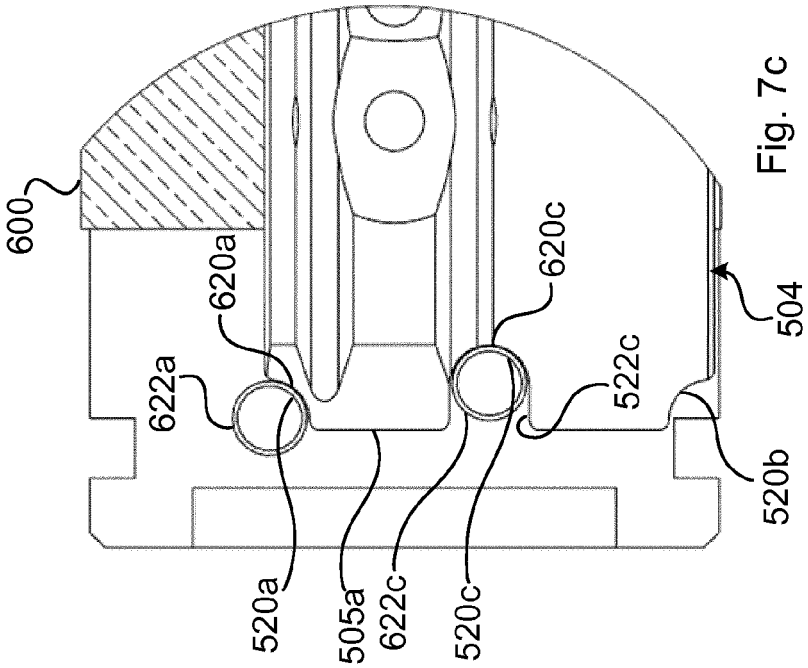

Fig. 7c

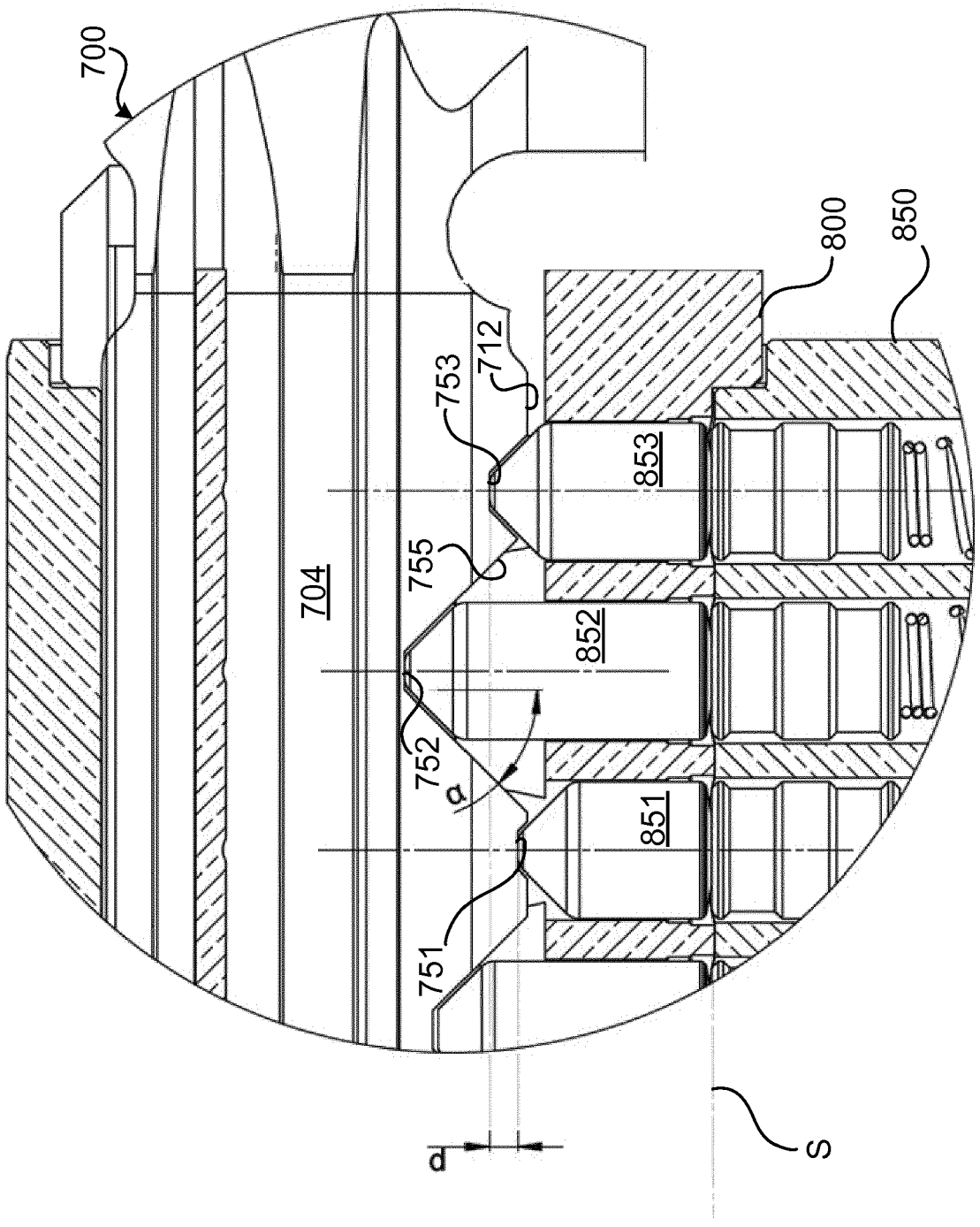

Fig. 8a

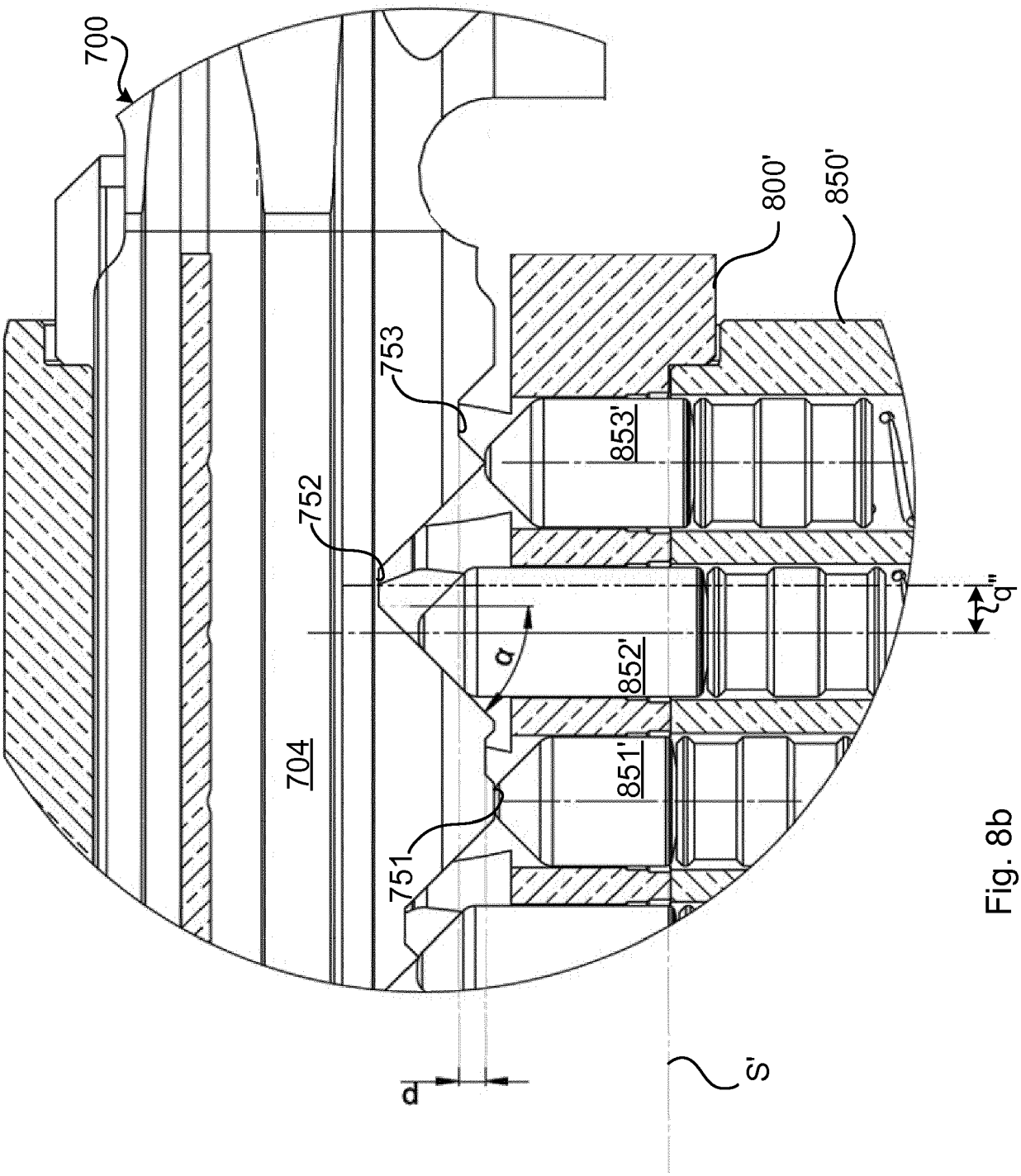

Fig. 8b

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EUROPEAN SEARCH REPORT

Application Number
EP 17 15 7816

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	29 August 2017	Westin, Kenneth

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