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This invention relates to tumbler locks and is particularly concerned with cylinder locks.

Cylinder locks include a body member of any external shape and having a cylindrical bore therein, and a barrel member rotatably mounted in that bore. In use, a latch or deadbolt is connected to the barrel so as to respond to rotation of the barrel by moving between operative and inoperative positions. Tumblers, which can be of any of several varieties, are operative to lock the barrel against rotation within the cylinder body and are releasable from that operative position by a correctly formed key inserted into a keyway of the lock.

Pin tumbler locks are in common use, but they suffer from a lack of security in that they can be "picked" with relative ease. Such locks form the subject of Australian Patents 165,562 and 412,722. Disc tumbler locks are sometimes more secure and particularly those of the side-locking bar type in which plate-like tumblers or discs control the location of that bar in barrel lock and release positions respectively. Examples of such locks are disclosed by U.S. Patent 3,789,638, U.K. Patent 641,072 and Australian Patent 498,983. Picking of such locks can be difficult and resistance to forced rotation will generally be greater than in the case of pin tumbler locks. Such locks however, are not so resistant to forced coaxial extraction of the barrel and furthermore it is possible to remove the side locking bar by drilling through the front face of the lock cylinder. Locks employing ball tumblers in place of the side locking bar are also susceptible to attack in the latter fashion.

It is a principal object of the present invention to provide a cylinder lock of improved security in that it has relatively high resistance to forced extraction and rotation of the barrel. It is a further object of the invention to provide such a lock which is difficult to pick or otherwise manipulate into a release condition without use of a correct key. Still another object of the invention is to provide such a lock which can be manufactured in relatively small dimensions. Other objects and advantages of the invention will become apparent from the following

description of one possible form of the invention.

In accordance with the present invention, there is provided a cylinder lock including, a body having a cylindrical bore therein, a barrel mounted within said bore for rotation relative to said body, a keyway within said barrel and extending in the axial direction thereof, a plurality of tumbler plates carried by said barrel so as to rotate therewith and each being arranged generally transverse to the rotational axis of said barrel, a plurality of locking recesses formed in a surface of said bore, each said tumbler plate being movable laterally relative to said barrel to adopt either a barrel lock position or a barrel release position, and a peripheral portion of at least two of said tumbler plates engages within a respective one of said locking recesses when those plates are in the barrel lock position to thereby hold said barrel against rotation relative to said body and to also hold said barrel against axial separation from said body in at least one direction, control means operable to adopt either an operative condition or an inoperative condition in which it prevents and allows respectively movement of said tumbler plates out of said barrel lock position, and said control means is responsive to a key so as to adopt either the said inoperative or operative condition thereof according to whether or not respectively said key is located within said keyway.

As stated in the preceding paragraph, the barrel is prevented from rotating relative to the lock body when the tumbler plates are in the barrel lock position. That is not to be understood as meaning that absolutely no amount of relative rotation can occur under the condition described. In fact, a small amount of relative rotation may be possible, but it is not sufficient to allow the barrel to perform a function such as release of a latch, as normally results from its rotation relative to the lock body. That is, the statement in question is to be read as meaning that the barrel is prevented from rotating to a degree sufficient for it to operate or release associated mechanism.

If there is more than two tumbler plates, it is preferred that each is engagable within its own individual locking recess provided in the cylinder body. It is also preferred that the tumbler plates move between the barrel
5 lock and barrel release positions under the control of a plurality of rotatable or turnable discs. It is further preferred that the tumbler plates are interconnected for simultaneous movement between the barrel lock and release
10 positions, but that is not essential. The discs may be of plate-like construction and can also be of any suitable peripheral shape and can be pivotally or otherwise mounted for relative rotation about an axis extending generally in

the same direction as, but not necessarily coincident with, the axis of rotation of the barrel.

It will be convenient to hereinafter describe the invention with reference to a particular lock construction which has some of the characteristics of the lock according to Australian Patent Application 86467/82. The disclosure of that patent application is therefore to be understood as imported into the present specification by cross reference. In particular, the barrel assembly of the example lock includes a plurality of cam discs which are rotatable about an axis substantially coincident with the axis of rotation of the barrel assembly. Each disc has a substantially centre opening which forms part of the lock keyway and that opening is of non-circular shape so as to cooperate with a key in such a way that the disc can be positioned by the key as necessary to release the barrel for rotation relative to the cylinder.

The essential features of the invention, and further optional features, are described in detail in the following passages of the specification which refer to the accompanying drawings. The drawings however, are merely illustrative of how the invention might be put into effect, so that the specific form and arrangement of the features (whether they be essential or optional features) shown is not to be understood as limiting on the invention.

In the drawings:

Figure 1 is an exploded perspective view of one form of lock incorporating an embodiment of the invention;

Figure 2 is a perspective view of the lock barrel cylinder shown in figure 1, but taken from a different angle;

Figure 3 is a longitudinal cross sectional view of the assembled lock of figure 1;

Figure 4 is a transverse cross sectional view taken along line IV-IV of figure 3;

Figure 5 is a view similar to figure 4, but showing the cam discs rotated by a key to a position at which the tumbler plates can be released from the barrel lock position;

Figure 6 is a view similar to figure 5 but showing the barrel assembly rotated a further distance and the

tumbler plates released from the barrel lock position;

Figure 7 is a transverse cross sectional view taken along line VII-VII of figure 3;

Figure 8 is a perspective view of an end of a key
5 usable with the lock of figure 1;

Figure 9 is a transverse cross sectional view taken along line IX-IX of figure 3;

Figure 10 is a perspective view of the end of a special change key for use with the lock of figure 1;

10 Figure 11 is a view similar to figure 9 but showing the retainer plate released by a key of figure 10;

Figure 12 is a view similar to figure 3 but showing another embodiment of the invention;

Figure 13 is a cross sectional view taken along line
15 XIII-XIII of figure 12.

In the example lock construction shown, a barrel assembly 1 includes a cylindrical sleeve 2 which is rotatably mounted within a cylindrical bore 3 of the lock body 4. Each of a plurality of cam discs 5 is rotatably located
20 within the sleeve 2 and in the preferred arrangement shown, those discs 5 are capable of unrestrained rotation within the sleeve 2. That is, each cam disc 5 is free to rotate through 360° or more relative to the sleeve 2 and to the other cam discs 5. The sleeve 2 forms one of the active components
25 of the assembly 1 in that rotation of the sleeve 2 is necessary to effect actuation of a latch or deadbolt for example (not shown), with which the lock is to be used. The axis of rotation of the sleeve 2 is preferably substantially coincident with the axis about which the cam discs 5 rotate
30 relative to the sleeve 2.

A plurality of tumbler plates 6 is mounted within the sleeve 2 so that each has its broad surfaces generally transverse to the longitudinal axis of the sleeve 2. Each tumbler plate 6 has a body part 7 and a locking lobe 8 which
35 projects laterally from the body part 7 and is slidably located within a respective slot 9 formed through the wall of the sleeve 2. Each lobe 8 is adapted to project through its respective slot 9 for location within a cooperative locking recess 10 provided in the surrounding surface of the

cylinder bore 3. An individual recess 10 is provided for each tumbler plate 6 and each recess 10 cooperates with its respective locking lobe 8 in such a way that rotation of the sleeve 2 is prevented by such cooperation unless the
5 respective tumbler plate 6 is able to move in a direction to extract the locking lobe 8 from the recess 10.

Each tumbler plate 6 is in a barrel lock position when its locking lobe 8 is within the associated locking recess 10 as shown in figures 3 and 4. Means is provided
10 for controlling the ability of the tumbler plate 6 to move clear of the recess 10 into a barrel release position as shown in figure 6. That control means includes the cam discs 5 and they are arranged so that every one must adopt a particular respective rotational position in order for
15 all tumbler plates 6 to be able to move into the barrel release position. Preferably, as shown, all tumbler plates 6 are interconnected so that they move in unison between the barrel lock and release positions, but they can be arranged for independant movement if required.

20 In the preferred arrangement shown, a locking pin 11 interconnects the various tumbler plates 6 and is arranged to cooperate with the cam discs 5 to form part of the control means. The pin 11 conveniently extends in the axial direction of the barrel assembly 1 and passes
25 through a hole 12 provided in each tumbler plate 6. With this arrangement, it is preferred that the tumbler plates 6 and cam discs 5 are alternately located in face to face relationship within the barrel sleeve 2 as best seen in figure 3. That is, a cam disc 5 intervenes between each
30 two adjacent locking plates 6. The interconnecting pin 11 is located outside the periphery 13 of the cam discs 5 so that its ability to move radially inwards of the barrel assembly 1 is controlled by the cam disc peripheries 13.

It is preferred, as shown, that each cam disc 5 has
35 at least one notch 14 provided in its periphery 13 which is adapted to receive a portion of the locking pin 11. When all of the notches 14 are aligned beneath the pin 11 as shown in figure 5, the locking pin 11 can move radially inwards of the barrel assembly 1 through a distance as

permitted by the notches 14 and that movement is sufficient to place all of the tumbler plates 6 in the barrel release position (figure 6). The notches 14 are aligned when each cam disc 5 is in a rotational position hereinafter called its lock release position, and that position is established by use of a correct key 15 as hereinafter described. The tumbler plates 6 are unable to move to the barrel release position if any one of the cam discs 5 is not in its lock release position, or if the longitudinally aligned notches 14 are not in radial alignment with the locking pin 11.

Each tumbler plate 6 has a locking lobe 8 as previously described and, in the form shown, that lobe 8 projects laterally from the body 7 which may be of any suitable peripheral shape. An opening 16 for the passage of the key 15 is provided through each plate 6 and in the form shown that comprises a slot extending into the body 7 from the side edge thereof remote from the locking lobe 8. It is generally convenient to locate the hole 12 for the locking pin 11 adjacent to the locking lobe 8 as shown in figure 1.

Each of the slots 9 in the sleeve 2 which slidably receives a locking lobe 8 has a length such as not to permit passage of the plate body 7. Each locking recess 10 may be a groove formed in the surface of the cylinder bore 3 and which progressively reduces in depth at each end portion to provide ramping surfaces which function as hereinafter described. At least one spring may act against the locking pin 11 and or one or more of the tumbler plates 6 to bias those plates 6 into the barrel lock position. Preferably, as shown in figure 7, a single U shaped spring 17 is located substantially midway along the tumbler plate 6/cam disc 5 assembly and acts between the locking pin 11 and the inside surface of the sleeve 2 to provide the desired bias. It is to be appreciated however, that such bias is not essential.

In the preferred construction shown, the keyway opening 18 of each cam disc 5 is substantially as described in Australian patent application 86467/82 and the cooperative key 15 is of the general form as also described in that patent application. The key blade (not shown) has a series

of relatively twisted or angularly disposed portions arranged in longitudinally spaced relationship along the length of the blade. Each of those portions cooperates with a respective one of the disc openings 18 to hold that particular disc 5 at a particular position of rotation relative to each other disc 5, and when the key 15 has a particular position relative to the cylinder body 4 it holds all cam discs 5 at the respective lock release position.

When the correct key 15 is fully inserted into the keyway 16,18 it preferably drivably engages the barrel assembly through means other than, or additional to, the cam discs 5 and tumbler plates 6. That is, turning movement of the key 15 is transmitted to the barrel assembly 1 through means other than the cam discs 5 and tumbler plates 6.

That means may include a terminal end portion 19 (figure 8) of the key blade and an adaptor 20 (figures 1 and 3) connected to the barrel sleeve 2 at the end thereof remote from the keyway entrance 21. Drive cooperation between the key 15 and the adaptor 20 however, may not be effected until the key 15 is approaching the fully inserted position.

Assuming the correct key 15 is employed, turning movement of the key 15 in either direction of rotation will cause corresponding movement of the barrel sleeve 2 through the key 15 and adaptor 20 connection. That will bring each locking lobe 8 into engagement with a ramping surface of the respective locking recess 10 so that continued turning movement of the key 15 will cause the tumbler plates 6 to be ramped inwards into the barrel release position (figures 5 and 6). Such inward movement is possible because each disc 5 is in the lock release position and allows the locking pin 11 to move radially inwards.

The key 15 cannot be withdrawn from the keyway 16,18 unless the cam discs 5 are able to rotate relative to one another. Location of the locking pin 11 in the cam disc notches 14 prevents such relative rotation so withdrawal of the key 15 is possible only when the tumbler plates 6 are able to move back into the barrel lock position (figures 4 and 5). If desired, two or more sets of locking recesses 10 may be provided in the cylinder body 4 to permit withdrawal

of the key 15 at more than one rotational position of the barrel assembly 1. When the key 15 is withdrawn, the cam discs 5 are rotated and are thereby scrambled so that the locking pin 11 is unable to move toward the barrel release position.

A lock as shown in figures 1 and 3 is arranged to permit removal of the barrel assembly 1 so that the combination can be altered by substitution of another barrel assembly 1. In the preferred form shown, that change - over of barrel assemblies 1 is effected by means of a special key as hereinafter described.

The barrel sleeve 2 and the adaptor 20 are preferably axially separable for the foregoing purpose. In the arrangement shown, the adaptor 20 is a generally cylindrical member which is rotatably mounted within the inner end portion of the cylinder body 4. A latch, deadbolt, or other actuator (not shown) may be attached to or formed integral with the end of the adaptor 20 remote from the lock keyway entrance 21. The other end portion of the adaptor 20 is receivable within the adjacent end portion of the barrel sleeve 2 and drive means connects the sleeve 2 and adaptor 20 against relative rotation whilst permitting axial separation of those members. For example, as shown, drive dogs 22 on the adaptor 20 slidably located within axial extending slots 23 formed in the end portion of the sleeve 2.

Retaining means is provided to releasably hold the sleeve 2 and adaptor 20 against axial separation and that can take any one of several forms. In the form shown, the retainer means includes a plate 24 which is arranged transverse to the barrel axis and is slidably mounted in a transverse passage 25 of the adaptor 20 for relative radial movement (figures 1 and 9). The retainer plate 24 is movable between operative and inoperative positions (figures 9 and 11 respectively) and may be spring biased towards the former. In the operative position (figure 9), the retainer plate 24 coacts with the sleeve 2 to prevent axial movement of that sleeve 2 out of the cylinder body 4. In the inoperative position (figure 11) however, there is no such coaction.

According to the embodiment shown, the retainer plate 24

has a nose portion 26 which projects laterally beyond one side of the adaptor 20, through a circumferential slot 27 in the wall of the sleeve 2 and into a circumferential groove 28 provided within the bore 3 of the cylinder body 4. The nose portion 26 is preferably stepped, so that, in the operative position, a relatively narrow section 26a locates within the cylinder groove 28 and a relatively wide section 26b locates within the circumferential slot 27 of the sleeve 2. One of the slots 23 forms a gate opening which extends from the circumferential slot 27 to the adjacent end of the sleeve 2 and, as shown in figures 1 and 2, has a width such as to slidably receive the narrow section 26a, but not the wide section 26b of the plate nose portion 26.

With the foregoing arrangement, when the retainer plate 24 is moved into the inoperative position as shown in figure 11, the wide section 26b is cleared from the sleeve circumferential slot 27 and the narrow section 26a is aligned with the gate opening 23. The sleeve 2 can then be separated from the adaptor 20, providing the tumbler plates 6 are not located within the locking recesses 10 of the cylinder body 4.

Movement of the retainer plate 24 into the inoperative position is preferably effected through a special change key 29 (figure 10) having a terminal end portion 30 which coacts with the retainer plate 24 to cause that movement. In the example shown, the retainer plate 24 has an opening 31 into which the terminal end portion 30 can project and a camming surface 32 of the terminal end portion 30 engages a surface 33 of the opening 31 to move the retainer plate 24 into the inoperative position against the action of the biasing spring 34. The normal key 15 however, has an end portion 19 which does not project into the retainer plate opening 31, or at least does not coact with that opening 31 in the foregoing manner.

When it is desired to remove the barrel assembly 1, the change key 29 is fully inserted to the position at which the retainer plate 24 is rendered inoperative. In the process, the cam discs 5 are moved into their respective lock release positions and consequently the barrel assembly 1 can be

rotated to a position at which the tumbler plates 6 are clear of the locking recesses 10. At that position, the barrel assembly 1 can be moved axially out of the cylinder body 4 by applying an axially outward force to the key 15.

5 Insertion of the barrel assembly 1 may be facilitated by providing a chamfer 35 (figure 3) on the rear edge of each locking lobe 8. That is, the edge which faces towards the rear or inner end of the lock body 4. The rear edge 36 of each locking recess 10 may be similarly chamfered
10 so that the barrel assembly 1 can be moved axially inwards while the locking lobes 8 and locking recesses 10 are longitudinally aligned.

The security of a lock as described can be improved by providing a hardened guard at the front outer end of the
15 barrel assembly 1. In the example shown, a hardened annular member 37 is secured to the front end of the sleeve 2 by a cap member 38 swaged or otherwise connected to that end of the sleeve 2. The hardened member 37 guards against drilling
20 to remove the locking pin 11, and in that respect has a portion overlying or in alignment with the adjacent end of the pin 11. Improper removal of the cap member 38 may be resisted by the manner of swaging of the cap member 38. In the arrangement shown in figure 3, a radially inner boss
25 portion 39 of the cap member 38 projects through the annular guard member 37 and is expanded at its terminal end 40 to locate against a frusto-conical surface 41 of the guard member 37. Furthermore, the locking pin 11 may have a head 42 which prevents its axial withdrawal through the
outer or front end of the assembly.

30 The lock particularly described can be modified in many ways without departing from the basic inventive concept. For example, the retainer plate 24 may locate beyond the rear end of the cylinder body 4 rather than within a circumferential groove 28 of the cylinder body 4. Also, the
35 facility for front end removal of the barrel assembly 1 need not be adopted and one such an arrangement is shown in figure 12.

In figure 12, components corresponding to those of the figure 3 construction will be given like references except

that they will be in the number series 100-199. According to the figure 12 arrangement, a circlip 143 retains the barrel assembly 101 and cylinder body 104 against axial separation and access to that circlip 143 may be possible only through
5 a plurality of holes 144 provided at the inner end of the lock body 104. As shown in figure 13, screws 145 which connect the latch or other actuator 146 to the barrel assembly 101 may coact with the circlip 143 to prevent its release while those screws 145 are in place.

10 Still further, in any embodiment, each cam disc may have a plurality of peripheral notches to provide for master keying and/or to inhibit picking of the lock.

A lock as described has many significant advantages. The use of tumbler plates which locate within individual locking
15 recesses increases the resistance to forced axial separation of the barrel assembly from the cylinder body. The fully rotational cam discs inhibit picking of the lock as well as forced rotation of the barrel assembly. Also, removal or destruction of the locking pin is difficult to achieve. The
20 lock is therefore very secure and that security is achieved in a relative simple construction. Furthermore, the lock can be made relatively small and can have a large number of key codes.

Various alterations, modifications and/or additions may
25 be introduced into the constructions and arrangements of parts previously described without departing from the spirit or ambit of the invention as defined by the appended claims.



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Claims

1. A cylinder lock including, a body having a cylindrical bore therein, a barrel mounted within said bore for rotation relative to said body, a keyway within said barrel and extending in the axial direction thereof, a plurality of tumbler plates carried by said barrel so as to rotate therewith and each being arranged generally transverse to the rotational axis of said barrel, a plurality of locking recesses formed in a surface of said bore, each said tumbler plate being movable laterally relative to said barrel to adopt either a barrel lock position or a barrel release position, and a peripheral portion of at least two of said tumbler plates engages within a respective one of said locking recesses when those plates are in the barrel lock position to thereby hold said barrel against rotation relative to said body and to also hold said barrel against axial separation from said body in at least one direction, control means operable to adopt either an operative condition or an inoperative condition in which it prevents and allows respectively movement of said tumbler plates out of said barrel lock position, and said control means is responsive to a key so as to adopt either the said inoperative or operative condition thereof according to whether or not respectively said key is located within said keyway.
2. A lock according to claim 1, wherein said tumbler plates move out of said barrel lock position as a consequence of said barrel rotation.
3. A lock according to either preceding claim, wherein said recesses are spaced apart in the axial direction of said bore and said peripheral portion of each tumbler plate is engagable within a respective one of said recesses.
4. A lock according to claim 3, wherein said barrel includes a cylindrical sleeve having a plurality of circumferentially extending slots formed through a wall thereof, and each said tumbler plate has a body part contained within said sleeve and said peripheral portion thereof is a lobe which projects laterally from said body part and slidably locates within a respective said slot in both said barrel lock and release positions.



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5. A lock according to any preceding claim, wherein said tumbler plates are interconnected so as to move in unison between said barrel lock and release positions.
6. A lock according to claim 5, wherein spring means resiliently urges said tumbler plates towards said barrel lock position.
7. A lock according to any preceding claim, wherein a spring circlip interacts between said barrel and said body to resist axial separation thereof when said tumbler plates are in the barrel release position, said circlip is located at a rear end portion of said body, and releasable means is provided at said rear end portion to prevent release of said circlip from operative interconnection with both said barrel and said body.
8. A lock according to claim 7, wherein said releasable means includes at least one screw which projects into said rear end portion and which also serves to secure an actuator to said barrel.
9. A lock according to claim 7 or 8, wherein said circlip is accessible for release through a plurality of holes formed through said body rear end portion.
10. A lock according to any preceding claim, wherein said control means includes a locking pin which extends in the axial direction of said barrel and interconnects said tumbler plates so that they move in unison between said barrel lock and release positions, and key responsive means interacting with said pin so as to prevent or allow lateral movement thereof towards said barrel release position according to whether said control means is in the operative or inoperative condition respectively.
11. A lock according to claim 10, wherein said barrel includes a cylindrical sleeve and said key responsive means includes a plurality of discs rotatably mounted within said sleeve, each said disc having a particular rotational position relative to said sleeve at which it allows movement of said locking pin towards said barrel release position, and an opening is formed through each said disc and is arranged to receive and cooperate with a key so as to permit adoption of said particular rotational position.



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12. A lock according to claim 11, wherein said discs are rotatable about the axis of said sleeve and that axis passes through each said disc opening.

13. A lock according to claim 11 or 12, wherein said sleeve has a plurality of circumferentially extending slots formed through a wall thereof, and each said tumbler plate has a body part contained within said sleeve and said peripheral portion thereof is a lobe which projects laterally from said body part and slidably locates within a respective said slot in both said barrel lock and release positions.

14. A lock according to claim 11, 12 or 13, wherein said tumbler plates and said discs are alternately located in face to face relationship along the axis of said barrel, and the body part of each said tumbler plate has an opening therethrough to allow passage of a key.

15. A lock according to any one of claims 11 to 14, wherein each said disc has a notch in the periphery thereof and said locking pin is located within each said notch when said tumbler plates are in the barrel release position.

16. A lock according to any one of claims 11 to 15, wherein said discs are freely rotatable relative to said sleeve.

17. A lock according to any one of claims 1 to 6 and 10 to 16, wherein said barrel is arranged for axial withdrawal from said body when the tumbler plates are in the barrel release position, a retainer member is connected to said barrel and projects laterally relative thereto to engage an opposed surface and thereby prevent said axial withdrawal, said retainer member is mounted for movement relative to said barrel so as to be movable into an inoperative position at which it does not engage said opposed surface, spring means resists movement of said retainer member into said inoperative position, and said retainer member is cooperable with a special key to be moved into said inoperative position.

18. A lock according to claim 10 or any claim appended thereto, wherein a hardened guard is provided over a front of said lock to prevent access to said locking pin.

19. A cylinder lock substantially as herein particularly described with reference to any one of the embodiments shown in the accompanying drawings.