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## KEY FOR A LOCKING CYLINDER

Description

The invention relates to a key for a locking cylinder, comprising a row of locking recesses arranged in a shank, the locking recesses each being delimited by flank contours and having support surfaces for supporting blocking elements of the locking cylinder, the angles of inclination of the flank contours vary over the row of locking recesses.

A locking cylinder of the type mentioned at the outset is known, for example, from GB 1 284 914 A. In this locking cylinder, two locking recesses have a shallower angle of inclination than the other locking recesses.

DE 10 2004 009 166 A1 discloses a key in which recesses for actuating pin tumblers have a free cut. The pin tumblers thus rest on edges of the free cuts. When the key is removed, the associated pin tumblers are moved simultaneously. The speed of movement of the pin tumblers in the case of recesses having free cuts is determined by the contour of the tip of the pin tumblers.

WO 2018/188971 A1 discloses a key in which locking recesses have different angles of inclination of the flank contours. Deep locking recesses have larger angles of inclination than shallower locking recesses. This is intended to create sufficient variation possibilities and to make copying more difficult.

A locking cylinder having a key is known, for example, from WO 2015/114172 A1. The locking cylinder has a plurality of blocking elements of which the distances from one another are different. Locking recesses in the key for controlling the blocking elements have the same distances as the blocking elements. This is to prevent the insertion force from increasing from blocking element to blocking element when inserting the key into the locking cylinder.

Furthermore, EP 2 281 985 A2 discloses a locking cylinder having a key in which the distances between individual blocking elements vary. The key bit control edges for controlling the blocking elements have the same distances as the contact surfaces on the blocking elements. This locking cylinder is designed to make unauthorized unlocking more difficult using a so-called picking method.

DE 298 18 143 U1 discloses a key for a locking cylinder in which latching recesses are provided for controlling blocking elements of the locking cylinder. The latching recesses have latching surfaces to support the blocking element. Transitions of inclined flanks adjacent to the latching surfaces have concavely rounded sliding surfaces. This is to avoid a catch when actuating the locking cylinder.

A disadvantage of the known keys is that the key is held by all blocking elements simultaneously when inserted, since the blocking elements usually each have the same dimensions at their ends facing the locking recesses. Removing the key from the locking cylinder requires a high removal force due to the key being held simultaneously by all blocking elements, as all static friction of the individual blocking elements must be released simultaneously.

The problem addressed by the invention is to further develop a key of the type mentioned at the outset in such a way that the removal force is kept as low as possible when the key is fully inserted into the locking cylinder.

This problem is solved according to the invention in that an increase in the angles of inclination is formed in a predetermined step sequence.

Due to this design, the individual locking recesses no longer have the same angles of inclination of the flank contours. The variance of the angles of inclination means that the blocking elements experience different accelerations when the key is removed. This keeps the removal force particularly low when the key is fully inserted into the locking cylinder. A slowly increasing force curve when removing the key can be easily achieved because an increase in the angle of inclination is formed in a predetermined step sequence.

According to another advantageous development of the invention, the different angles of inclination of the flank contours can be easily produced in limited space conditions if the angle of inclination of a shallow locking recess is smaller than the angle of inclination of a deep locking recess. Since blocking elements penetrating shallow locking recesses only have to be moved a short distance, a shallower angle of inclination is sufficient to control the blocking element. This means that blocking elements penetrating shallow locking recesses experience only slight

acceleration when the key is removed. This keeps the removal force of the key particularly low.

According to another advantageous development of the invention, it contributes to further equalizing the removal force if the increase in the angles of inclination of the flank contours is formed as a continuous series.

According to another advantageous development of the invention, the blocking elements can initially be released with little effort and then accelerated if the angles of inclination of the flank contours are not constant, so that the flank contour has a different angle of inclination at the deepest point of the locking recess than at the shallowest point.

According to another advantageous development of the invention, it contributes to further reducing the removal force of the key if the support surfaces of individual locking recesses have different widths. The variation in the widths of the locking recesses prevents the blocking elements from being controlled simultaneously by the different locking recesses. Rather, the variance of the widths in the locking cylinder causes the blocking elements to be moved in a sequence, since the blocking elements each have the same dimensions at their ends facing the locking recesses.

According to another advantageous development of the invention, a particularly uniform control of the blocking elements when the key is removed can be achieved if an increase in the widths of the locking recesses is formed in a predetermined step sequence. This means that when the key is removed, one blocking element after the other is released.

According to another advantageous development of the invention, a particularly low removal force can be achieved if all widths of the locking recesses or the flank contours of all locking recesses are variable over the row of locking recesses.

According to another advantageous development of the invention, the manufacture of the variably formed locking recesses is particularly cost-effective if the shank has a rectangular cross-section and has a key front and a key back on its narrow sides and if the locking recesses are arranged in the key front. This means that the locking recess is accessible during manufacture from the broad

sides of the shank using a milling or cutting tool and can penetrate the shank. This makes it particularly easy to create the flank contours with great variability.

The invention permits numerous embodiments. For further clarification of its basic principle, several of the embodiments are shown in the drawings and described  
5 below. In the drawings:

Fig.1 shows a locking cylinder having a key inserted therein,

Fig.2 shows an enlarged view of a portion of the key from Fig. 1,

Fig.3 shows a further embodiment of the key from Fig. 2,

Fig.4 shows a portion of a further embodiment of the key,

10 Fig.5 shows a greatly enlarged view of a portion of a locking recess of the key from Fig. 4.

Fig. 1 shows a longitudinal section through a portion of a locking cylinder 1 having a housing 2 and a core 3 rotatably arranged therein. Furthermore, the locking cylinder 1 has a locking bit 4 which is connected to the core 3 for conjoint rotation.  
15 A key 6 for closing the locking cylinder 1 is inserted into a locking channel 5 of the core 3. The locking cylinder 1 has blocking elements 7 designed as pin tumblers for optionally blocking or releasing the movement of the core 3. The blocking elements 7 scan locking recesses 9 arranged in a shank 8 of the key 6 and each have the same dimensions at their ends facing the locking recesses 9.  
20 Furthermore, the blocking elements 7 are arranged at the same distance from each other. The blocking elements 7 each have a core pin 10 guided in the core 3 and a housing pin 11 guided in the housing 2 and a spring element 12 for preloading the housing pin 11 against the core pin 10. The parting planes of the housing pins 11 and the core pins 10 of all blocking elements 7 lie in the parting  
25 plane between the housing 2 and the core 3, so that the core 3 can be rotated together with the locking bit 4 relative to the housing 2.

Fig. 2 shows, in a greatly enlarged representation, the key 6 having the locking recesses 9a - 9e and the blocking elements 7 of the locking cylinder 1 in the

abutting regions. It can be seen that the locking recesses 9a - 9e each have support surfaces 13a - 13e and the core pins 10 are each shaped

like a truncated cone at their ends for supporting the support surfaces 13a - 13e.

The support surfaces 13a - 13e have different widths, where  $x=0$  defines a

5 standard width of the support surfaces 13a - 13e. One of the support surfaces 13e has this width. The remaining support surfaces 13a-13d are widened by a

specified step sequence relative to the standard width and are denoted by  $x+1$  to

$x+4$ . In a step sequence of 0.1 mm, the standard width of the support surface 13a

having the denotation  $x+1$  is widened by 0.1 mm and the support surface 13b

10 having the denotation  $x+4$  is widened by 0.4 mm. When the key 6 is removed, the

blocking element 7 interacting with the locking recess 9e denoted by  $x=0$  is

controlled first and only then is the blocking element 7 interacting with the locking

recess 9a denoted by  $x+1$  controlled. The blocking element 7 interacting with the

locking recess 9b denoted by  $x+4$  is controlled last in terms of time. This means

15 that the static friction forces of the individual blocking elements 7 are overcome

one after the other. Furthermore, the locking recesses 9a - 9e have flank contours

14a - 14e with angles of inclination  $A1$  to  $A5$ . The angles of inclination  $A1$  -  $A5$  vary

over the row of locking recesses 9a - 9e. In the embodiment shown, the angle of

inclination  $A5$  of a shallow locking recess 9e is smaller than the angle of inclination

20  $A4$  of a locking recess 9d machined deeply into the key 6.

Fig. 3 shows a further embodiment of a key 6' which differs from that of Fig. 2 only

in that the step sequences are formed as a continuous series over the locking

recesses 9a' - 9e'.

Fig. 4 shows a portion of a further embodiment of the key 6", which differs from

25 that of Fig. 1 in that flank contours 14a" - 14e" of the locking recesses 9a" - 9e"

have different angles of inclination  $A1''$  to  $A5''$  in their regions abutting the free

ends of the blocking elements 7. The angles of inclination  $A1''$  -  $A5''$  increase over

the row of locking recesses 9a" - 9e", so that the angle of inclination  $A5''$  is greater

than the angle of inclination  $A1''$ . This means that the blocking elements 7

30 experience different accelerations when the key 6" is removed.

The locking recesses 9a" - 9e" of the key 6" from Fig. 4 also have support surfaces 13" of different widths, as shown in Fig. 2 or 3.

Fig. 5 shows, greatly enlarged, one of the locking recesses 9a" from Fig. 4 with the adjacent region of one of the blocking elements 7. It can be seen that the flank contour 14a" is not constant, so that the flank contour 14a" has the angle of inclination A1" at the deepest point, the angle of inclination B1 in the middle region and the angle of inclination C1 in the shallowest region.

## PATENTKRAV

1. Nøgle (6) til en låsecylinder (1) med en række låseudsparinger (9a-9e), der er anbragt i et skæft (8), hvor låseudsparingerne (9a-9e) hver især er afgrænset af flankkonturer (14a-14e) og har understøtningsflader (13a-13e) til understøtning af blokeringsselementer (7) i låsecylinderen (1), hvor flankkonturerne (14a-14e) hældningsvinkler (A1-A5) varierer over rækken af låseudsparinger (9a-9e), **kendetegnet ved, at** flankkonturerne (14a-14e) hældningsvinkler (A1-A5) stiger over rækken af låseudsparinger (9a-9e), **og ved at** stigningen i hældningsvinklerne (A1-A5) er dannet i en forudbestemt trinsekvens.
- 10 2. Nøgle ifølge krav 1, **kendetegnet ved, at** en flad låseudsparings (13e) hældningsvinkel (A5) er mindre end en dyb låseudsparings (13d) hældningsvinkel (A4).
3. Nøgle ifølge enten krav 1 eller 2, **kendetegnet ved, at** en stigning i flankkonturerne (14a-14e) hældningsvinkler (A1-A5) er dannet som en  
15 kontinuerlig række.
4. Nøgle ifølge mindst et af kravene 1 til 3, **kendetegnet ved, at** flankkonturerne (14a-14e) hældningsvinkler (A1, B1, C1) ikke er konstante, således at flankkonturen (14a-14e) har en anden hældningsvinkel (A1, B1, C1) på det dybeste punkt af låseudsparingen (9a"-9e") end på det fladeste punkt.
- 20 5. Nøgle ifølge mindst et af kravene 1 til 4, **kendetegnet ved, at** enkelte låseudsparingers (9a-9e) understøtningsflader (13a-13e) har forskellige bredder.
6. Nøgle ifølge mindst krav 5, **kendetegnet ved, at** en stigning i låseudsparingerne (9a-9e) bredder er dannet i en forudbestemt trinsekvens.
7. Nøgle ifølge mindst et af kravene 1 til 6, **kendetegnet ved, at** alle bredder  
25 af låseudsparingerne (9a-9e) eller flankkonturerne (14a-14e) i alle låseudsparinger (9a"-9e") er variable over rækken af låseudsparinger (9a-9e).
8. Nøgle ifølge mindst et af kravene 1 til 7, **kendetegnet ved, at** skæftet (8) har et rektangulært tværsnit og har en nøgleforside og en nøglebagside på de smalle sider, **og ved at** låseudsparingerne (9a-9e) er anbragt i nøgleforsiden.

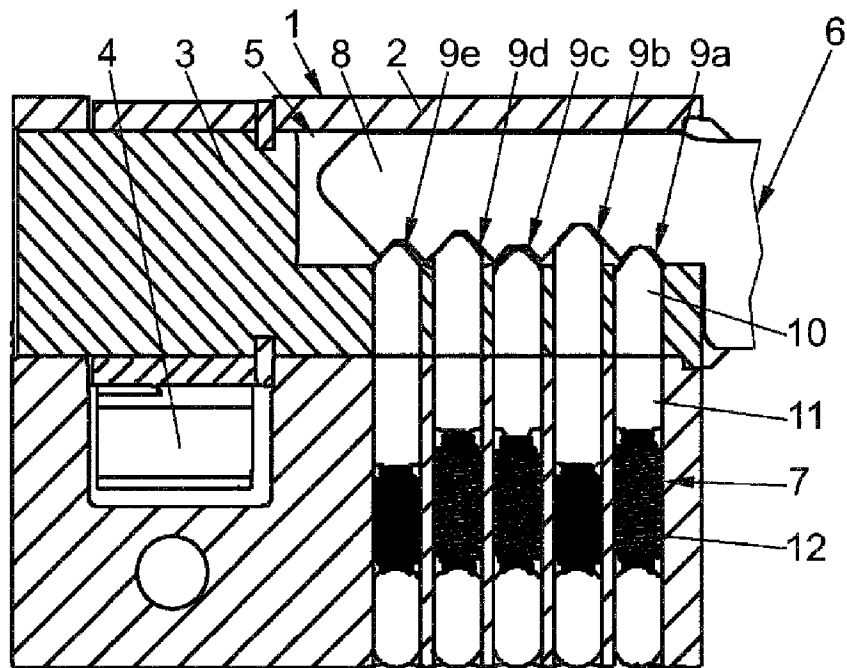


FIG 1

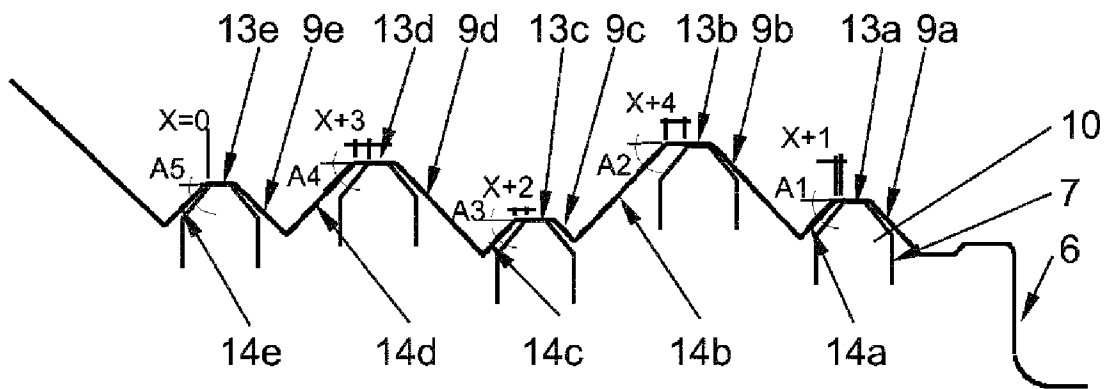


FIG 2

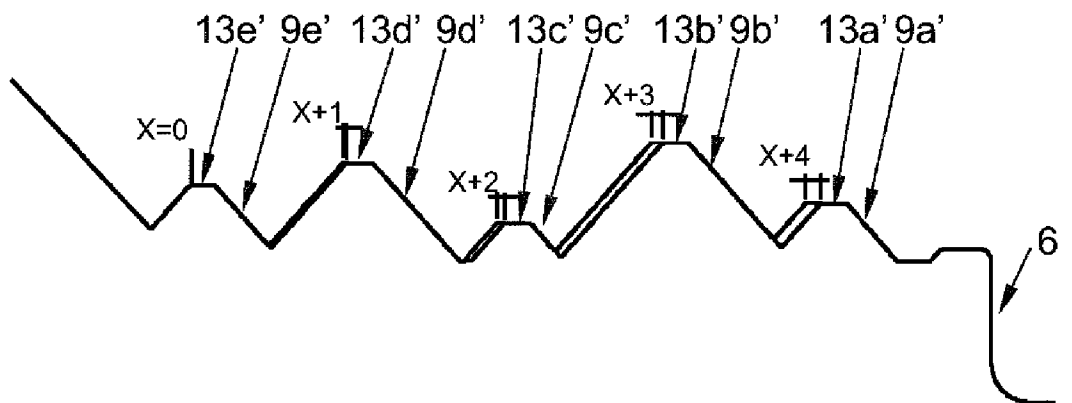


FIG 3

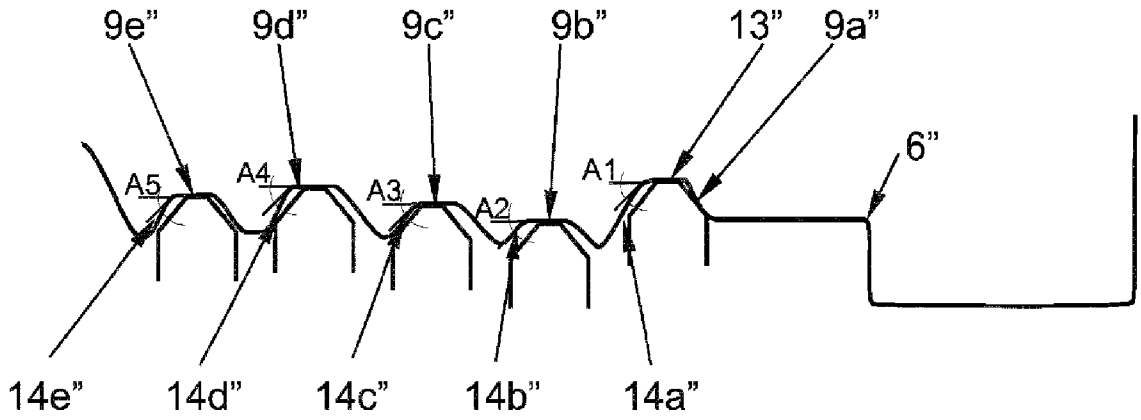


FIG 4

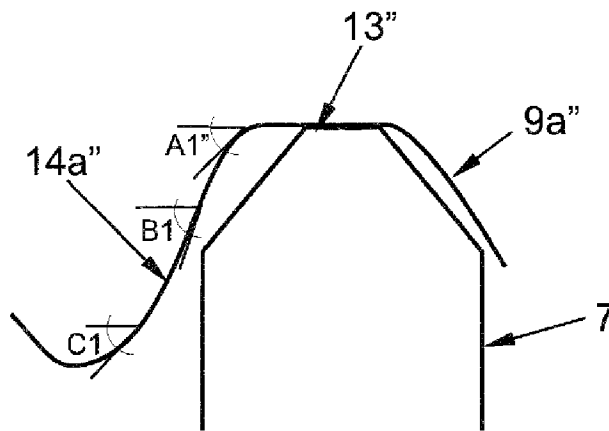


FIG 5