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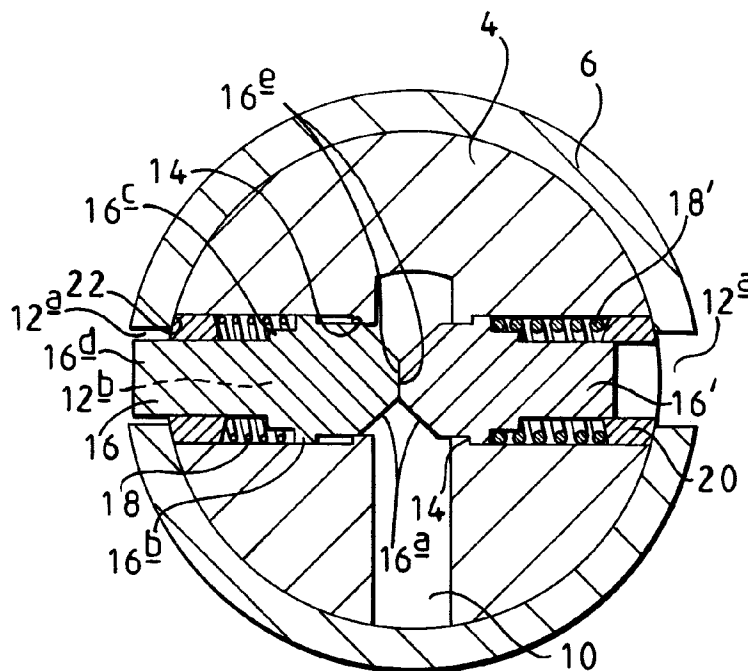
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AL LT LV MK RO SI(30) Priority: **18.07.1997 GB 9715114**(71) Applicant: **Cowper, Brian****New Malden, Surrey KT3 3HP (GB)**(72) Inventor: **Cowper, Brian****New Malden, Surrey KT3 3HP (GB)**(74) Representative: **Prutton, Roger****MARKS & CLERK,****Alpha Tower,****Suffolk Street Queensway****Birmingham B1 1TT (GB)**(54) **Lock cylinder**

(57) A key-operable lock cylinder (2) comprises a rotor (4), a stator (6), a keyway (10) extending axially into the rotor (4) and a plurality of locking pins (16, 16'). The rotor (4) is mounted within the stator (6) for rotation about its axis and a plurality of transverse passageways (12) extend through the rotor (4) and the stator (6) and intersect the keyway (10). A pair of the locking pins (16, 16') are slidably mounted in each passageway (12) and the locking pins (16, 16') of a pair are resiliently biased

so as to be in mutual abutment within the keyway (10) by a biasing means associated with each locking pin (16, 16'), such that one locking pin (16, 16') of each pair projects across an interface (22) between the rotor (4) and stator (6) so as to prevent rotation of the rotor (4). In use, when a complementary key (30) is inserted in the keyway (10), the locking pins (16, 16') are movable by the key (30) such that all the locking pins (16, 16') become located entirely within the rotor (4), so as to permit rotation of the rotor (4) (Fig 2).

**FIG 2****EP 0 892 130 A2**

Description

The present invention relates to an improvement in the design of locks. More specifically, the present invention is concerned with improvements to pin-tumbler type locks.

A conventional pin-tumbler lock cylinder comprises a rotor rotatably mounted within a stator. The rotor has an axial keyway and a plurality of transverse holes which are aligned with blind passages in the stator. A pair of locking pins in mutual abutment are slidably mounted in each of said passages and biased by a spring located in the blind passage such that one pin of each pair is located in the rotor and the other pin of each pair projects across the interface between the rotor and stator so preventing rotation of the rotor. When the correct key is inserted, the pins are urged against their bias to a position in which the interfaces between the pins of each pair are aligned with the interface between the rotor and stator, thereby allowing rotation of the rotor. On rotation of the rotor, one pin of each pair is retained in the stator, the other in the rotor. If the wrong key is inserted, one or more pair(s) of pins is/are misaligned thereby preventing rotation.

Such a lock is vulnerable to being picked by a method in which a tool is inserted into the keyway and a slight torsion applied while a second tool is used to sequentially urge each pair of pins into alignment. The ease with which this is achieved is dependent upon the tolerances at which the pins, passages and transverse holes are machined. Conventionally, the stator is part cylindrical with a lobed region in which the pins are located. Such a stator is relatively difficult and expensive to manufacture.

It is an object of the present invention to provide a pin-tumbler lock cylinder which obviates or mitigates the above-stated disadvantages of known pin-tumbler lock cylinders.

According to a first aspect of the present invention, there is provided a key-operable lock cylinder comprising a rotor, a stator, said rotor mounted within the stator for rotation about its axis, a keyway extending axially into the rotor, a plurality of locking pins and a plurality of transverse passageways extending through said rotor and said stator and intersecting said keyway, a pair of said locking pins being slidably mounted in each passageway, wherein for each pair, the locking pins of a pair are resiliently biased so as to be in mutual abutment within the keyway by a biasing means associated with each locking pin, such that one locking pin of each pair projects across an interface between the rotor and stator so as to prevent rotation of the rotor, whereas in use, when a complementary key is inserted in the keyway, the locking pins are movable by said key such that all the locking pins become located entirely within the rotor, so as to permit rotation of the rotor.

Thus, it is to be understood that for each pair of pins, the total length of the pins must not exceed the diameter

of the rotor.

Advantageously, the stator may have a circular section. This is easier and less expensive to manufacture than the conventional lobed stator.

The total length of a pair of pins may be less than the diameter of the rotor, such that the pins of a pair do not necessarily abut when the complementary key is in the keyway. However, the smaller the total length of a pair of pins relative to the diameter of the rotor, the less accuracy is required in positioning of the pins to allow the rotor to rotate, so reducing the security of the lock cylinder.

Preferably, for each pair of pins, the total length of the pins is substantially the same as the diameter of the rotor. In this case, the pins of a pair will be in mutual abutment when the complementary key is in the keyway and there will only be one location along the transverse passageway where abutment of the pins is possible to allow rotation of the rotor.

The pins may have different lengths. For the lock cylinder to be operated, the complementary key must correctly position each pair of pins. The number of different lengths of pin and the number of pairs of pins determines the number of possible key configurations.

Preferably six pairs of pins (and transverse passageways) are provided.

Preferably, a first pin of each pair is selected from one of five lengths of pin, said five lengths chosen such that the second pin of each pair may be selected from the same five lengths of pin, such that the total length of the pair is substantially the same as the diameter of the rotor. Thus, only five different pins are required to be manufactured as opposed to as many as ten in the case where the five lengths of the first pin are chosen at random. If necessary, more possible key configurations can be provided by increasing the number of pins and/or increasing the number of different lengths of pin from which the first pin of each pair is selected. Preferably, the number of possible key combinations is increased by varying the axial spacing of the transverse passageways between different lock cylinders.

Preferably, one pin of each pair is biased more strongly than the other pin of the pair. In the case where the pins of a pair are of unequal length, the shorter pin is more strongly biased. This helps to ensure that one pin of each pair projects across the interface between the rotor and stator when no key is in the keyway. Preferably, the biasing means is a compression spring.

Preferably, for each pair, the pins are shaped (eg. tapered, ramped or curved) at the ends of abutment so as to facilitate movement of the pins by the key. Most preferably, the pins are tapered.

Preferably, the keyway has a centre line which is offset from the axis of the rotor.

According to a second aspect of the present invention, there is provided a key for use with a lock according to said first aspect, said key having a handle and a shank, said shank fitting in the keyway and provided with

a row of recesses along its length on a first major surface and a row of recesses on an opposite major surface such that said recesses on the first and the opposite major surfaces are aligned in pairs so as to be capable of accommodating the locking pins.

Preferably said recesses are tapered. More preferably said aligned pairs of recesses are interconnected, so as to form a plurality of passages between said first and opposite major surfaces, said passages having a restriction therein where the recesses are interconnected.

The recesses may be of different depths. Thus, in the case where the recesses are interconnected, the position of the restriction relative to the first and opposite major surfaces may vary from one passage to another.

Preferably, first and second rows of aligned recesses are provided, said rows being offset by an equal distance from a centre line of the shank and each recess in the first row on the first major surface being identical to the corresponding recess in the second row on the opposite major surface, similarly for the recesses in the second row on the first major surface and the corresponding recesses in the first row on the opposite major surface.

Thus, it will be understood that the shank of the key has a C_2 -axis of rotational symmetry, such that when the key is inserted in its complementary lock having a keyway with a centre line offset from the axis of the rotor, the key can operate the lock irrespective of the orientation of the shank in the keyway.

Preferably, the shank is tapered at an end remote from the handle so that in use, separation of the pins to allow insertion of the shank into the keyway is facilitated.

Embodiments of the present invention will now be described by way of example, with reference to the accompanying drawings in which:-

Fig 1 is a perspective view of an embodiment of a lock cylinder according to the present invention,

Fig 2 is a sectional view of part of the lock cylinder shown in Fig 1,

Fig 3 is a sectional view of part of the locking cylinder of Fig 1 with its complementary key inserted,

Fig 4 is a sectional view of part of the locking cylinder of Fig 1 with a metal rod inserted,

Fig 5 is a sectional view of a different embodiment,

Fig 6 is a perspective view of a key, and

Fig 7 is a cross sectional view of the key of Fig 6.

Referring to Figs 1 and 2, the lock cylinder 2 shown is that which is more fully described in copending British Patent Application No. 9715111.2. As far as it relates to the present invention, the lock cylinder 2 comprises a cylindrical rotor 4, a stator 6 of annular cross section and a cam 8. The rotor 4 has an axially extending keyway 10 which is eccentrically located along a diameter of the rotor 4. The rotor 4 is received by and is a close sliding fit in the stator 6. The cam 8 is driveably coupled with

the rotor 4. A row of six transverse passages 12 pass through the rotor 4 and stator 6 intersecting the keyway 10.

A region 12a of each passage 12 through the stator 6 is narrower than a region 12b of the passage 12 through the rotor 4. At each interface of the passage 12 with the keyway 10, an annular seat 14 is provided. In each passage 12 is located a pair of locking pins 16, 16'. Each pin 16, 16' has a tapered end region 16a, an annular rim 16b, a stepped region 16c and a cylindrical end region 16d. In a rest position shown (Fig 2), the pins 16, 16' abut each other at ends 16e adjacent the tapered end regions 16a. The clearance between the end region 16d of the pin 16 and the region 12a of the passage 12 is not critical. This permits lower tolerances in the diameter of the region 12a of the passage 12 and in the pitch between adjacent regions 12a. In conventional locks, the rotor and stator passages must be accurately aligned to avoid a shoulder at the stator-rotor interface. Since the pins must be able to move freely across the interface, a shoulder on which a pin might catch would reduce the security of the lock.

The pins 16, 16' are resiliently biased towards each other by a compression spring 18, 18' associated with each pin. Each spring 18, 18' is held in place by the annular rim 16b of its associated pin 16, 16', at one end, and an annular collar 20 at a second end, said collar 20 abutting the stator 6 at an interface 22 between the rotor 4 and stator 6. For each pair of pins 16, 16', one compression spring 18' is more strongly biased. In the case where the pins 16, 16' are of different lengths, the shorter pin 16' is provided with the more strongly biased spring 18' (as shown, Fig 2). For, each pin 16, 16', the distance from the end 16e of the pin 16, 16' to the rim 16b is such that in the rest position shown (Fig 2) the longer pin 16 projects across the interface 22 between the rotor 4 and stator 6. If the pins 16, 16' are equal in length, either may be provided with the more resilient spring 18'.

The lock as described is secure against picking by the previously mentioned method of applying torsion. Although it might be possible to urge one pin 16, 16' outwardly, the other pin 16', 16 will become easily locked across the interface 22 because the bias of the relatively weak spring 18', 18 will be overcome by any slight torsion. Physically pulling the pin 16', 16 into the rotor 4 would be extremely difficult.

Referring to Figs 6 and 7, a key 30 comprises an integrally formed handle 32 and a shank 34. The shank 34 is tapered at a free end 36. On a first major surface 38a, the shank 34 has first 40a and second 40b rows of tapered recesses 42a, 42a' along its length, said rows 40a, 40b being positioned either side of a centre line. The recesses 42a, 42a' interconnect with tapered recesses 42b, 42b' on an opposite major surface 38b of the shank 34. For each row position in the first row 40a, the depth of the interconnecting recess 42b on the opposite major surface 38b is the same as the depth of the

recess 42a' in the same row position of the second row 40b of the first major surface 38b, similarly for the second row 40b, i.e the shank 34 has a C₂-axis of rotational symmetry along its length.

In use, with no key 30 in the keyway 10, the pins 16, 16' projecting across the interface 22 between the rotor 4 and stator 6 prevent the rotor 4 from being turned (Fig 2). If an object such as a screwdriver 50 (Fig 4) is inserted in the keyway 10 (Fig 4) the pins 16, 16' are urged outwardly against their bias such that both pins 16, 16' of each pair project across the interface 22. A similar situation arises for at least one pair of pins 16, 16' if a non-complementary key is inserted in the keyway 10

In order to free the rotor 4 for rotation, the shank 34 of the complementary key 30 must be inserted in the keyway 10. This is facilitated by the tapered end region 36 of the key 30 which moves the pins 16, 16' apart as the shank 34 is inserted. The symmetrical nature of the shank 34 removes the requirement of placing the key 30 in the keyway 10 in the correct orientation, since either of the possible orientations will have the same effect.

Referring to Fig 3, the complementary key 30 is correctly positioned in the lock and the first row 40a of interconnected recesses 42a, 42b on the shank 34 is aligned with the locking pins 16, 16'. The other row 40b of interconnecting recesses 42a', 42b' is inoperative and not shown. The pins 16, 16' are urged into and received into the recesses 42a, 42b, the pins 16, 16' being a close fit therein. The ends 16e of the pins 16, 16' of a pair may abut, but the radial position of each pin 16, 16' is primarily determined by the depth of the recess 42a, 42b in which it is seated. The pins 16, 16' and recesses 42a, 42b correspond so that the end regions 16d of the pins 16, 16' do not project across the interface 22 between the rotor 4 and the stator 6, so allowing the rotor 4 to be turned.

Referring to Fig 5, an alternative embodiment is shown in which, with the key 30 correctly positioned in the keyway 10, one pin 16 is not in contact with the shank 34 of the key 30, so that only the radial position of the second pin 16' is determined by the depth of the recess 42b in which it is seated, the radial position of the first pin 16 being solely determined by the position of the second pin 16' with which it is in abutment. The second pin 16' which is seated in the recess 42b of the key 30 is provided with the more resilient spring 18'.

Claims

1. A key-operable lock cylinder (2) comprising a rotor (4), a stator (6), said rotor (4) mounted within the stator (6) for rotation about its axis, a keyway (10) extending axially into the rotor (4), a plurality of locking pins (16, 16') and a plurality of transverse passageways (12) extending through said rotor (4) and

said stator (6) and intersecting said keyway (10), a pair of said locking pins (16, 16') being slidably mounted in each passageway (12), wherein for each pair, the locking pins (16, 16') of a pair are resiliently biased so as to be in mutual abutment within the keyway (10) by a biasing means (18, 18') associated with each locking pin (16, 16'), such that one locking pin (16) of each pair projects across an interface (22) between the rotor (4) and stator (6) so as to prevent rotation of the rotor (4), whereas in use, when a complementary key (30) is inserted in the keyway (10), the locking pins (16, 16') are movable by said key (30) such that all the locking pins (16, 16') become located entirely within the rotor (4), so as to permit rotation of the rotor (4).

2. A lock cylinder (2) in accordance with Claim 1, characterised in that the pins (16, 16') of at least one pair of pins have different lengths.

3. A lock cylinder (2) in accordance with Claim 1 or 2, characterised in that for each pair of pins (16, 16'), the total length of the pins (16, 16') is substantially the same as the diameter of the rotor (4) such that the pins (16, 16') of a pair are adapted to be in mutual abutment when the complementary key (30) is in the keyway (10).

4. A lock cylinder (2) in accordance with Claim 3, characterised in that a first pin (16) of each pair is selected from one of five lengths of pin, said five lengths chosen such that the second pin (16') of each pair may be selected from the same five lengths of pin.

5. A lock cylinder (2) in accordance with any preceding claim, characterised in that six pairs of pins (16, 16') and six transverse passageways (12) are provided.

6. A lock cylinder (2) in accordance with any preceding claim, characterised in that the transverse passageways (12) are not evenly spaced axially along the rotor (4).

7. A lock cylinder (2) in accordance with any preceding claim, characterised in that one pin (16, 16') of each pair is biased more strongly than the other pin (16', 16) of the pair.

8. A lock cylinder (2) in accordance with Claim 7 when appended to any one of claims 2 to 6, characterised in that the shorter pin (16') is more strongly biased.

9. A lock cylinder (2) in accordance with any preceding claim, characterised in that for at least one pair, the pins (16, 16') are shaped at their ends (16e) of mutual abutment so as to facilitate movement of the pins (16, 16') by the key (30).

10. A lock cylinder (2) in accordance with Claim 9, characterised in that the pins (16, 16') of at least one pair are tapered.
11. A lock cylinder (2) in accordance with any preceding claim, characterised in that the keyway (10) has a centre line which is offset from the axis of the rotor (4). 5
12. A key (30) for use with a lock cylinder (2) in accordance with any preceding claim, said key (30) having a handle (32) and a shank (34), characterised in that said shank (34) is adapted to fit in the keyway (10) and is provided with a row of recesses (42a) along its length on a first major surface (38a) and a row of recesses (42b) on an opposite major surface (38b) such that said recesses (42a, 42b) on the first and the opposite major surfaces (38a, 38b) are aligned in pairs so as to be capable of accommodating the locking pins (16, 16'). 10 15 20
13. A key (30) in accordance with Claim 12, characterised in that said aligned pairs of recesses (42a, 42b) are interconnected, so as to form a plurality of passages between said first and opposite major surfaces (38a, 38b), said passages having a restriction therein where the recesses (42a, 42b) are interconnected. 25
14. A key (30) in accordance with Claim 12 or 13, characterised in that the recesses (42a, 42b) of an aligned pair are of different depths. 30
15. key (30) in accordance with any one of Claims 12 to 14, characterised in that first (42a, 42b) and second (42a', 42b') rows of aligned recesses are provided, said rows being offset by an equal distance from a centre line of the shank (34) and each recess (42a) in the first row on the first major surface (38a) being identical to the corresponding recess (42b') in the second row on the opposite major surface (38b), similarly for the recesses (42a') in the second row on the first major surface (38a) and the corresponding recesses (42b) in the first row on the opposite major surface (38b). 35 40 45
16. A key (30) in accordance with any preceding claim, characterised in that the shank (34) is tapered at an end (36) remote from the handle (32) so that in use, separation of the pins (16, 16') to allow insertion of the shank (34) into the keyway (10) is facilitated. 50

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