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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, 400 800) which is rotatably journaled in the housing about a rotational axis and which exhibits a front end and a keyway (206, 406) having opposite key way sides and a height direction which is parallel with the keyway sides and perpendicular to the rotational axis , which key way extends axially from an entrance opening at the front end. The keys (100, 300, 400, 500, 600, 700) comprises a key bow (102, 302, 502, 602); and a key blade (104, 304, 504, 604) having opposite key blade sides defining a longitudinal direction; and a height direction which is parallel to the key blade sides and perpendicular to the longitudinal direction, 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. 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, 520a', 520b', 520a", 520b", 620a, 620b) arranged at the key blade (104) of each key, and at least two second stop (220a, 220b, 420a, 420b) surfaces arranged in the keyway (206, 406) of each plug, 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. The first stop surfaces (120a, 120b, 320a, 320b, 520a', 520b', 520a", 520b", 660a, 620b) are defined by a respective grove (122a, 122b, 322a, 322b) which grooves are formed in one and the same key blade side (106, 306) and the second stop surfaces (220a, 220b, 420a, 420b) are arranged on a respective stop member (222a, 222b, 422a, 422b) which protrude laterally into the keyway (206, 406) from one and the same keyway side.

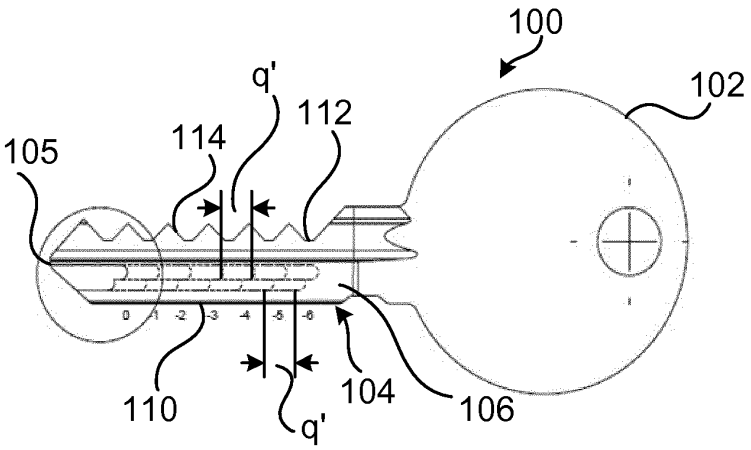

Fig. 1a

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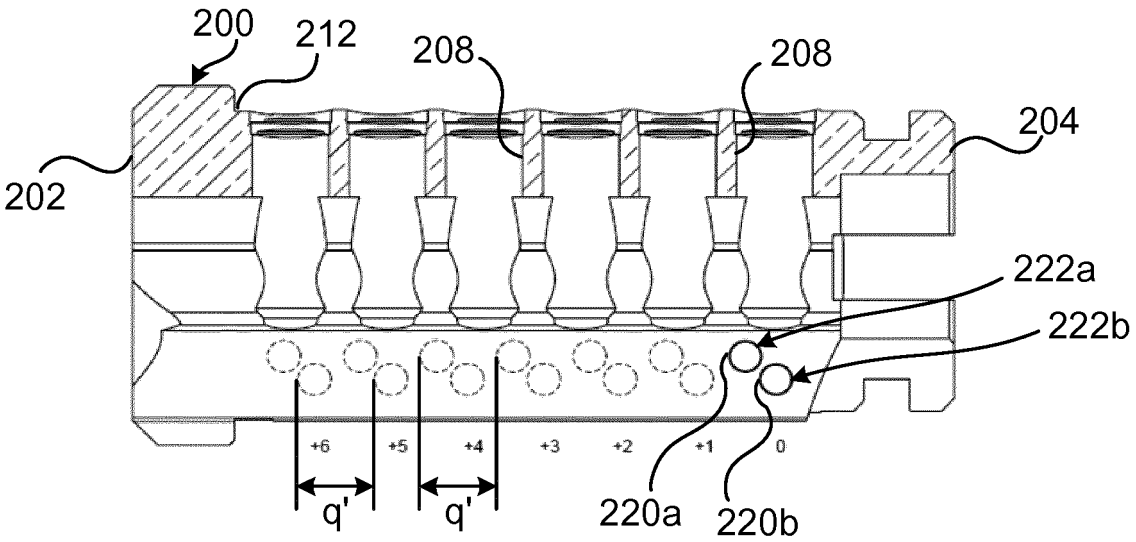


Fig. 2c

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, sawn 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. The fully inserted position may be defined by a collar or shoulder arranged at the key, at the junction between the key blade and the key bow. The shoulder then 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 0 637 663 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 1 523 603 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.

[0011] EP 2 360 334 B1 discloses a cylinder lock and key combination wherein the key comprises a stop arranged at the shoulder and the plug comprises a corresponding stop arranged at the front end of the plug for defining the fully inserted position of the key. The plug further comprises a blocking element which extends into the keyway and which is received in a recess formed on the key blade when the key is inserted into the fully inserted position.

[0012] EP 2 314 807 A2 discloses a lock system comprising a key and a lock cylinder. The key comprises a key blade with a side surface in which a groove is formed. The grove extends longitudinally from the key tip and defines a stop element, at the rear end of the grove, which end is opposite to the key tip. The lock cylinder comprises a corresponding stop element which protrudes into the key way and which is received in the grove when the key is inserted in the key way. The fully inserted position of the key is defined by the stop element of the key making contact with the stop element of the lock cylinder when inserting the key in the key way.

Summary of the invention

[0013] It is an object of the present invention to provide an enhanced cylinder lock and key system.

[0014] 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.

[0015] A further object is to provide such a system at which a comparatively high number of possible permutations may readily be achieved.

[0016] Yet another object is to provide such a system which is reliable in use.

[0017] 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.

[0018] 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.

[0019] 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.

[0020] 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 having opposite keyway sides and a height direction which is parallel with the keyway sides and perpendicular to the rotational axis, which key way extends axially from an entrance opening at the front end. The keys are of the kind comprising a key bow and a key blade having opposite key blade sides defining a longitudinal direction; and a height direction which is parallel to the key blade sides and perpendicular to the longitudinal direction. 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. The first stop surfaces are defined by a respective grove which grooves are formed in one and the same key blade side and the second stop surfaces are arranged on a respective stop member which protrude laterally into the keyway from one and the same keyway side.

[0021] 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.

[0022] 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.

[0023] 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.

[0024] By defining the first stop surfaces by groves formed in one and the same key blade side and by forming the second stop surfaces on stop members protruding laterally in to the keyway from one and the some keyway side a number of advantages are achieved. For example, this allows for a space saving arrangement of the stop surfaces on the key and in the key way. The opposite sides of the key blade and the keyway may thus be used for other purposes than defining the fully inserted position. It is for instance possible to use these opposite sides for forming additional key profile groves and key profile ribs respectively. The opposite sides may also be used for forming an additional side code on the key blade and arranging corresponding side code pin tumblers in the plug.

[0025] The first stop surfaces may be arranged mutually adjacent in the height direction, each first stop surface having an extension in the height direction of the key blade, and one of said first stop surfaces may have a largest extension in the height direction which is larger than the height extension of all other first stop surfaces.

[0026] This allows for that the space requirement in the height direction of the key blade is limited. Hereby, two or more first stop surfaces may readily be arranged at the key blade without the risk of interfering with those portions of the key blade that are dedicated for the key code or for the cross sectional profiling of the key blade.

[0027] Correspondingly the second stop surfaces may be arranged on a respective stop member in the keyway, which stop members are arranged overlapping in the height direction of the keyway. The arrangement of the stop members defining the second stop surfaces overlapping in the height direction of the keyway limits the space requirements for the stop members in the keyway. This results i.a. in that comparatively strong stop members may be utilized in the keyway without the risk of interfering with the movement of the pin tumblers or with other members in the keyway. This in turn results in a reduced risk of the stop members to fail or be worn out such that the correct definition of the fully inserted position may be maintained over a long time of use.

[0028] Additionally, by arranging the second stop surfaces inside the keyway, the correct position of the second stop surfaces at a certain lock is concealed and may not easily be detected from the outside of the lock. Thereby, unauthorized production of functioning keys for that lock is prevented.

[0029] On the other hand, when knowing the correct positions of the second stop surfaces and thereby the correct corresponding positions for the first stop surfaces on an authorized key, it is comparatively easy to produce the first stop surfaces on the key blade. The invention thus provides for that authorized persons may readily produce keys for the inventive system, thereby benefitting from the advantages of the system.

[0030] The arrangement of the first stop surfaces at the key blade further provides for that the desired multiple first and second stop surface configuration may be applied also to systems comprising cylinder locks of the modern and widely spread type where the cylinder plug exhibits keyways which are open in one radial direction, i.e. where the keyways are formed as a radial slit in the plug.

[0031] The height extensions of the first stop surfaces having a height extension which is smaller than the largest height extension may preferably lie within the interval between 50% and 75% of the largest height extension.

[0032] The total extension in the height direction of the first stop surfaces may be smaller than the number of first stop surfaces multiplied by the largest extension in the height direction.

[0033] The first stop surfaces may be concavely

formed with a constant radius of curvature.

[0034] The constant radius of curvature may then be approx. equal to half of the largest extension in the height direction of the first stop surfaces.

[0035] The first stop surface having the largest extension in the height direction may be positioned axially further away from the key tip than all other first stop surfaces.

[0036] 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 may be axially separated by a stop separation distance q, wherein $q \geq 0{,}5 * p * \tan \alpha$.

[0037] The key blade may exhibit a side code arranged to cooperate with corresponding side pin tumblers of the plug, which side code is formed in the key blade side being opposite to the key blade side forming the first stop surfaces, and the side code may be arranged overlapping at least one first stop surface in the height direction.

[0038] The plug may comprise a profile rib which protrudes laterally into the keyway from the keyway side being opposite to the stop members and the key blade may exhibit a corresponding profile grove which is formed in the key blade side being opposite to the key blade side forming the first stop surface, and the profile grove may be arranged overlapping at least one first stop surface in the height direction.

[0039] The lateral distance between the profile groove (330) and the grooves forming the first stop surfaces (320a, 320b) may preferably be between 10% and 20% of the overall thickness of the key blade (304).

[0040] The number of selectable axial positions for the first and second stop surfaces may be 2-7, preferably 3.

[0041] The first and second stop surfaces may be the only surfaces which axially define the fully inserted position of the key in the keyway.

[0042] All stop members may have the same extension in the height direction of the keyway.

[0043] The stop members may each define a convexly curved second stop surface having the same radius of curvature.

[0044] The selectable axial positions for the first and second stop surfaces may be equidistantly separated.

[0045] The cylinder locks may comprise pin tumbler locks or disc tumbler locks and the keys may be of the conventional notched, sawn or cut key type, dimpled key type, engraved key type, side coded key type or disc cylinder key type.

[0046] The selectable axial positions for the first and second stop surfaces may be equidistantly separated by a stop separation distance; each of the first stop surfaces being positioned at a selected one of the predetermined number of a respective set of selectable axial positions, the selectable positions of one set being axially offset to at least one other set and each of the second stop surfaces may be positioned at a selected one of the predetermined number of a respective set of selectable axial positions, the selectable positions of one set being axially offset to at least one other set.

[0047] At least two sets of selectable axial positions for the first stop surfaces may be mutually axially offset by half the equidistant stop separation distance and at least two sets of selectable axial positions for the second stop surfaces may be mutually axially offset by half the equidistant stop separation distance.

[0048] The invention also relates to a cylinder lock and key combination, a key for a cylinder lock and key system of the above described type, a key blank for producing such a key and to a cylinder lock for such a 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.

[0049] 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.

[0050] Further objects and advantages of the invention appear from the description of embodiments below and from the appended claims.

[0051] 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

[0052] 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 side view from the opposite side of the key shown in fig. 1a. Fig 1d is a front view of the key shown in fig. 1a and fig. 1e shows a detail thereof in enlarged scale.

Fig. 2a is a perspective view of a cylinder plug of a cylinder lock comprised in the system comprising the key shown in fig. 1a and fig 2b shows a detail thereof in enlarged scale. Fig. 2c is a longitudinal section of the plug shown in fig. 2a. Fig. 2d is a front view with some parts broken away of the plug shown in fig. 2a and fig 2e shows a detail thereof in enlarged scale.

Figs 3a-e are views corresponding to figs 1a-e showing a key comprised in a cylinder lock and key system according to another embodiment of the invention.

Fig. 4a is longitudinal section through a cylinder plug of a cylinder lock comprised in the system comprising the key shown in fig. 3a and fig 4b shows a detail thereof in enlarged scale. Fig. 4c is a front view of the plug shown in fig 4a and fig 4d shows a detail thereof in enlarged scale. Fig 4e is a perspective view of the plug shown in fig 4a and fig. 4f shows a detail thereof in enlarged scale.

Figs 5a-e are views corresponding to figs 1a-e showing a key comprised in a cylinder lock and key system according to further embodiment of the invention.

Fig 6a is a side view of a key comprised in a system according to another embodiment and fig. 6b shows a detail thereof in enlarged scale.

Fig. 7a is a longitudinal section in enlarged scale through a portion of a cylinder lock with an inserted key and fig 7b is a corresponding section illustrating the fey shown in fig. 7a, when inserted into another cylinder lock.

Detailed description of embodiments

[0053] Figs. 1a-e 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 blade 104 exhibits a profiled cross section as best seen in fig. 1e. 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 sawn or cut key. The key is further insertable into the plug 200 shown in figs. 2a-e.

[0054] 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.

[0055] 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-e the first key stop surfaces 120a, 120b are defined by a respective groove 122a, 122b which are formed in the first key blade side 106. The grooves 122a, 122b extend rearward in the longitudinal direction from the key tip 105. The rear edges of grooves 122a, 122b thereby define a respective first stop surface 120a, 120b, such that the rear edge of upper groove 122a defines the upper first stop surface 120a and the rear edge of the lower groove 122b defines the lower first stop surface 120b.

[0056] In the example shown in figs. 1a-e the grooves 122a, 122b have been formed by a milling operation using an end-cutter or shank end mill having the same diameter for both grooves 122a, 122b. The first stop surfaces 120a, 120b which are formed by the rear edges of the respective groove 122a, 122b are thus concavely curved and formed as respective forwardly facing segments of a cylindrical inner envelope surface.

[0057] The upper groove 122a extends further from the key tip 105 than the lower groove 122b. Additionally, the grooves 122a, 122b extend mutually adjacent and are overlapping in the height direction. By this means the two first stop surface 120a, 120b are arranged mutually adjacent in the height direction. Also, the height x of the upper first stop surface 120a is larger than the than the height y of the lower first stop surface 120b. In the shown example the height extension y of the lower first stop surface 120b constitutes approx. 70% of the height extension x of the upper first stop surface 120a. Preferably the height extensions y of all first stop surfaces not having the largest height extension should lie within the interval between 50% and 75% of the largest height extension x

[0058] Expressed differently, the combined height z of the two first stop surfaces is smaller than two times the height of the stop surface 120a having the largest height. With the example shown in figs. 1a-e the following thus applies:

$$z = x + y < 2x$$

[0059] Figs. 2a-e illustrate 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-e forms part. The plug 200 is intended to be rotationally received in a cylindrical bore of a lock housing (not shown) 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. 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 a key blade such that the sawn key blade 104 shown in Figs. 1a-e, the coded upper key blade edge 112 will contact the inner ends of the pin tumblers 210 and displace the pin tumblers radially in the pin tumbler channels 208. If a correct key blade 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.

[0060] As seen in figs 2a-e, the plug is provided with stop members 222a and 222b defining a respective second stop surface 220a, 220b. In the shown example, the stop members 222a, 222b are each formed of a cylindrical stud which extends transversely into the keyway 206, from a common side of the keyway 206. 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.The two stop members 222a, 222b exhibit essentially the same but somewhat smaller diameter that the diameter of the end-cutter used for forming the grooves 122a, 122b defining the first stop surfaces on the key 100. The radius of curvature of the second stop surfaces 220a, 220b is the same for both second stop surfaces. 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.

[0061] As seen in figs 2a-e, the stop members 222a, 222b are positioned such that they overlap in the height direction of the plug, i.e. in a direction which is which is parallel with the keyway 206 and perpendicular to the rotational axis of the plug 200. By this means, the second stop surface 220a being positioned closer to the front end 202 of the plug 200, will define an active second stop surface which is larger in the height direction than the second stop surface 220b (or surfaces) which are arranged rearward of the first mentioned second stop surface. This relationship between the height extensions of the active second stop surfaces 220a, 220b correspond to the above described relationship between the height extension of the first stop surfaces 120a, 120b.

[0062] This overlapping relationship of the stop members 222a, 222b and the height extension relationship of the first 120a, 120b and second 220a, 220b stop surfaces allows for a space saving arrangement of the stop members 222a, 222b, the grooves 122a, 122b and the stop surfaces 120a, 120b, 220a, 220b. As a result, the entire stop surface arrangement does only to a limited degree limit the portions of the key blade's and the keyway's cross section that are available for varying the profiles of the key blade and the keyway. Thereby, the number of possible permutations defined by these profiles may be kept high. Additionally, said overlapping relationship allows for that the dimensions of the stop members 222a, 222b are comparatively large, whereby the stop members may be made strong and durable such that the risk of breakage or failure is reduced. Further more, the areas of the first 120a, 120b and second 229a, 220b stop surfaces may be made comparatively large whereby the contact pressures and the component wear are reduced.

[0063] The key 100 shown in figs. 1a-e is a correct key for the plug 200 shown in figs. 2a-e. 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. 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.

[0064] In the example shown in figs. 1a-e and 2a-e, 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.

[0065] 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.

[0066] 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. In the example shown in fig. 1a the cylinder lock and key system has seven possible first stop surface positions. These possible first stop surface positions are numbered 0 to -6 in fig. 1a. Correspondingly, as shown in fig. 2c, the second stop surfaces at each plug comprised in the system may be arranged at any respective one of seven possible second stop surface positions. The

possible second stop surface positions are numbered 0 to +6 in fig. 2a.

[0067] In the example shown in figs. 1a and 2c the possible first stop surface positions are equidistantly separated by a stop surface separation distance q' which is equal for the upper 120a and the lower 120b first stop surface. Correspondingly, as seen in fig. 2c, the possible second stop surface positions are separated by a second stop surface separation distance q' which is equal for the upper and lower second stop surfaces and also equal to the stop surface separation distance q' for the first stop surfaces. As also indicated in figs. 1b and 2c, the possible stop surface positions for the upper first and second stop surfaces are off set the possible stop surface positions for the lower first and second stop surface positions.

[0068] With the shown example it is thus possible to greatly increase the number of system permutations simply varying the positions of the first 120a, 120b and the second 220a, 220b stop surfaces.

[0069] An advantage of defining the first stop surfaces by grooves formed in one and the same side of the key blade is that the grooves 122a, 122b may be made comparatively deep without the risk of any considerable weakening the key blade 104. Hereby, the first stop surfaces 120a, 120b, may be given a comparatively large area, thereby reducing the wear of the first and second stop surfaces. Another advantage is that the entire opposite side 108 of the key blade may be used for other purposes, such as for forming a so called side code.

[0070] Figs 3a-e and 4a-f illustrate a key and a plug comprised in a system according to the invention. Figs. 3a-e show a key 300 which is a sawn key and comprises a key bow 302 and a key blade 304. The key blade 304 has a left key blade side 306 and a right key blade side 308 as seen in the forward direction of the key. An upper key blade edge 312 exhibits a cut code 314.

[0071] The key 300 is provided with two first stop surfaces 320a, 320b. Both first stop surface 320a, 320b are defined by a respective groove 322a, 322b formed in the left key blade side 306. Just as in the previous embodiment, the two first stop surfaces 320a, 320b are arranged overlapping in the height direction of the key blade 304.

[0072] Just as in the example shown in Figs. 1a-e, the axial positions for each first stop surface 320a, 320b may be selected as any one out of a predetermined number of possible first stop surface positions by varying the length from the key tip 305 of each groove 322a, 322b.

[0073] However, at this embodiment the possible first stop surface positions are concentrated to a smaller axial region arranged at a front portion of the key blade 304.

[0074] One of the first stop surface 320a 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 first stop surface 320b 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 axial distance q". This stop surface separations distance q" is considerably smaller than the stop surface separation distance q' shown in fig. 1a The upper first stop surface 320a is thus positioned at one position of a first upper set of selectable possible positions. The lower first stop surface 320b is correspondingly positioned at one position of a second, lower set of possible selectable positions. The first, upper set of selectable positions are offset the second, lower set of selectable positions. I.e. each of the selectable positions a of the first set is axially offset a corresponding axial position b of the second set. In the shown example the first set is positioned offset the second set by a distance q"/2.

[0075] Figs. 4a-f illustrate a plug 400 comprised in a cylinder lock which forms part of a system that also comprises the key shown in figs. 3a-e. The plug 400 exhibits a front end 402 and a rear end 404. A keyway 406 extends axially from the front end 402.

[0076] As shown in fig. 4b a plug 400 of this system has one upper stop member 422a defining an upper second stop surfaces 420a which may be positioned at any one of three selectable axial positions A=+1, A=o, and A=-1 comprised in a first set of selectable axial positions being axially separated by a stop surface separation distance q". A lower stop member 422b defines a lower second stop surface 420b which may be positioned at any one of a second set of selectable axial positions B=+i, B=o and B=-1, also separated by the axial distance q". The first A and second B set of selectable axial positions for the second stop surfaces are offset each other by a distance q"/2.

[0077] Such an arrangement of the selectable axial positons for the first 320a, 320b and second 420a, 420b 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.

[0078] A particular advantage is achieved if the equidistant 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. 7a shows in enlarged scale a portion of a key blade 704 of a conventional notched correct key 700 inserted in 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. 7a 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.

[0079] Now, it has proven advantageous to set the stop separation distance q as shown in figs. 3b and 4b 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.;

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

[0080] By this means it is assured that the code surfaces of a key comprised in the system but intended not to open a particular lock of the same system will not coincidentally be aligned with any pin tumbler when the 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. 7b which illustrates the key 700 shown in fig. 7a, 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.

[0081] A seen in fig 7b, 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 80' and the cylinder housing 850'. All shown pin tumblers 851', 852', 853, intersect the shear line S' whereby rotation of the plug 804' 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 80' 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'.

[0082] 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 crownings 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.

[0083] 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 * tan α. 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.

[0084] 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.

[0085] In practice, the code cut angle α is, both at sawn or cut keys and at dimpled keys, normally set within the interval of 40° - 60°

[0086] As best seen in 4c-f, the plug may exhibit a profile rib 430 which extends axially over the entire keyway. The profile rib 430 protrudes laterally into the keyway 406 from the keyway side which is opposite the keyway side from which the stop members 422a, 422b protrude.

[0087] As shown in fig. 3 e, the key 300 exhibits a corresponding profile groove 330 which is formed in the right hand key blade side 308, i.e. in the key blade side 308 which is opposite the key blade side 306 in which the grooves 322a, 322b and the first stop surfaces 320a, 320b are formed. The cross sectional shape of the profile groove 330 corresponds to the profile rib 430 of the plug 400 such that the profile rib, for allowing insertion of the key 300 in the plug 400, will be received in the profile groove 330 during insertion of the key.

[0088] The profile rib 430 is positioned vertically such that it overlaps the second stop surfaces 420a, 420b and

the profile grove 330 is thus arranged such that it overlaps the first stop surfaces 320a, 320b in the height direction. By this means a comparatively narrow slit or passage is formed in the keyway, between the profile rib 430 and the laterally protruding stop members 422a, 422b. The lateral width of the passage is in fig4c indicated by t'. Such a narrow passage has the advantage of rendering it more difficult the introduce a thin tool into the keyway for manipulating the pin tumblers (not shown) which are arranged in a pin tumbler channel 408' (see fig. 4a) which is positioned in proximity to or behind the stop members 422a, 422b.

[0089] At the key 300 this means that the lateral distance t" (see fig. 3e) between the bottom of the grooves 322a, 322b forming the first stop surfaces 320a, 320b and the bottom of the profile groove 330 must be somewhat smaller than t' for allowing the key blade 304 to be inserted between the profile rib 430 and the stop members 422a, 422b. It has shown advantageous to choose this lateral distance t" to lie between 10% and 20% of the overall thickness T of the key blade 304. Preferably t" is approx. 15% of T.

[0090] By this means the passage between the profile rib 420 and the stop members 422a, 422b may by made sufficiently small to greatly reduce the possibility introduce manipulation tools while at the same time not reduce the thickness of the material of the key blade 304 bridging the profile groove 330 and the groves 322a, 322b to such an extent that the mechanical strength of the key blade is jeopardized.

[0091] Figs. 5a-e shows a further example of a key 500. This key 500 is a dimpled key where the code is formed by so called dimples formed by recesses in the key blade sides 506, 508. The key 500 is further reversible which means that it is symmetrical with respect to the longitudinal rotational axis of the key blade 504, such that it may be inserted in a keyway in any of two rotational orientations separated by 180°.

[0092] Here, two primary first stop surfaces 520a', 520b' are formed in the left key blade side 506, generally in the same manner as shown and explained above with reference to figs. 1a-e. In order to allow the reversibility, two secondary first stop surfaces 520a", 520b" are formed in the right key blade side 508. The primary 520a', 520b' and the secondary 520a", 520b" are arranged symmetrically with respect to the longitudinal rotational axis of the key blade 504.

[0093] Figs. 6a-b show a further variant of a key 600 comprised in a key and lock system according to the invention. The key 600 is a sawn key with a key bow 602 and a key blade 604 provided with a lower edge 610 and an upper edge 612. The upper edge exhibits a code 612 comprising several code surfaces 616', 616" arranged one after the other in the longitudinal direction. Each code surface 616', 616" is arranged to be aligned with and come in contact with a respective tumbler pin (not shown) when the key 600 is inserted in the plug of a cylinder lock for which the key is intended. The code surfaces 616', 616" are arranged at different possible code surface depths which may be measured as the code surface distance from the lower edge 610 of the key blade. The possible code surface positions are separated by a code pitch which is the smallest distance in the height direction by which the code surfaces may be separated. The possible code surface positions comprise a greatest possible code depth which corresponds to a smallest code surface distance d_{min}. In the shown example the front most code surface 616' is positioned at the smallest code surface distance d_{min}.

[0094] At this embodiment the lower first stop surface 620b is axially positioned further away from the key tip 605 than the upper first code surface 620a. Correspondingly the extension in the height direction x of the lower first stop surface 620b is larger than the extension in the height direction y of the upper first stop surface 620a. The upper first stop surfaces 620a extends above the smallest code surface distance d_{min}, such that this first stop surface 620a overlaps the upper region of the key blade 604, where a code surface may be positioned. In order not for the first code surfaces to interfere with any of the code surfaces of a coded key, the uppermost first stop surface is positioned axially in front of the front most possible code surface position 616'. The uppermost first stop surface 620a is axially separated from the front most code surface position by a separation distance s, which in the shown example is approx. 0,2 mm. According to this embodiment of the invention, all possible stop surface positions for the uppermost first stop surface are spaced forwardly from the front most possible code surface position by the separation distance s.

[0095] It may be noted that the correct fully inserted position of a key in a particular lock may be defined by only one first stop surface making contact with one second stop surface or by two first stop surfaces making simultaneous contact with a respective second stop surface. In cases where the key and cylinder lock are provided with more that two first and second stop surfaces, any number of pairs och first and second stop surfaces may be used for defining the fully inserted position.

[0096] 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. For example, the number of selectable axial positons of the first and second stop surfaces may be 2, 3, 4, 5, 6, 7 or any higher integer number. 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, 400, 800) which is rotatably journaled in the housing about a rotational axis and which exhibits a front end and a keyway (206, 406) having opposite key way 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

keys (100, 300, 500, 600, 700) of the kind comprising

a key bow (102, 302, 502, 602); and
a key blade (104, 304, 504, 604) having opposite key blade sides defining a longitudinal direction; and a height direction which is parallel to the key blade sides and perpendicular to the longitudinal direction, 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, 520a', 520b', 520a", 520b", 620a, 620b) 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 (a, b), and
- at least two second stop (220a, 220b, 420a, 420b) surfaces arranged in the keyway (206, 406) of each plug, and 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
the first stop surfaces (120a, 120b, 320a, 320b, 520a', 520b', 520a", 520b", 660a, 620b) are defined by a respective grove (122a, 122b, 322a, 322b) which grooves are formed in one and the same key blade side (106, 306) and that and the second stop surfaces (220a, 220b, 420a, 420b) are arranged on a respective stop member (222a, 222b, 422a, 422b) which protrude laterally into the keyway (206, 406) from one and the same keyway side.

2. A cylinder lock and key system according to claim 1, wherein the first stop surfaces (120a, 120b,, 320a, 320b, 520a', 520b', 520a", 520b", 660a, 620b) are arranged mutually adjacent in the height direction, each first stop surface having an extension (x, y) in the height direction of the key blade, and wherein one (120a, 320a, 520a', 520a", 620b) of said first stop surfaces has a largest extension (x) in the height direction which is larger than the height extension (y) of all other (120b, 320b, 520b', 520b", 620a) first stop surfaces.

3. A cylinder lock and key system according to claim 1 or 2, wherein the stop members (222a, 222b, 422a, 422b) are arranged overlapping in the height direction of the keyway (206, 406).

4. A cylinder lock and key system according to claim 2 or 3, wherein the height extensions (y) of the first stop surfaces (120b, 320b, 520b', 520b", 620a) having a height extension (y) which is smaller than the largest height extension (x) lie within the interval; $0{,}50\ x \leq y \leq 0{,}75\ x$.

5. A cylinder lock and key system according to any of claims 2-4, wherein the total extension (z) in the height direction of the first stop surfaces (120a, 120b, 320a, 320b, 520a', 520b', 520a", 520b", 620a, 620b) is smaller than the number of first stop surfaces multiplied by the largest extension (x) in the height direction.

6. A cylinder lock and key system according to any of claims 1-5, wherein the first stop surfaces (120a, 120b, 320a, 320b, 520a', 520b', 520a", 520b", 620a, 620b) are concavely formed with a constant radius of curvature.

7. A cylinder lock and key system according to claim 6, wherein the constant radius of curvature is approx. equal to half of the largest extension (x) in the height direction of the first stop surfaces (120a, 320a, 520a', 520a", 620b).

8. A cylinder lock and key system according to any of claims 2-7, wherein the first stop surface (120a, 320a, 520a', 520a", 620b) having the largest extension (x) in the height direction is positioned axially further away from the key tip (105) than all other first stop surfaces (120b, 320b, 520b', 520b", 620a).

9. A cylinder lock and key system according to any of claims 1-8, wherein the keys are provided with a code arranged at the key blade (702) 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 $q \geq 0{,}5 * p * \tan \alpha$.

10. A cylinder lock and key system according to any of claims 1-9, wherein the key blade exhibits a side code arranged to cooperate with corresponding side pin tumblers of the plug, which side code is formed in the key blade side being opposite to the key blade side forming the first stop surfaces, and wherein the side code is arranged at least partially overlapping at least one first stop surface in the height direction.

11. A cylinder lock and key system according to any of claims 1-9, wherein the plug (400) comprises a profile rib (430) which protrudes laterally into the key way (406) from the key way side being opposite to the stop members (422a, 422b) and the key blade (304) exhibits a corresponding profile grove (330) which is formed in the key blade side (308) being opposite to the key blade side (306) forming the first stop surfaces (320a, 320b), and wherein the profile grove is arranged at least partially overlapping at least one first stop surface in the height direction.

12. A cylinder lock and key system according to any of claims 11, wherein the lateral distance between the profile groove (330) and the grooves forming the first stop surfaces (320a, 320b) is between 10% and 20% of the overall thickness of the key blade (304).

13. A cylinder lock and key system according to any of claim 112, wherein the first and second stop surfaces (120a, 120b, 220a, 220b, 320a, 32b, 420a, 420b, 520a', 520b', 520a", 520b", 620a, 620b) are the only surfaces which axially define the fully inserted position of the key in the keyway.

14. A cylinder lock and key system according to any of claims 3-13, wherein the stop members (222a, 222b, 422a, 422b) each define a convexly curved second stop surface (220a, 220b, 420a, 420b) having the same radius of curvature.

15. A cylinder lock and key system according to any of claims 1-14, wherein the keys (500) are reversible and comprise at least two primary first stop surfaces (520a', 520b') at one key blade side and at least two secondary first stop surfaces (520a", 520b") arranged at the opposite key blade side, which secondary first stop surfaces are arranged symmetrically to the primary first stop surfaces with respect to a central axis of the key blade.

16. A cylinder lock and key combination including,

a cylinder lock comprising

a housing having a cylindrical bore; and
a cylindrical plug (200, 400) which is rotatably journaled in the housing about a rotational axis and which exhibits a front end and a keyway (206, 406) 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, 500, 600) comprising

a key bow (102, 302, 502, 602); and
a key blade(104, 304, 504, 604) having opposite key blade sides defining a longitudinal direction; and a height direction which is parallel to the key blade sides and perpendicular to the longitudinal direction, 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, 520a', 520b', 520a", 520b", 620a, 620b) arranged at the key blade, each first stop surface facing forward in the insertion direction; and
- at least two second stop surfaces (220a, 220b, 420a, 420b) 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

the first stop surfaces (120a, 120b, 320a, 320b, 520a', 520b', 520a", 520b", 620a, 620b) are defined by a respective grove (122a, 122b, 322a, 322b) which grooves are formed in one and the same key blade side (106, 306) and that and the second stop surfaces (220a, 220b, 420a, 420b) are arranged on a respective stop member (222a, 222b, 422a, 422b) which protrude laterally into the keyway (206, 406) from one and the same keyway side.

17. A key (100, 300, 500, 600, 700 for a cylinder lock and key system according to any of claims 1-15, which key comprises a key bow (102, 302, 502, 602) and a key blade (104, 304, 504, 604,) with opposite key blade sides defining a longitudinal direction; and a height direction which is parallel to the key blade sides and perpendicular to the longitudinal direction, , 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, 520a', 520b', 520a", 520b", 620a, 620b) 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** the first stop surfaces are defined by a respective grove (122a, 122b, 322a, 322b) which grooves are formed in one and the same key blade side (106, 306)

18. A key blank for producing a key according to claim 17, which key blank comprises a key bow arranged at a rear end of the key blank, a key blade protruding forwardly from the key bow and having opposite key blade sides defining a longitudinal direction and a height direction which is parallel to the key blade sides and perpendicular to the longitudinal direction, 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** the first stop surfaces () are defined by a respective grove () which grooves are formed in one and the same key blade side ().

19. A cylinder lock for a system according to any of claims 1-15, which cylinder lock comprises a housing having a cylindrical bore and a cylindrical plug (200, 400) which is rotatably journaled in the housing about a rotational axis and which exhibits a front end (202, 402) and a keyway (206, 406) having opposite key way 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 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, 420a, 420b) 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** the second stop surfaces (220a, 220b, 420a, 420b) are arranged on a respective stop member (222a, 222b, 422a, 422b) which protrude laterally into the keyway (206, 406) from one and the same keyway side.

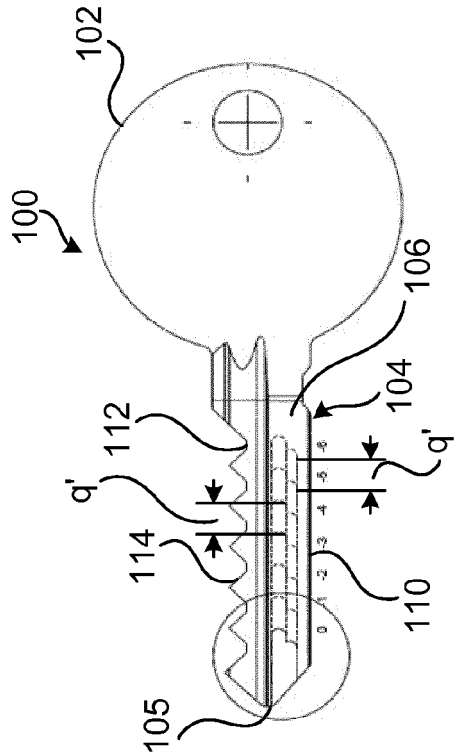


Fig. 1a

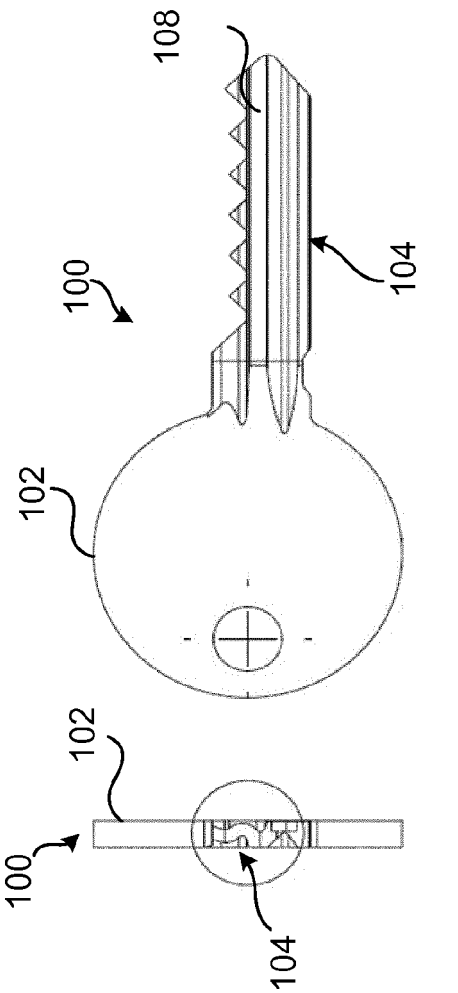


Fig. 1d

Fig. 1c

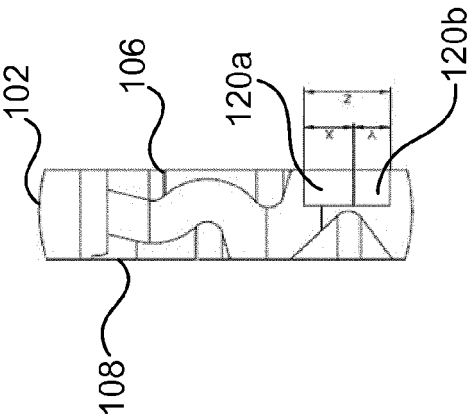


Fig. 1e

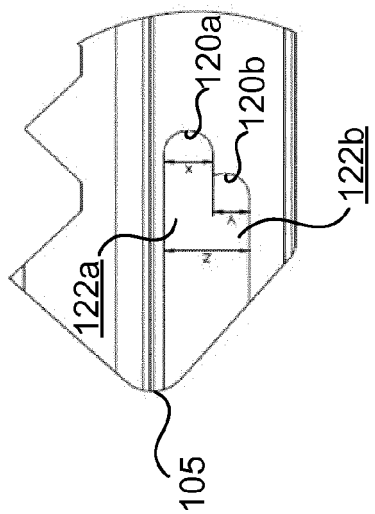


Fig. 1b

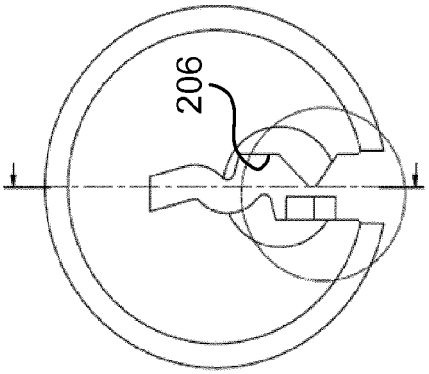


Fig. 2d

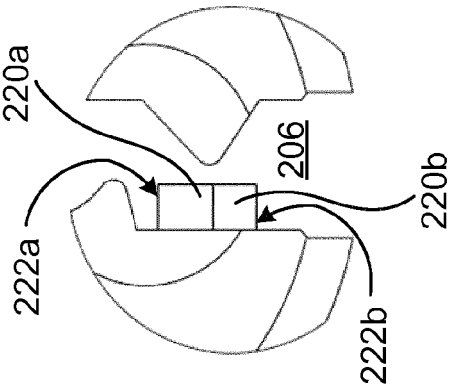


Fig. 2e

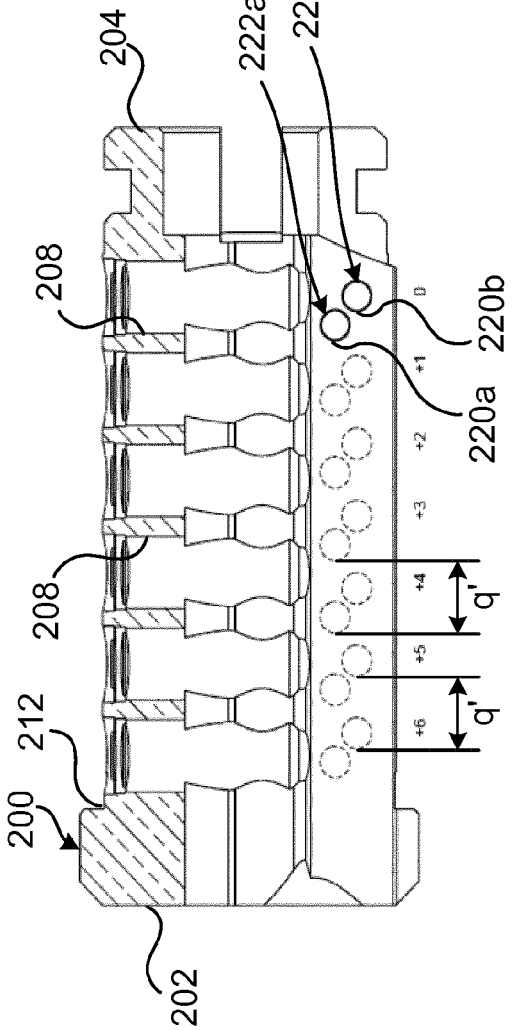


Fig. 2c

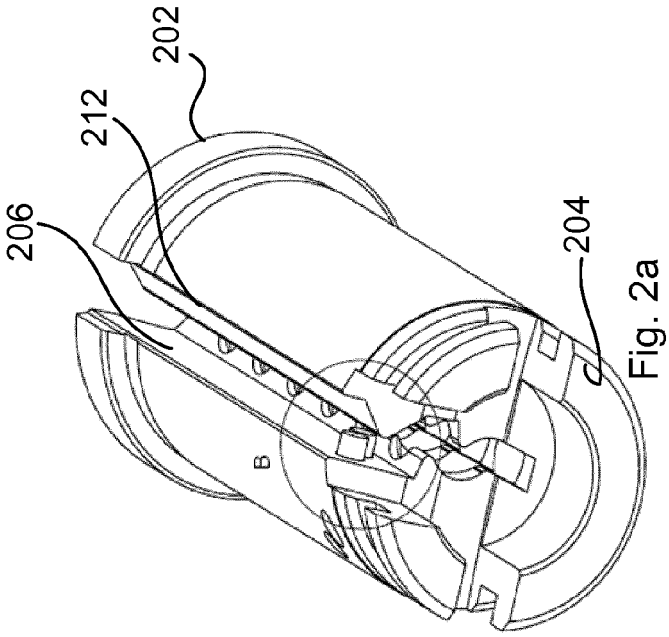


Fig. 2a

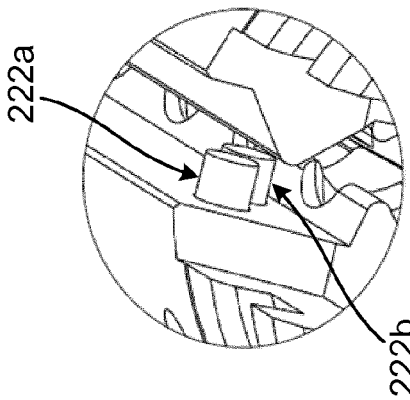


Fig. 2b

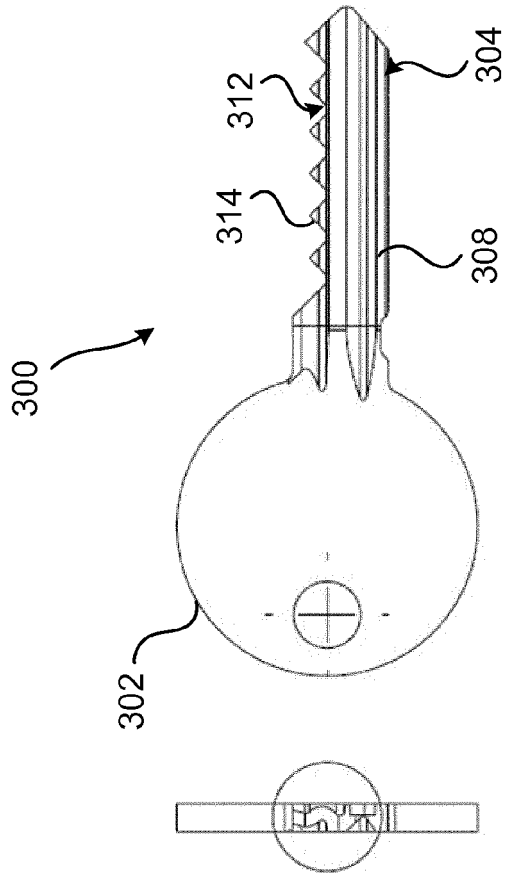


Fig. 3c

Fig. 3d

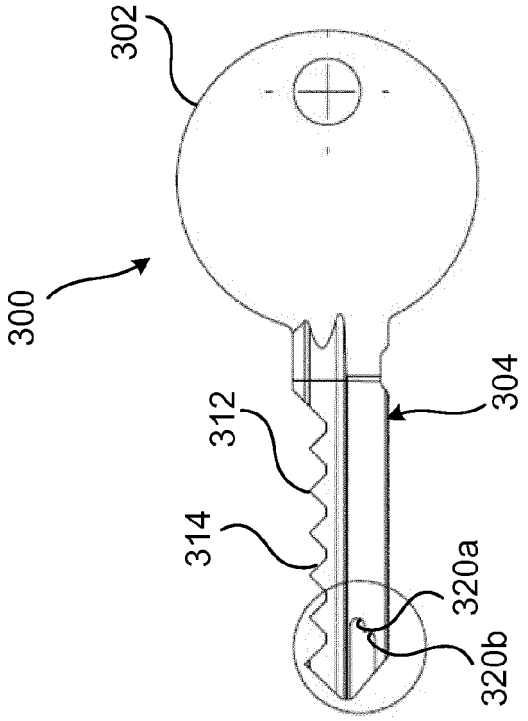
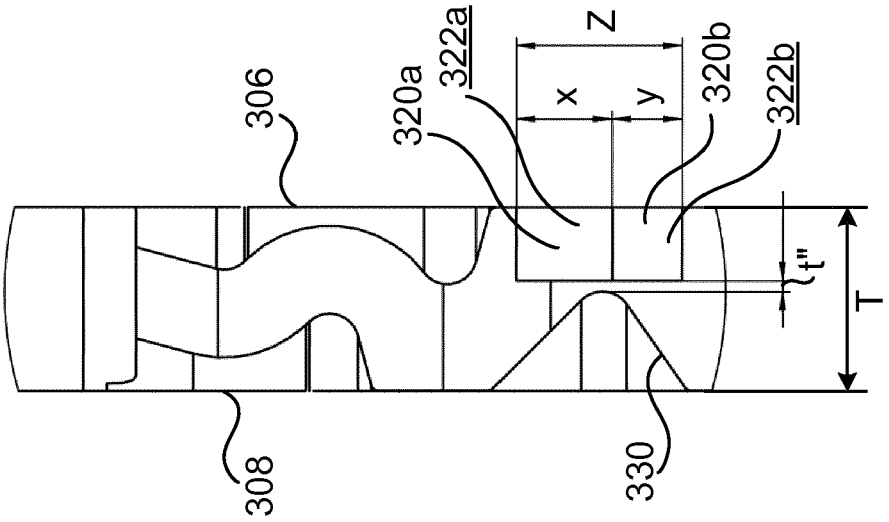


Fig. 3a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320a
322a
Z
x
y
320b
322b
t"
T
308
330

Fig. 3e

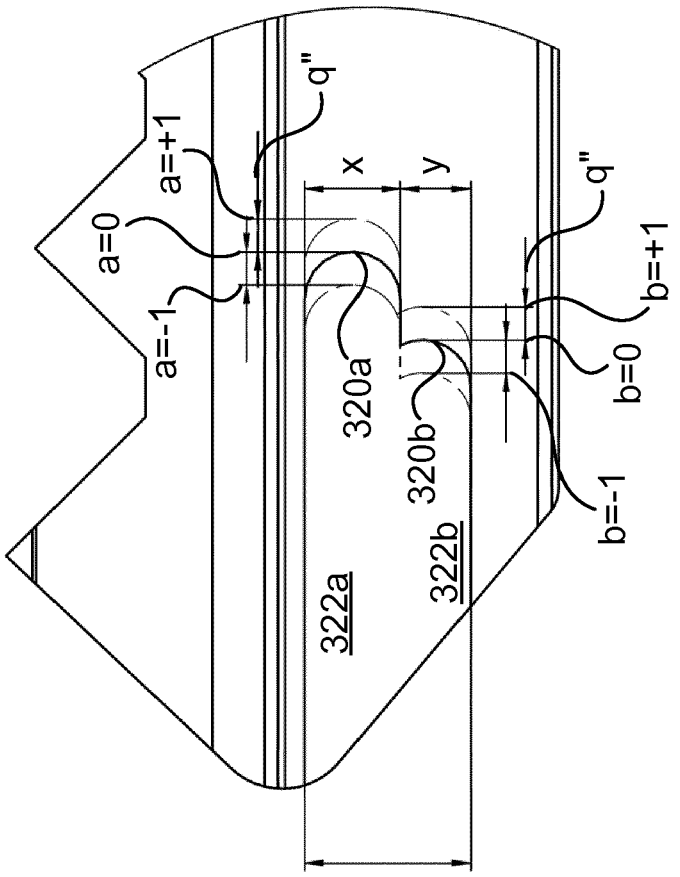
q"
a=+1
a=0
a=-1
x
y
q"
b=+1
b=0
b=-1
320a
320b
322a
322b

Fig. 3b

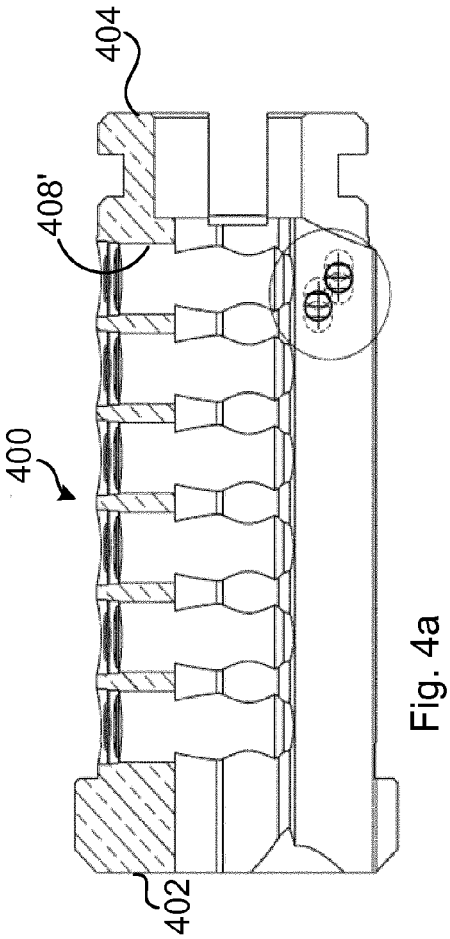

Fig. 4a

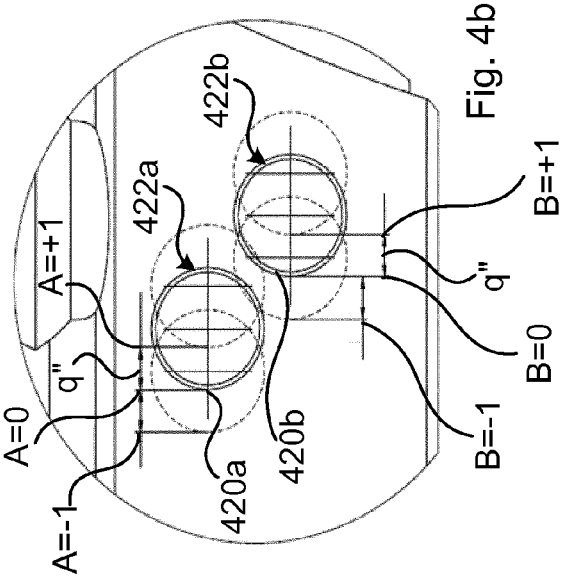

Fig. 4b

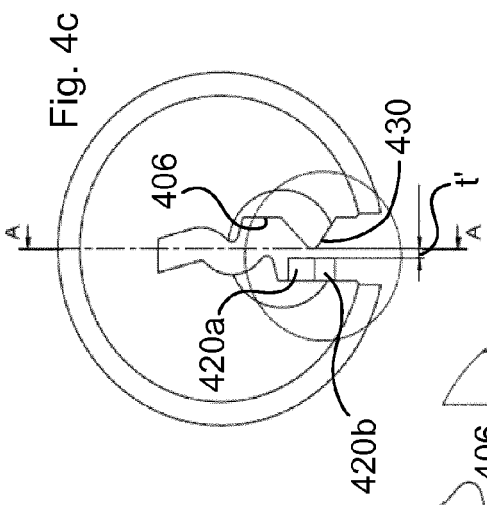

Fig. 4c

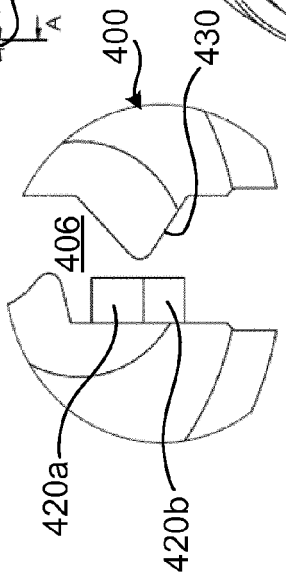

Fig. 4d

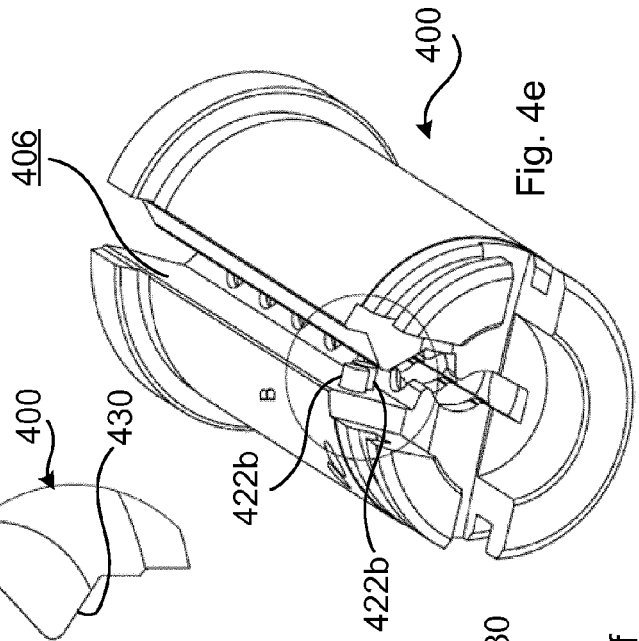

Fig. 4e

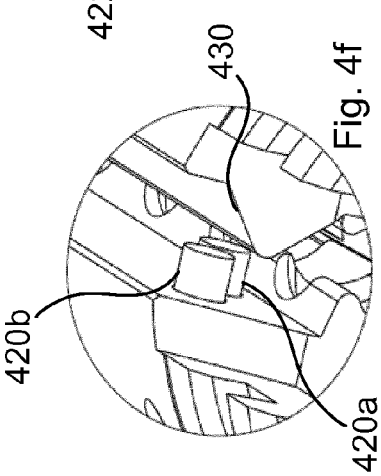

Fig. 4f

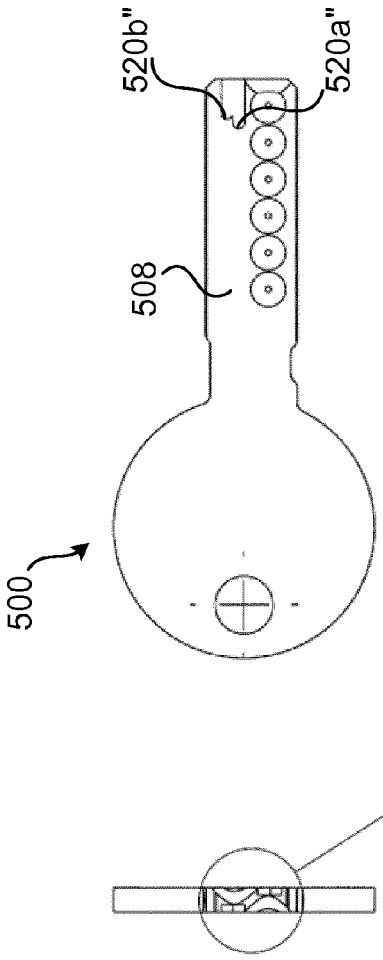

Fig. 5c

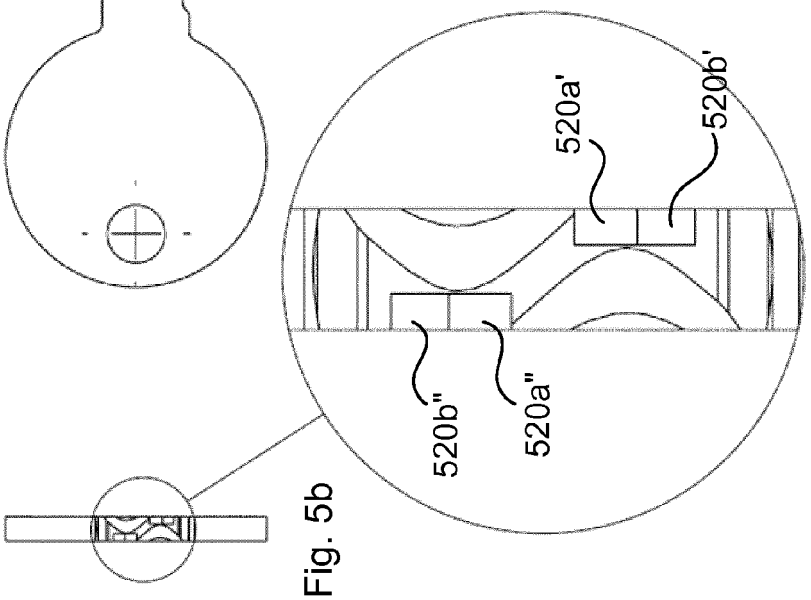

Fig. 5e

Fig. 5b

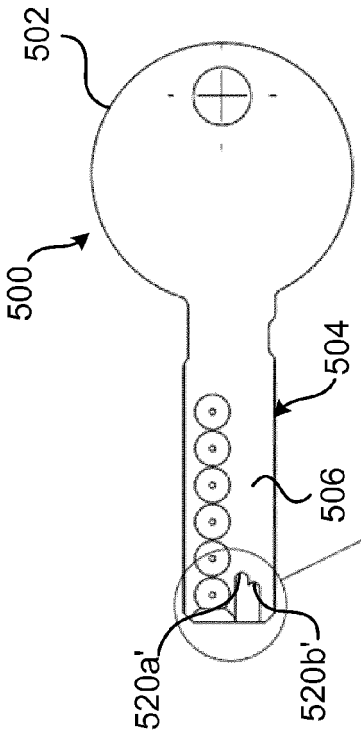

Fig. 5a

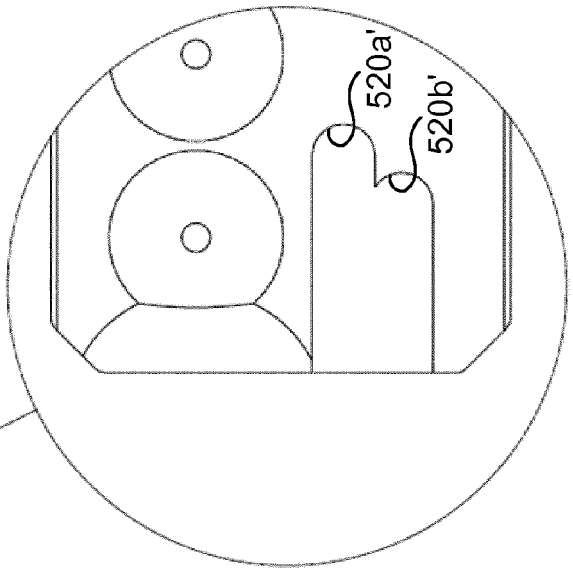

Fig. 5b

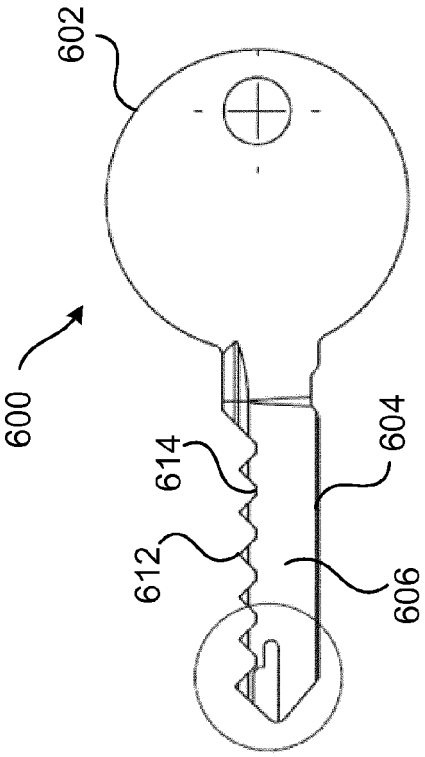
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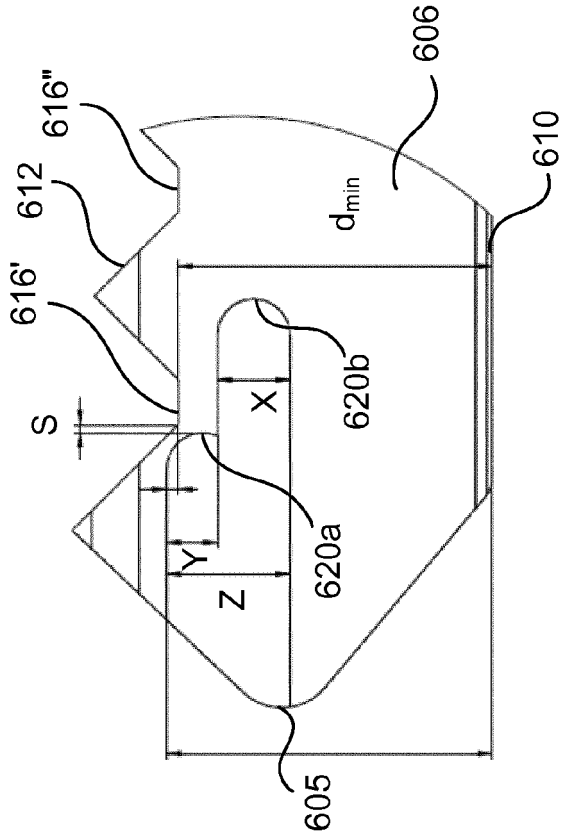
Fig. 6a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616"
610
612
d_{min}
616'
620b
X
S
620a
Y
Z
605

Fig. 6b

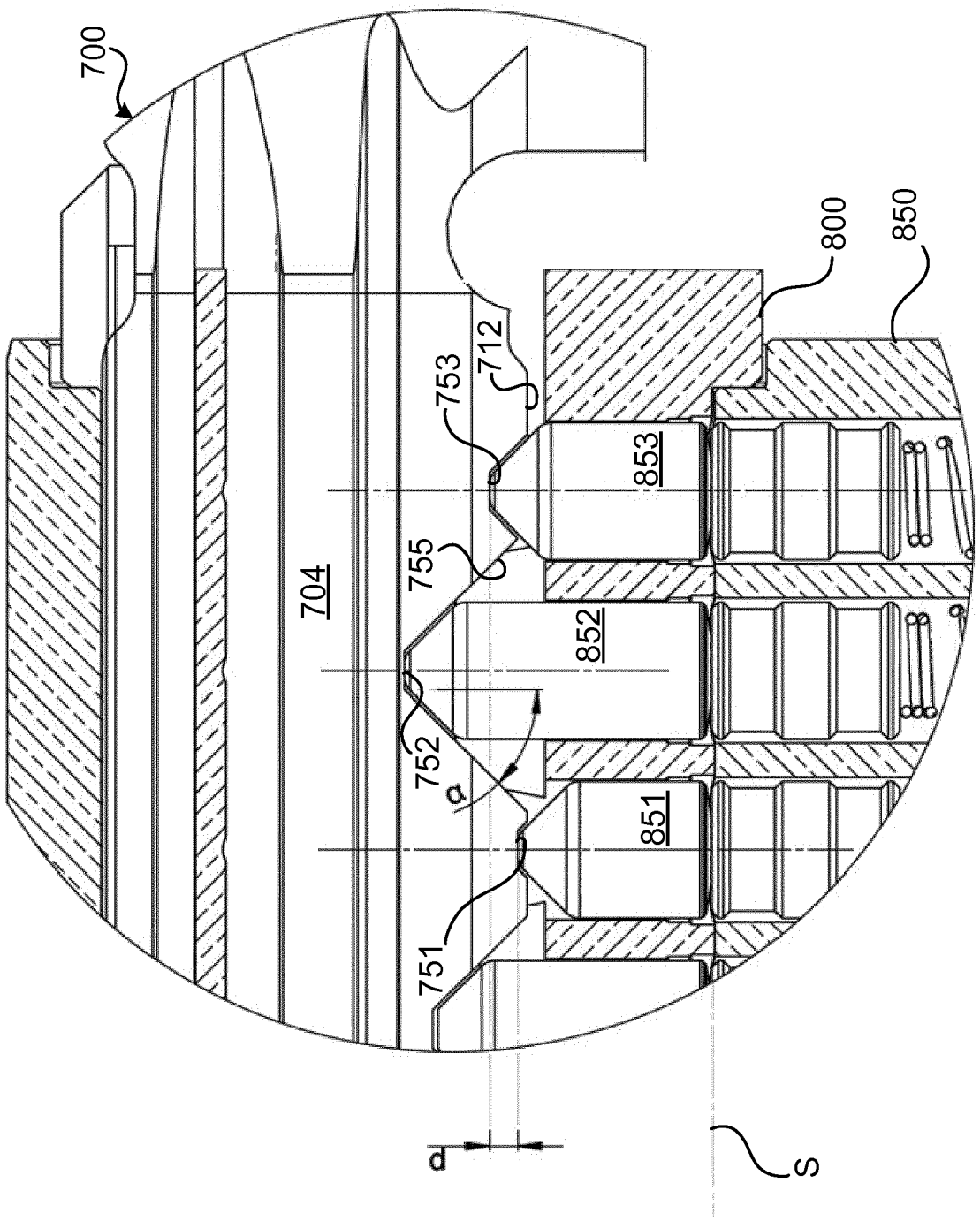

Fig. 7a

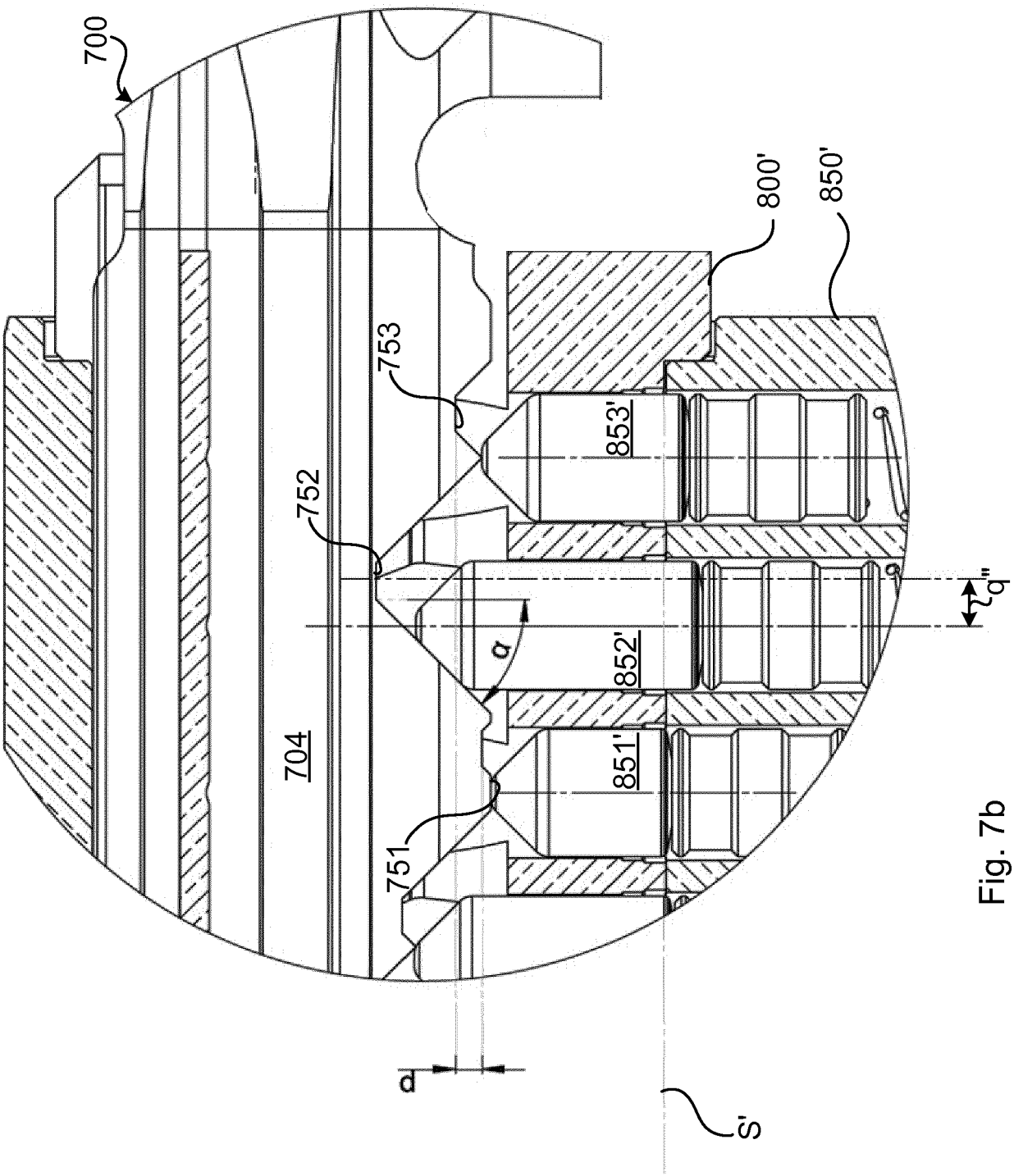

Fig. 7b

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EUROPEAN SEARCH REPORT

Application Number
EP 17 15 7813

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 1 939 377 A1 (BKS GMBH [DE]) 2 July 2008 (2008-07-02) * paragraphs [0021], [0025], [0027], [0041], [0089], [0090]; claims 1-8; figures 1-9 *	1-7,9, 11-19	INV. E05B27/00 E05B15/08
X	DE 200 23 221 U1 (BREMICKER SOEHNE KG A [DE]) 15 May 2003 (2003-05-15) * page 1, line 5 - line 18; figures 3,4a * * page 1a * * page 1b, line 6 - line 26 * * page 2, line 17 - line 20 * * page 3, line 10 - line 21 * * page 11, line 1 - page 12, line 11 *	1,2,5-7, 9,11-14, 16-19	
X	DE 18 12 051 A1 (VOSS KG J) 18 June 1970 (1970-06-18) * pages 4,10; figures 1-17 *	1,2,4-8, 10-19	
X,D	EP 2 360 334 B1 (DORMA GMBH & CO KG [DE]) 1 April 2015 (2015-04-01) * paragraphs [0009], [0010], [0013], [0015], [0026]; figures 1,2 *	1,2,4-9, 11-14, 16-19	TECHNICAL FIELDS SEARCHED (IPC) E05B
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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	7 July 2017	Viethen, Lorenz

CATEGORY OF CITED DOCUMENTS

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