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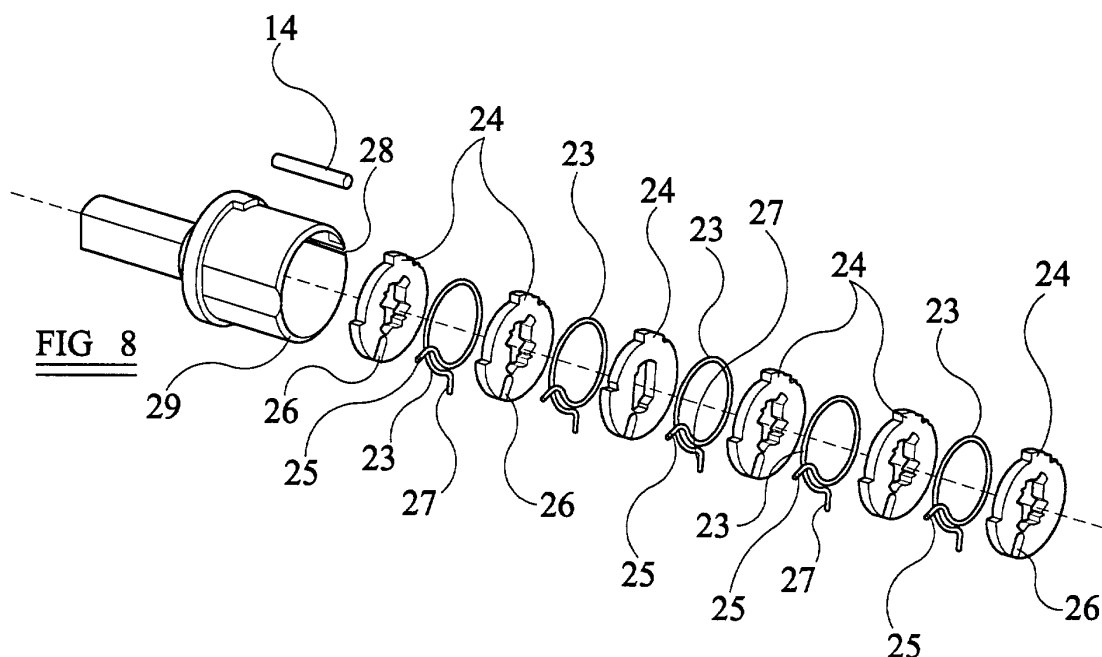
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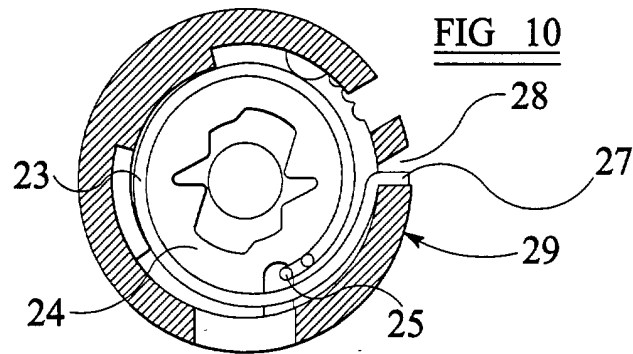
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(54) **Rotary tumbler cylinder lock**

(57) A rotary cylinder lock comprising a barrel (10,31) angularly movable in a housing (13) and a plurality of angularly movable, axially spaced tumblers (24) within the barrel. The tumblers have respective notches (12) which can be brought into alignment by operation of a correct key to allow a blocking member (14) to enter said aligned notches and allow angular movement of the

barrel. In one embodiment tumblers are biased away from their respective positions, in which the blocking member can enter their respective notches, by torsion springs (23) at one side of a tumbler. Additionally the pack of tumblers can be sub-divided into two or more independent tumbler sub-packs by one or more dividers (39). In another embodiment, the biasing is by compression springs (30) at the circumference of the tumblers.





Description

[0001] This invention relates to rotary cylinder locks, and in particular automotive rotary tumbler locks. Locks of this type are disclosed, for example, in our UK Patent No. 2266119B and in European Patent No. 0215237B.

[0002] The basic mechanism of a rotary tumbler cylinder lock, shown in Figures 1 to 7, comprises a barrel 10 shown in Figures 1A, 2A and 3A, which houses an axial series of rotary tumblers 11 shown in Figures 1B, 2B and 3B, each having a peripheral notch or pocket 12 located at a predetermined position and such that each tumbler can be turned by a correct key through a respective angle to align all the notches. The barrel is normally blocked against rotation relative to an outer housing 13 by a peripheral locking or roller bar 14 held in a recess 15 in the outer housing and extending across the shear line into the barrel. The locking bar is normally prevented from moving inwardly away from this position (Figure 4A) by resting on the peripheries of the tumblers. When, during unlocking, the tumblers are turned to align all their notches/roller pockets with the locking bar, however, the locking bar can be received within the channel collectively formed by the tumbler notches (Figure 4B) and pass out of the housing recess to permit rotation of the barrel to an unlocking position (Figure 4C).

[0003] During locking, the key is rotated in the locking sense, thereby rotating the barrel to a position (Figure 5A) where the bar 14 is forced out of engagement. Further rotation of the key rotates the tumblers to engage an internal stop face of the barrel (Figure 5B) and rotates the barrel to a positive stop provided externally. The key is then returned to a vertical position (Figure 5C) ready for extraction.

[0004] The tumblers have central key apertures 16 collectively defining a keyway and each tumbler is turned through the correct angle to receive the locking bar by means of a correctly angled cut on the key bit engaging part of the edge of the respective key aperture. Upon return rotation of the key and barrel from the unlocking position the locking bar is returned to its barrel-blocking position in the recess of the outer housing and, as the key moves back to its insertion and withdrawal (or "zero") position, the tumblers are scattered to misalign their notches by the engagement of part of the key bit with another part of the edge of the respective key apertures. Movement of the locking bar into the aligned tumbler notches when the mechanism is unlocking is normally achieved by a camming action of the bar against an inclined face of the outer housing recess under torque applied to the barrel, and return movement of the bar into the housing recess when the barrel is returning to zero may be achieved e.g. by means of an external torsion spring 17 or by a camming action of the tumbler notches against the bar - in which latter case the bar may be of cylindrical form, i.e. a roller. Figure 6 shows other components of the lock assembly, namely a barrel return bush 18, a retaining clip 19 and a bearing

washer 20.

[0005] An automotive rotary tumbler lock has recognised advantages when compared with the disc type lock which is also in popular use. The simple internal mechanism of the former generally prevails where combined climatic extremes of high humidity and cold may be sufficient to cause freezing. This is especially important in the case of externally mounted locks. Resistance to freezing due to fewer internal parts is a particularly valuable attribute of the rotary lock, but in terms of security, its innate simplicity is also a weakness. It is known that both systems can be picked or 'jiggled' within a certain time span, usually by persons possessing the necessary skills for legitimate business reasons, for example, qualified Locksmiths. There is however latterly evidence that picking is now being employed by car thieves.

[0006] An object of the invention is to improve the pick-resistance of a rotary tumbler lock, preferably by introducing modification(s) which do not detract from the system's fundamental mechanical simplicity or design robustness.

[0007] According to the invention there is provided a rotary cylinder lock comprising a housing, a barrel angularly movable in the housing, a plurality of angularly movable, axially spaced tumblers within the barrel, the tumblers having respective peripheral notches which can be brought into alignment by operation of a correct key to allow a blocking member to enter said aligned notches and allow angular movement-of the barrel, wherein at least one tumbler is biased away from its position in which said blocking member can enter its notch.

[0008] The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1A shows a barrel and tumbler arrangement of a known rotary cylinder lock, with respective notches of the tumblers out of alignment, corresponding to a locked state,

Figure 1B schematically shows the tumblers of Figure 1A and a locking bar,

Figures 2A and 2B respectively correspond to Figures 1A and 1B, but show the tumbler notches substantially aligned,

Figures 3A and 3B respectively correspond to Figures 2A and 2B, but show the locking bar in the aligned notches of the tumblers, corresponding to a state of the lock in which it can be unlocked,

Figures 4A to 4C are cross-sectional views of the known lock, corresponding respectively to successive states of unlocking the lock,

Figures 5A to 5C are views corresponding to Fig-

ures 4A to 4C, but showing successive locking states,

Figure 6 is an exploded perspective view showing components of the known lock,

Figure 7 is an exploded perspective view of spacers and tumblers of a barrel component shown in Figure 6,

Figure 8 is a view equivalent to Figure 7, but showing the interior components of the barrel according to one embodiment of the present invention,

Figures 9A to 9D show in detail respective tumblers of Figure 8,

Figure 10 is a cross-sectional view of a lock of said one embodiment of the present invention,

Figure 11 is a cross-section of the barrel shown in Figure 10,

Figure 12 is a view equivalent to Figure 8, but in respect of a further embodiment of the present invention,

Figure 13 is an enlarged view, corresponding generally to Figure 10, of said further embodiment of the present invention,

Figure 14 is an exploded perspective view of the interior components of a barrel of a lock of the present invention in a still further embodiment, and

Figure 15 is an enlarged longitudinal cross-sectional view through an assembled barrel within the lock housing of said still further embodiment.

[0009] As described for the prior art rotary tumbler lock illustrated in Figures 1 to 7, the tumblers 11, generally 6 or 8 in number, are usually separated by respective spacer elements 21. The function of the spacer elements is to provide separation between adjacent tumblers, so that when the key is inserted into the lock, only the active facets of the key, known as the 'cuts', engage each tumbler. Without spacer elements, there would be a risk of a key-cut falsely operating the adjacent tumbler (s), owing to variations in manufacturing tolerances. Since the tumbler is free in the rotational sense, the spacer, which is fixed with respect to the barrel 10, acts as a separator to prevent false rotation. To prevent spontaneous rotation of the tumblers due to vibration, it is usual to have one of the spacers in the form of a spring washer, for example as indicated by the numeral 22, to provide a small degree of axial loading.

[0010] To operate the lock, the key is inserted and turned either clockwise or counterclockwise, according

to the hand of the lock. If the key is suited to the lock, full rotation is permitted allowing the locking or roller bar 14 to free the engagement between the barrel 10 and the housing 13. Further rotation of the key turns the barrel with respect to the housing and thus can cause a coupled device, such as a latch, to release. The means of rotating the barrel by the key can be via one or more of the tumblers, or by the engagement of the chisel-end of the key with drive dogs formed in the barrel, or both.

[0011] From the above, it can be appreciated that by utilising a simple tool, a locksmith or similarly skilled person could exploit the passive action of the rotary tumblers within the rotary tumbler lock.

[0012] If a tumbler were to be moved angularly from its initial position, i.e. that shown in Figures 4A and 5C, for instance by using a special lock-picking tool, it will remain at that set position. If then, by means of skill and knowledge, the operator manipulates each tumbler in turn into position as if by the suited key, the security of the lock is potentially breached.

[0013] To counter this potential breach, the present invention resides generally in the changed status of the rotary tumblers from a passive to an active function.

[0014] One embodiment of the invention will now be described with reference to Figures 8 to 11. By comparing Figure 8 with the corresponding view shown in Figure 7 for the prior art lock arrangement, it can be seen that the spacers 21, including the spring washer 22, have been replaced by respective torsion springs 23. All but one tumbler 24 of this embodiment has a torsion spring 23 housed in the annular space previously occupied by the spacer element. One end 25 of the spring 23 engages the tumbler 24 at its periphery, being received in a notch or pocket 26 of the tumbler. The other end 27 of the spring locates, as shown in Figure 10, in a recess 28 provided in the barrel, this recess being shown in Figures 8, 10 and 11. By this means, all but said one tumbler is actively biased away from its operating position, thus inhibiting picking. The tumbler which is not sprung will depend upon whether the locking is anticlockwise or clockwise. For example if there is anticlockwise locking, the tumbler 24 directly adjacent the barrel in Figure 8 will be sprung whilst the tumbler 24 furthest from the barrel in the row of tumblers will not be sprung, and this can be appreciated by considering the direction in which the end 25 of the spring 23 is turned, this end being at right angles to the general plane of the spring coil. Conversely if there is clockwise locking, the arrangement will effectively be reversed so that this tumbler furthest from the barrel as viewed in Figure 8, will be sprung whilst the tumbler nearest the barrel, as shown in Figure 8, will not be sprung. To facilitate end-loading, the function of the spring washer 22 is catered for by each spring 23 being specified with a slight helix, as can be seen to some degree from Figure 8. It will be appreciated that there will be an improvement, albeit slight, in the security of the lock even if only one of the tumblers is provided with this biasing from its 'operative'

position. However generally it is desirable that where n tumblers are provided, $n-1$ are so biased.

[0015] Figures 9A to 9D respectively show the construction of the tumblers of Figure 8, with each tumbler 24 having a notch 26 for the end 25 of the spring. With regard to the arrangement shown in Figure 8, it would normally be the case that the tumblers shown in Figures 9A to 9D respectively would be the first four tumblers positioned in the direction moving away from the barrel, with the furthest most two tumblers being further tumblers identical to the first two, i.e. those shown in Figures 9A and 9B respectively. In Figures 8, 10 and 11, the barrel is indicated by the numeral 29, this barrel differing from the one described in relation to the prior art arrangement, in having the recess 28 formed as an elongate slot in its periphery.

[0016] A second embodiment of the invention is shown in Figures 12 and 13. Here the spacer elements 21, and spring washer 22, are retained, the biasing being by way of compression springs 30 at the circumference of each tumbler and acting between the tumbler and the barrel 31.

[0017] As shown in detail in Figure 13, the barrel is provided with an internal, generally radial stop surface 32 and each tumbler 33 has two stop surfaces 34, 35 respectively angularly spaced around its periphery. The stop surfaces are generally radially disposed, and are arranged so that, as shown in Figure 13, the surface 34 engages an internal radially extending stop surface 36 of the barrel in the locked state of the assembly, this stop surface 36 being, in this example, angularly spaced by only a few degrees around the interior of the barrel from the stop surface 32. In this position the stop surface 35 of the tumbler 33 is spaced approximately 45° around the interior of the barrel from the stop surface 32 and between this stop surface 35 of the tumbler 33 and the stop surface 32 of the barrel is defined a part annular space in which the compression spring 30 is received, as shown in Figure 13. Accordingly in this position the biasing force of the compression spring acts upon the tumbler 33 to force its surface 34 against the stop surface 36 of the barrel, so that the notch 37 of the tumbler is out of alignment with the recess 38 in the barrel where the locking bar of the assembly is located.

[0018] Although of different construction, the effect of this alternative embodiment is the same as with the first embodiment described, in that the tumbler shown in Figure 13 is actively biased away from its operating position, i.e. where its notch 37 is aligned with the recess 38, thus inhibiting picking. With this second embodiment, there is a compression spring 30 at the circumference of every tumbler. As a result, not only does this system retain the spacer (and spring washer) components, it also allows all the tumblers to be active, in contrast to the first embodiment described, where one of the tumblers remains passive. Again it is believed that it would be feasible to have only one of the tumblers biased as described, although, again, picking would be

best resisted by all of the tumblers being so biased.

[0019] The first and second embodiments disclose a rotary cylinder lock, the fundamental security of which is improved as compared to similar types of such locks disclosed, for example, in UK Patent No. 2266119B and European Patent No. 0215237B. Security in this instance means the device's ability to resist actuation by means of manipulation (picking or jiggling), or by any method that avoids intrinsic damage, with the exception of an authorised key. As disclosed with said first and second embodiments, the fundamental security is improved by the addition of return springs acting on the majority of the tumblers within the lock barrel component. By making one or more of the tumblers 'active', i.e. sprung, the lock can be made 'jiggle' resistant to basic Locksmiths' tools.

[0020] It is known, however, that specifically designed tools are commercially available to Locksmiths and professional trades persons of that ilk, and with some practice these may be employed to defeat a sprung tumbler system. For example, if such a tool was designed so as to allow the operator, during picking, to nullify the return action of the springs, the operation could be completed to overcome the security of the lock.

[0021] The legitimate need within the trade to pick locks is generally accepted, for example, in the case of lost keys. However it is generally the preference of the purchaser, whether an individual or a vehicle manufacturer, to request the maximum level of security. The refinement of the first and second embodiments, as will be described hereinafter, demonstrates how such a customer requirement could be fulfilled in order to resist actuation by known special tools.

[0022] In accordance with a third embodiment of the present invention, a rotary cylinder lock of the invention has the tumblers thereof sub-divided into at least two independent arrangements. For example for a lock with six tumblers, these would be divided into two independent sub-packs each of three tumblers or alternatively of four and two tumblers respectively. In another arrangement, for example with eight tumblers, the pack of tumblers could be divided into three independent sub-packs or arrangements of three, three and two tumblers respectively. Preferably each division is by way of a metallic divider which is fixed relative to the lock barrel.

[0023] As stated, this invention relates to a refinement of the first and second embodiments of the present invention.

[0024] Figures 14 and 15 illustrate the refinement of said third embodiment of the present invention. In particular it will be noted by comparing Figure 14 with Figure 8 that the middle torsion spring, i.e. that biasing the third tumbler from the barrel as shown in Figure 8 of said earlier application is removed and replaced by a divider 39, which can be in the form of a metallic plate with a generally centrally circular opening therethrough. Components identical with those shown in Figure 8 are numbered as in that Figure.

Figure 15 shows a typical arrangement according to this third embodiment of the present invention, where the barrel 10 contains six tumblers 17 within the pack. However this number can be varied and equally well could be eight or ten. As shown in Figure 15 there are four tumbler return springs in the form of said torsion springs 18. However the tumbler nearest the open end of the barrel is not biased, and moreover the middle torsion spring, as viewed in Figure 15, is replaced by the divider 39 which separates the pack of six tumblers into two sections. It can be seen that the divider is shaped so as to be received through a slot 40 in the barrel and to engage the barrel diametrically, and thus become an 'integral' part thereof when fully assembled on a coaxial centre line.

[0025] The width of the divider is identical to that of a torsion spring 23, so that it thus preserves the pitch between adjacent tumblers. When the barrel is assembled into its respective housing 11, and retained by the washer 20 and clip 19, each tumbler group or sub-pack resides independently in an end space either side of the divider. Thus all the biased tumblers are free to rotate against the return force of their associated torsion spring, without binding. Since the depth 'X' of the barrel is always slightly greater than 'Y' (the depth occupied by the assembled tumbler pack), the tumblers cannot be trapped by an axial force which may be applied externally during attempted picking of the lock. Since the tumbler pack is divided into two independent sub-packs, the complexity of lock manipulation is compounded. It is therefore anticipated that a special tool capable of simultaneously blocking both tumbler sub-packs and providing a third element for picking or jiggling would be complex and cumbersome for practical use.

[0026] It will be appreciated that the divider could be disposed other than at the centre of the pack of tumblers as shown in Figures 14 and 15. For example for a lock with six tumblers, it could be positioned nearer one end of the barrel or the other to divide the pack into two sub-packs of four and two tumblers respectively or vice versa. It will also be appreciated that more than one divider could be provided. For example for a barrel provided with eight tumblers, the pack of tumblers could be divided into three independent arrangements or sub-packs of three, three and two tumblers respectively.

Claims

1. A rotary cylinder lock comprising a housing (13), a barrel (10,31) angularly movable in the housing, a plurality of angularly movable, axially spaced tumblers (24) within the barrel, the tumblers having respective notches (12) which can be brought into alignment by operation of a correct key to allow a blocking member (14) to enter said aligned notches and allow angular movement of the barrel, **characterised in that** at least one tumbler (24) is biased

away from its position in which said blocking member (14) can enter its notch (12).

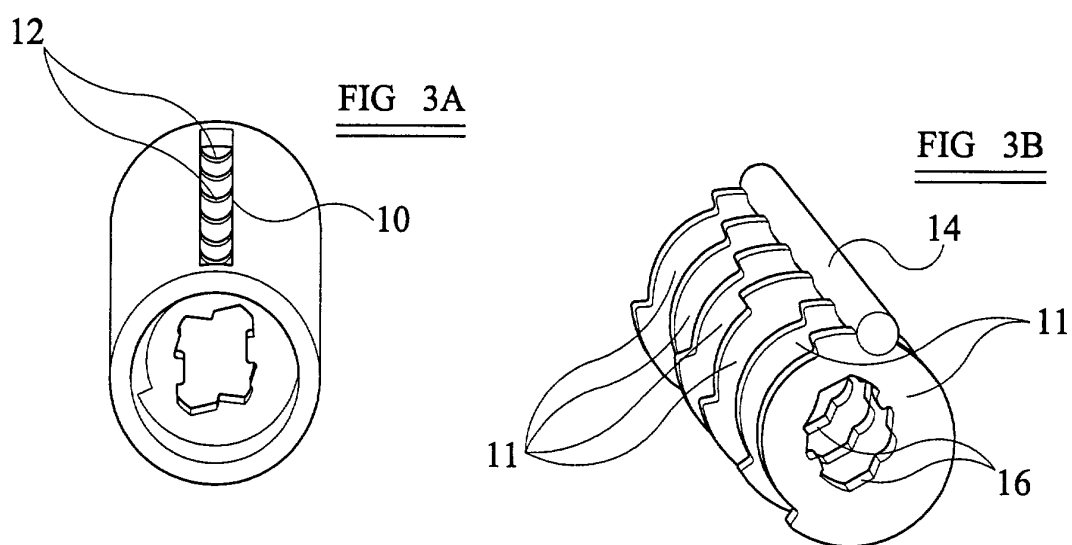
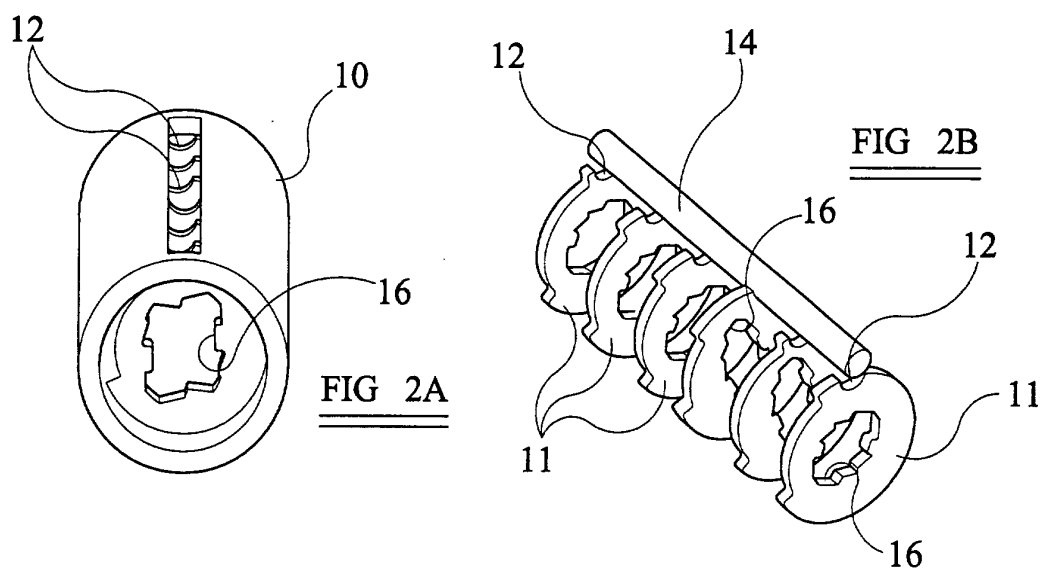
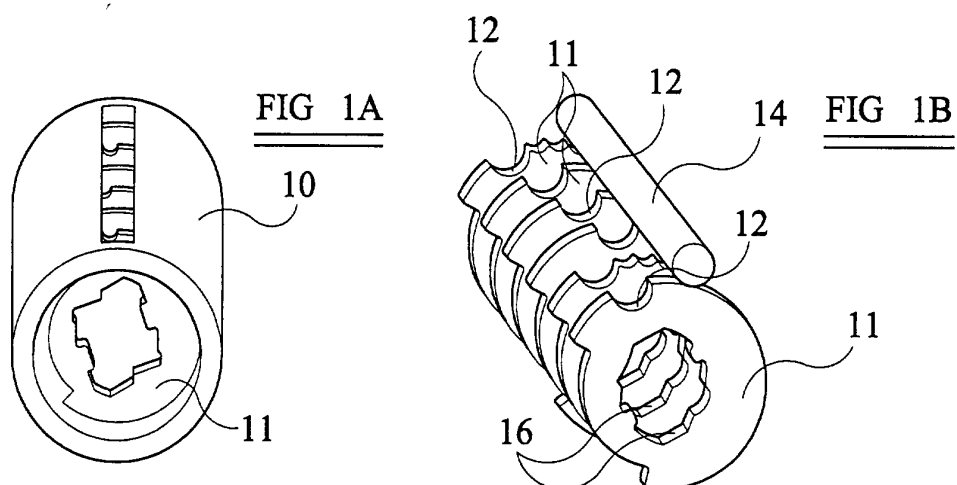
2. A lock as claimed in Claim 1, wherein said at least one tumbler (24) is biased away from its position in which said blocking member (14) can enter its notch (12) by means of a torsion spring (23).
3. A lock as claimed in Claim 2, wherein one end (25) of the torsion spring (23) engages with its associated tumbler and the other end (27) of the torsion spring engages with the barrel.
4. A lock as claimed in Claim 3, wherein said one end (25) of the torsion spring is at right angles to the plane of the coil of the torsion spring and locates in a recess (26) in the tumbler.
5. A lock as claimed in Claim 2 or Claim 3, wherein said other end (27) of the torsion spring locates in a recess (28) in an inner wall of the barrel.
6. A lock as claimed in Claim 5, wherein said recess (28) in the inner wall of the barrel extends through said wall to form a slot, and said slot extends along the length of the barrel parallel to the longitudinal axis thereof.
7. A lock as claimed in any one of Claims 3 to 6, wherein the torsion spring (23) is helical.
8. A lock as claimed in any one of Claims 1 to 7, comprising a pack of n tumblers (24), where $n \geq 2$, and $n - 1$ tumblers are biased.
9. A lock as claimed in Claim 8, wherein the unbiased tumbler is at one end of the pack of tumblers.
10. A lock as claimed in any one of Claims 1 to 9, in which a pack of at least two tumblers is provided, the pack being sub-divided into at least two independent sub-packs.
11. A lock as claimed in Claim 10, wherein the or each division of the packs is by means of a divider (39) fixed relative to the barrel.
12. A lock as claimed in Claim 11, wherein the or each divider (39) is a plate engaged in at least one slot (40) in the barrel.
13. A lock as claimed in Claim 11 or Claim 12, wherein the or each divider (39) has a central circular opening therethrough.
14. A lock as claimed in any one of Claims 11 to 13, wherein the or each divider (39) is disposed between adjacent tumblers,

15. A lock as claimed in Claim 14, wherein the width of the divider (39) is such as to preserve the pitch between adjacent tumblers.
16. A lock as claimed in Claim 1, wherein said at least one tumbler (24) is biased away from its position in which said blocking member (14) can enter its notch (12) by means of a compression spring (30). 5
17. A lock as claimed in Claim 16, wherein the compression spring (30) acts between the tumbler and the barrel. 10
18. A lock as claimed in Claim 17, wherein the compression spring (30) acts at the circumference of the tumbler. 15
19. A lock as claimed in Claim 18, wherein one end of the spring engages a first stop surface (32) of the barrel, and the other end of the spring engages a first stop surface (35) of the tumbler. 20
20. A lock as claimed in Claim 19, wherein the spring is received in a part annular space defined between said first stop surface (32) of the barrel and said first stop surface (35) of the tumbler. 25
21. A lock as claimed in Claim 19, wherein the tumbler is biased by the compression spring (30) to a position where a second stop surface (34) of the tumbler engages a second stop surface (36) of the barrel. 30
22. A lock as claimed in any one of Claims 19 to 21, wherein when said tumbler is in said biased position, its first stop surface (35) is spaced approximately 45° around the interior of the barrel from said first stop surface (32) of the barrel. 35
23. A lock as claimed in any one of Claims 16 to 22, comprising a pack of n tumblers, wherein $n \geq 2$, and all the tumblers are biased. 40

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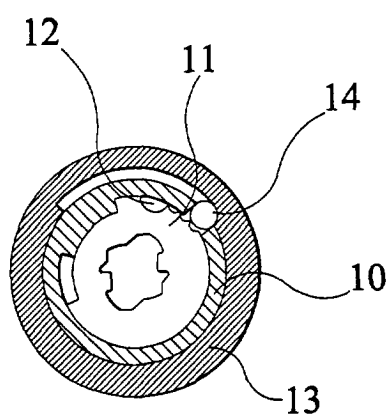


FIG 4A

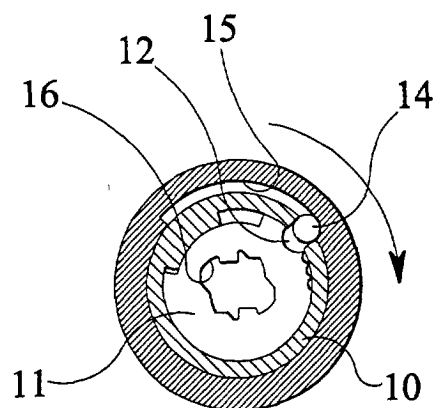


FIG 4B

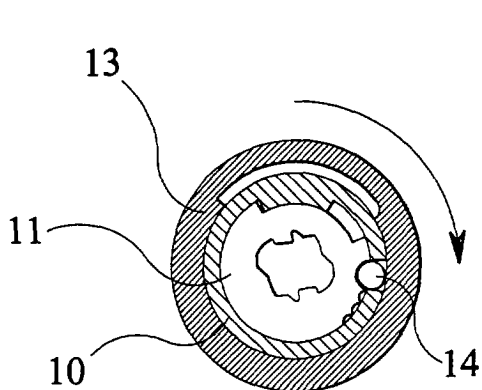


FIG 4C

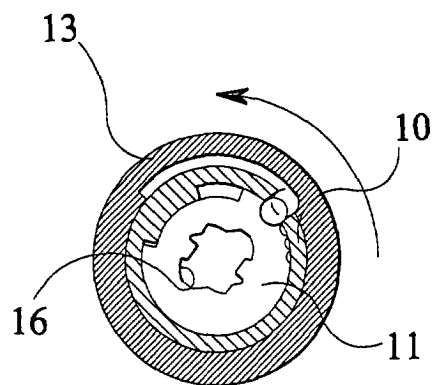


FIG 5A

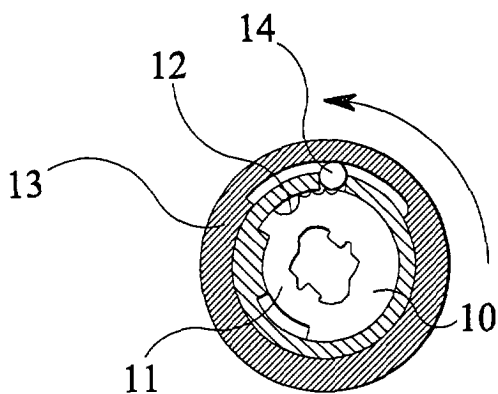


FIG 5B

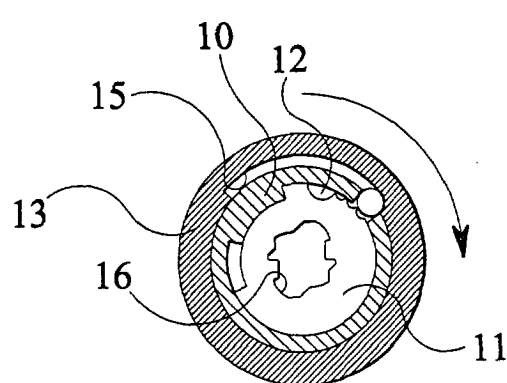
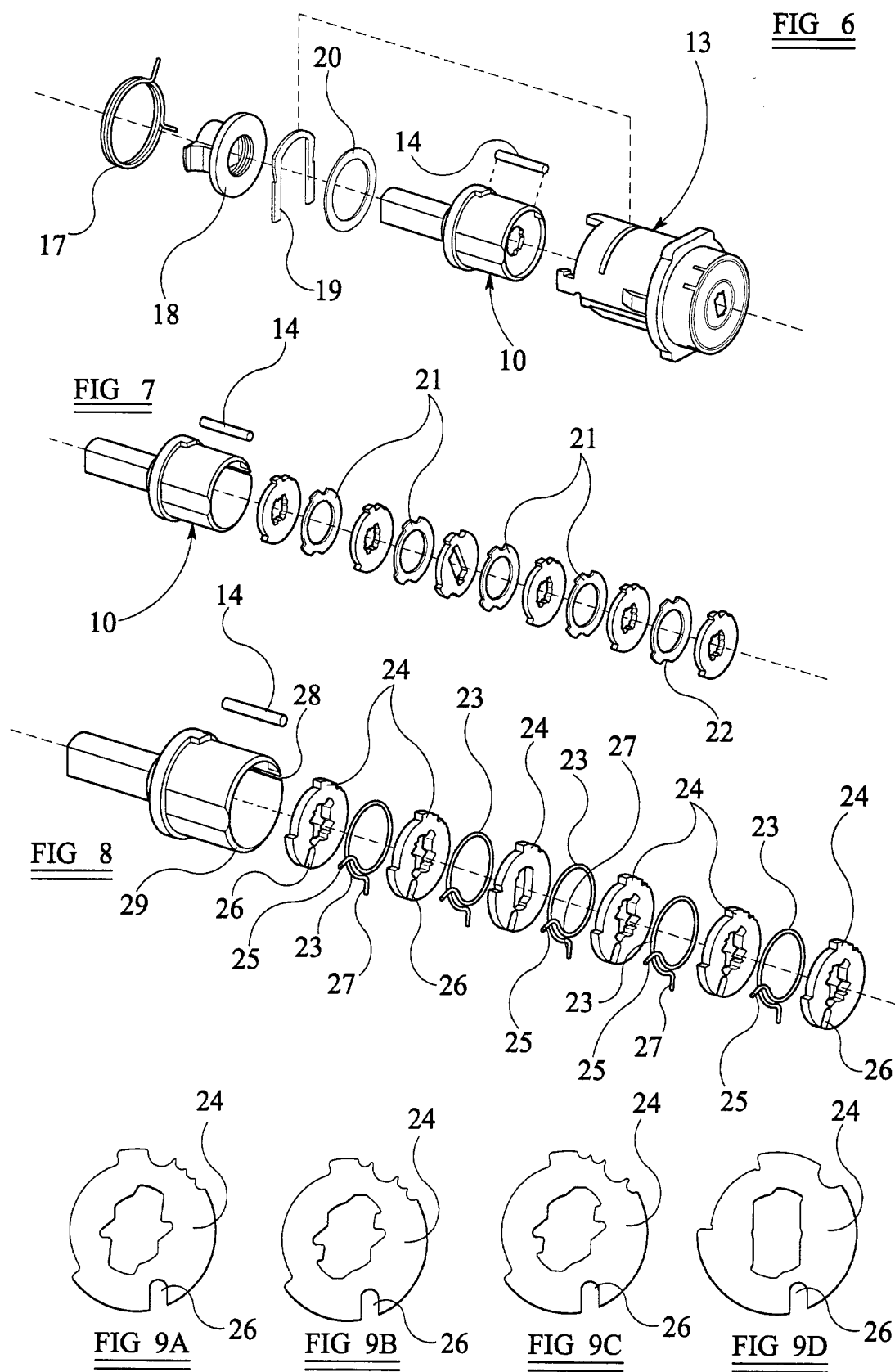
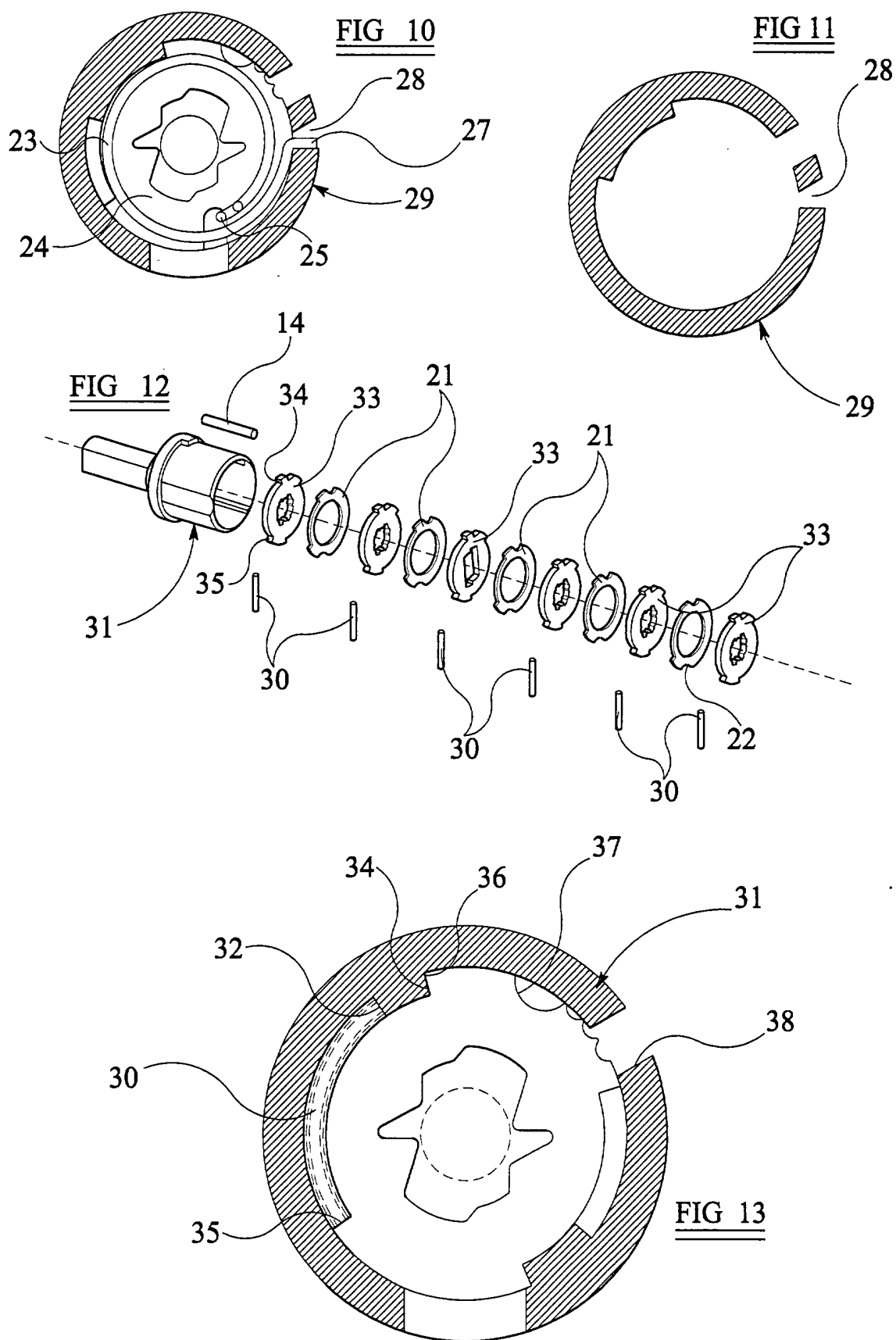


FIG 5C





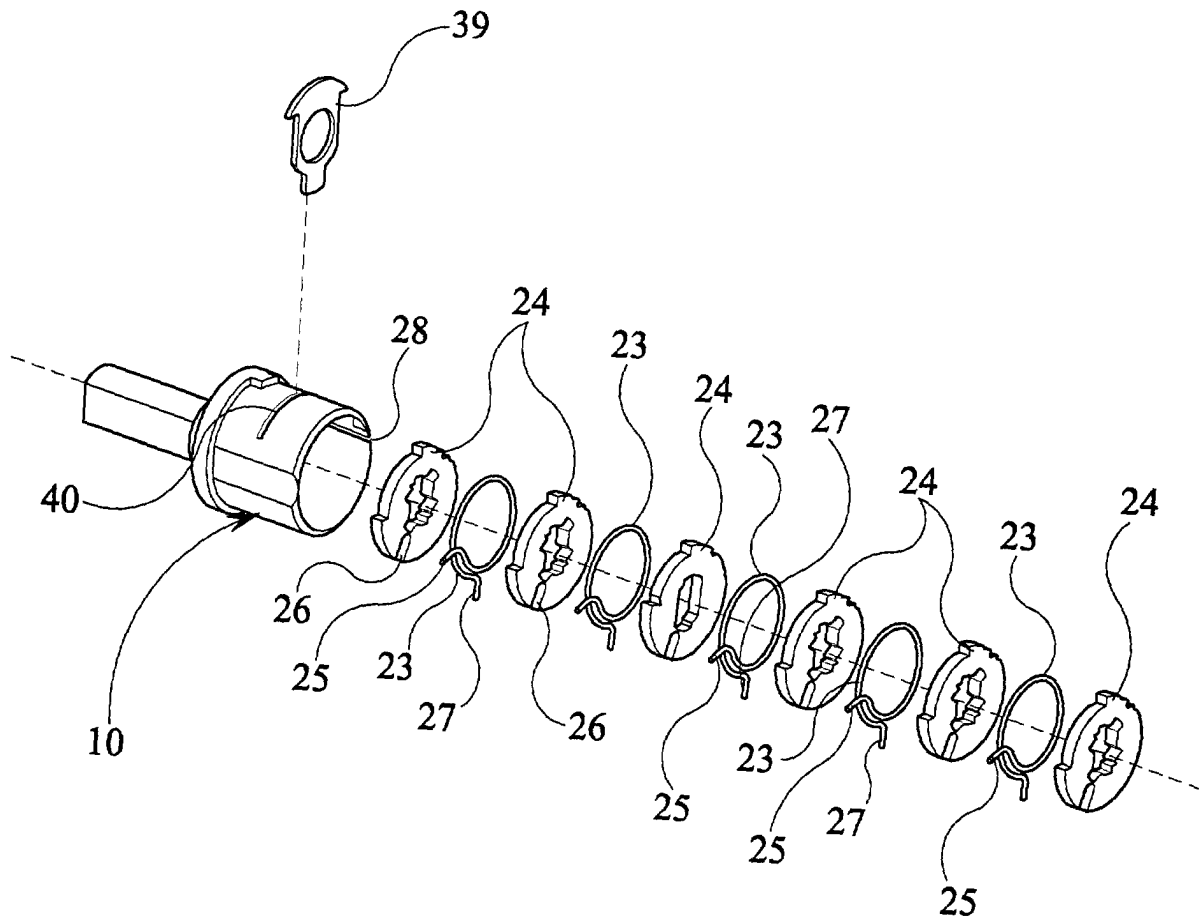


FIG 14

