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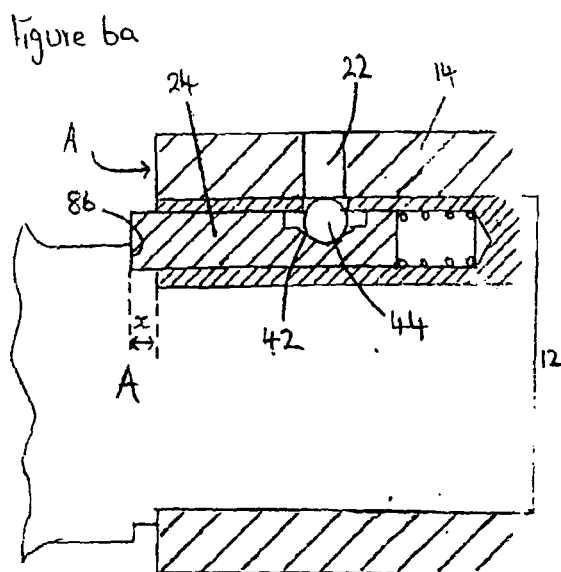
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(54) **Improved lock cylinder & key therefor**

(57) The invention relates to a key comprising a handle, a shaft, a stop shoulder and an unlocking shoulder. The stop shoulder and the unlocking shoulder are axially spaced apart by a predetermined distance such that when the shaft is inserted into the keyway of a complementary lock, the unlocking shoulder serves to move the lock into an unlocked position when the stop shoulder abuts the lock to denote that the shaft is fully inserted in the keyway. The unlocking shoulder is provided by a first

partial transverse cut-out in the stop shoulder. The key further comprises a second partial transverse cut-out extending along the length of the shaft to allow the shaft to by-pass a partial obstruction in the keyway, and wherein the width of the shaft is narrowed to produce a gap, the gap being provided to permit the key to turn past the obstruction to unlock the lock. Also disclosed is a lock for use with the above key and a method of manufacturing the key.



Description

[0001] The present invention relates to an improvement in the design of locks and keys. More particularly, the present invention relates to improvements in cylinder locks.

Background

[0002] A conventional key-operated pin-tumbler lock mechanism is commonly used in cylinder locks. This type of lock mechanism comprises a casing with a cylindrical hole which houses a plug. The plug has an axial slot for receiving a key, known as the keyway, and a series of transverse holes which are aligned with a series of corresponding holes in the lock casing. The holes contain a set of key pins of differing lengths, behind which are a set of spring-loaded driver pins. Without a key in the lock, the pins are biased by the springs such that the key pins are located in the plug while the driver pins sit across the interface (the shear line) between the plug and the casing, thereby preventing rotation of the plug. When the correct key is inserted into the lock, the ridges on the key move the driver pins into the holes against their bias so that the ends of the key pins and the driver pins align with the shear line, allowing the plug to rotate. If an incorrect key is inserted, one or more pairs of the pins are misaligned with the shear line and the plug is prevented from rotating. A disadvantage of this type of lock mechanism is that it is vulnerable to picking, whereby tools are inserted into the keyway to move the pins into alignment with the shear line. A number of mechanisms have therefore been devised to improve the security of cylinder locks.

[0003] The Applicant's earlier European patent, EP0892130 B1, describes a lock cylinder mechanism in which a series of passages extend across the diameter of the plug, intersecting the keyway. Each passage contains a pair of pins which are biased towards each other by compression springs. In each pair, the pins may be of the same length or one of the pins may be longer than the other pin. Where one pin is longer than the other, the shorter pin is associated with a stronger spring, such that when the lock is in its rest position, the longer pin projects across the shear line. When the complementary key is inserted into the keyway, the shorter (or one of the same length) pins are moved slightly outwardly, allowing the longer (or other of the same length) pins to move inwardly into a set of recesses provided in the key so that they are within the confines of the plug and no longer project across the shear line, allowing the plug to rotate. The key may have two rows of recesses for engagement with a single set of pins. In this embodiment, the shank of the key has a C_2 -axis of rotational symmetry so that the key can operate the lock in either orientation of the shank in the keyway. The mechanism described in this patent is more resistant to picking, since the usual method of applying a torque to the plug to locate the shear line would

prevent the locking pins moving to the unlocked position, thereby preventing this method of manipulation.

[0004] An inherent disadvantage of the type of lock mechanisms described above is that space limitations limit the number of different combinations. In practice, 30,000 combinations may be considered secure enough, but ideally a single combination would be used only once making all keys unique. It follows that the greater the number of combinations, the greater the security.

[0005] It is therefore an object of the present invention to provide a key-operable lock cylinder and a key therefor which mitigates at least some of the above-stated disadvantages of known mechanisms.

Statements of invention

[0006] According to a first aspect of the present invention there is provided a key-operable lock comprising:

- a casing;
- a plug having a keyway therein, the plug being rotatably housed within the casing;
- a locking member; and
- a locking means,

the lock having a locked position wherein the locking means projects across an interface between the plug and the casing such that the plug is prevented from relative rotation within the casing, and an unlocked position wherein the locking means is relocated so as to permit rotation of the plug within the casing; and wherein the locking member is arranged for axial movement to cause the locking means to relocate.

[0007] The lock may further comprise a retaining means to retain at least a part of the locking member in the lock. The retaining means may form a partial obstruction in the keyway. Two retaining means may be provided, one at each end of the keyway.

[0008] An advantage of the above is that the lock will only be compatible with keys configured to by-pass the partial obstruction on entry into the keyway and to permit the key to be turned in the lock (passed the partial obstruction) in order to unlock the lock. This therefore provides an increased level of security in the lock.

[0009] The locking member may extend out of the plug and/or casing in the locked position of the lock.

[0010] Thus, embodiments of the present invention provide a lock, operable by a key, and which includes a locking member extending out of the plug and/or casing.

This is contrary to known locks where the entire locking mechanism is housed within the plug and/or casing. Although conventional thought might lead one to believe that having the locking member extending out of the lock would make the lock less secure than if it were fully enclosed within the lock, since this feature would make it easier to access and therefore potentially easier to tamper with than a mechanism that is fully enclosed, the Applicants believe that the present aspect has certain

advantages. In particular, having the locking member extending out of the plug and/or casing allows for the locking member to be much more easily inserted, removed or replaced since the remainder of the lock may remain in situ and/or substantially unaltered during these operations. Thus, it is possible to alter the lock while it is in position, for example on a door, by simply removing the locking member and replacing it with a different locking member (e.g. configured for use with a different key). This will significantly reduce the time and effort required in changing locks when compared to those incorporating wholly enclosed locking mechanisms since there is no need to remove the lock casing or plug to alter or replace the lock in order to make the lock suitable for use with an alternative key. The present invention may also enable the locking member to be inserted into the lock as the last step in the assembly of the lock. This is helpful in that an inventory of similar or identical locks can be maintained along with an inventory of different locking members and these can be finally assembled together when required in order to provide a number of unique locks or assemble a master key suite of locks (e.g. using appropriate locking members in each one).

[0011] In certain embodiments, it may be possible to remove and/or replace the locking member by placing the required key in the lock and rotating the key a specified amount (e.g. 30°, 90°, 180°) before extracting the key and allowing the locking member to also be extracted and/or replaced. Thus, it may only be possible to remove and/or replace the locking member by using a suitable key to place the lock in a position whereby the removal and/or replacement of the locking member is permitted. Accordingly, only authorised persons may be able to alter the lock.

[0012] In addition to the above, having the locking member extending out of the lock may provide a visual indication that the lock is in the locked position and/or that the lock comprises more than simply a standard pin tumbler type mechanism, which may help to deter persons looking to pick or tamper with the lock.

[0013] The locking member may be axially movable by a complementary key such that when said key is inserted into the keyway, the locking member causes the locking means to relocate to thereby place the lock in the unlocked position. The key may comprise a handle and a shaft having a stop shoulder and an unlocking shoulder, the stop shoulder and the unlocking shoulder being axially spaced apart by a predetermined distance such that when the shaft is inserted into the keyway of the lock, the unlocking shoulder serves to move the lock into an unlocked position when the stop shoulder abuts the lock to denote that the shaft is fully inserted in the keyway. The unlocking shoulder may be provided by a first partial transverse cut-out in the stop shoulder. A second partial transverse cut-out may extend along the length of the shaft to allow the shaft to by-pass a partial obstruction in the keyway, and wherein the width of the shaft narrows to produce a gap, the gap being provided to permit the

key to turn past the obstruction to unlock the lock.

[0014] The locking member may also extend out of the plug and/or casing in the unlocked position of the lock. Thus, the locking member may be configured to move from a first (locked) position projecting a first distance from the plug and/or casing to a second (unlocked) position projecting a second distance from the plug and/or casing. The first distance may be greater than the second distance such that the locking member is moved inwardly from the locked position to the unlocked position.

[0015] It will be understood that the locking member may directly or indirectly cause the locking means to relocate. For example, in one embodiment, movement of the locking member directly moves the locking means into an unlocked position. In another embodiment, movement of the locking member may allow the locking means to relocate into an unlocked position.

[0016] Embodiments of the first aspect of the invention therefore provide a locking mechanism that is only operable by a key correctly configured to move the locking member to cause the locking means to move to an unlocked position. The lock mechanism can be used alone or in conjunction with an additional (primary) locking mechanism such as a conventional pin-tumbler lock mechanism, and thus can be used to provide an additional level of security to conventional lock systems.

[0017] The locking member may be capable of causing the locking means to move into a further locked position, for example when a non-complementary key is inserted into the lock. Thus only a key configured to operate a particular lock is capable of moving the locking member by the exact distance required to cause the locking means to move into the unlocked position. Therefore without the correct key, it is difficult to guess the unlocked position of the locking means so that the lock is more resistant to picking.

[0018] In an embodiment, the locking means may relocate into one of a first or a second unlocked position. The provision of first and second unlocked positions provides a master key facility. The locking means may move into the first unlocked position upon insertion of a complementary standard key into the lock, and into the second unlocked position upon insertion of a complementary master key into the lock.

[0019] The locking member may be axially moveable within the plug, within the casing or within the plug and casing. In an embodiment, the locking member is wholly or partially received in the plug when the lock is in an unlocked position. In another embodiment, the locking member is wholly or partially received in the casing when the lock is in an unlocked position. Part of the locking member may extend out of the plug and/or casing in some or all positions of the lock. Alternatively, the locking member may extend out of the plug and/or casing only when the lock is in a locked position with no key inserted. In a particular embodiment, the whole of the locking member is confined within the plug and/or casing in all unlocked positions of the lock, such that no part of the locking mem-

ber protrudes from the plug and/or casing in these positions. The locking member may have a front end, a rear end and a surface therebetween. In an embodiment, the rear end of the locking member is situated within the plug while the front end of the locking member extends out of the plug in all positions of the lock.

[0020] The locking means may form a part of or be integral to the casing or the plug. Alternatively, the locking means may form a part of or be integral to the locking member. For example, the locking means may take the form of a projection (or clip) which extends from the locking member, the plug or the casing. In a particular embodiment, the locking means is provided by a part of the locking member.

[0021] Alternatively, the locking means may be independent of the casing, the plug and the locking member. In an embodiment, the locking means is constituted by a ball. The ball may be disposed on the surface of the locking member. Alternatively, the ball may reside in a cut-out in the surface of the locking member.

[0022] One of the locking member, plug or casing may include a recess into which the locking means is moved to permit rotation of the plug.

[0023] The recess may be provided in the plug or in the casing. In an embodiment, the recess is provided in the surface of the locking member. In a particular embodiment, the cut-out in the surface of the locking member has a flat base in which the recess is formed.

[0024] In another embodiment, first and second recesses are provided in the locking member. The first and second recesses may provide a first and a second unlocked position of the lock. The locking means may move into the first recess when a standard complementary key is inserted into the lock. The locking means may move into the second recess when a complementary master key is inserted into the lock. In an embodiment, the first and second recesses are provided in the surface of the locking member. The first and second recesses may be axially aligned and spaced apart from each other by a predetermined distance.

[0025] In an embodiment, the locking member is constituted by a rod. The rod may be substantially cylindrical or cuboidal. The recess or recesses may be provided in the surface of the rod, which receive the locking means in an unlocked position of the lock.

[0026] In an alternative embodiment, a part of the rod constitutes the locking means. In this embodiment, the rod may contain a further part which aligns with a recess in the plug or casing in the unlocked position. The further part of the rod may constitute a portion of reduced diameter.

[0027] In an embodiment, the lock additionally comprises a biasing means. The biasing means may be disposed so that it abuts the rear end of the locking member. In an embodiment, the biasing means comprises a spring. Alternatively, the biasing means may be provided by a resilient member which deforms when the locking member is moved against its bias. The biasing means

may provide a biasing force which returns the locking member to its rest position once a key has been removed from the lock, and in so doing the locking member causes the locking means to return to the locked position (i.e. with the locking means projecting across the interface between the plug and the casing).

[0028] The retaining means may retain at least a part of the locking member within the plug and/or casing, or it may retain the whole of the locking member within the plug and/or casing in all unlocked positions of the lock. The retaining means may therefore serve to retain at least a part of the locking member in the plug and/or casing at all times, and prevents the locking member from being completely detached from the plug and/or casing when in the locked position.

[0029] Conveniently, the retaining means may be constituted by the locking means, or the retaining means may be independent of the locking means. In an embodiment, the retaining means is constituted by a ball which is situated in a cut-out in a longitudinal surface of the locking member. The cut-out may have a flat base and front and rear walls. Alternatively, the cut-out may be constituted by an angular depression.

[0030] In another embodiment, the retaining means may be constituted by a portion of the plug and/or casing. For example, the plug and/or casing may comprise a projection or retaining clip obstructing a part of the locking member such that the locking member is retained in the lock. In particular embodiments, the lock may be configured to allow the locking member to pass the obstruction of the projection/clip in one or more positions of the lock so as to permit the removal and/or replacement of the locking member.

[0031] In one embodiment, the locking member may be constituted by a rod which comprises a first diameter portion forming the locking means and a second diameter portion, having a smaller diameter than the first diameter portion, arranged to align with the retaining means so as to allow the key to turn past the retaining means when the lock is in its unlocked position.

[0032] In an embodiment, an aperture is provided which engages the locking means when the lock is in a locked position, allowing the locking means to span the interface between the plug and the casing so that rotation of the plug is prevented. The aperture may be provided in the locking member, or it may be provided in the plug or casing. In a particular embodiment, the aperture is provided in an inner surface of the casing.

[0033] The lock may further comprise an additional (primary) locking mechanism. The additional locking mechanism may be arranged such that radial movement of a component is required to place the lock in an unlocked position. In a particular embodiment, the primary locking mechanism is a conventional pin-tumbler lock mechanism, as described above. In another embodiment, the primary locking mechanism is a locking mechanism of the type described in the Applicant's earlier European patent EP0892130 B1.

[0034] In embodiments comprising an additional locking mechanism including a set of radial pins, an additional set of holes may be provided in the plug and/or casing to accommodate the pins and thereby permit removal of the key at a second position of the lock. This second position may be such that removal and/or replacement of the locking member is permitted (e.g. by bringing the locking member clear of its retaining means). Thus, in this embodiment, the lock may be changed by simply changing the locking member (e.g. such that it extends out of the lock by a different amount either when in the locked position or in the unlocked position) and replacing the key with one having the same shaft configuration as before (i.e. to align the pins of the additional locking mechanism) but having an unlocking shoulder set back a different distance from the stop shoulder in order to accurately move the new locking member into the unlocked position.

[0035] Accordingly, with the present invention it is possible to increase the number of unique lock combinations by simply changing the configuration of the locking member. Thus, the number of unique locks any one manufacturer can produce can at least be doubled by enabling two different locking members to be employed with each existing (primary) locking mechanism. If three or more different locking members are made available the number of unique combinations will multiply accordingly, thereby increasing the perceived security of the locks provided.

[0036] According to a second aspect of the present invention there is provided a key for use with a lock according to the first aspect of the invention, said key comprising:

- a handle;
- a shaft;
- a stop shoulder; and
- an unlocking shoulder,

the stop shoulder and the unlocking shoulder being axially spaced apart by a predetermined distance such that when the shaft is inserted into the keyway of a complementary lock, the unlocking shoulder serves to move the lock into an unlocked position when the stop shoulder abuts the lock to denote that the shaft is fully inserted in the keyway and wherein the unlocking shoulder is provided by a first partial transverse cut-out in the stop shoulder, the key further comprising a second partial transverse cut-out extending along the length of the shaft to allow the shaft to by-pass a partial obstruction in the keyway, and wherein the width of the shaft narrows to produce a gap, said gap being provided to permit the key to turn past the obstruction to unlock the lock.

[0037] It will be understood that the transverse direction will be substantially horizontal when the key is orientated in a vertical plane such as commonly required for insertion into a keyway. Thus, when viewed from above in this orientation and/or when looking at a hori-

zontal cross-section through the stop shoulder in this orientation, the unlocking shoulder will be set back (e.g. stepped back) from the remainder of the stop shoulder. In other words, the stop shoulder will not extend uninterrupted across the thickness of the key but will include a recess terminating in the unlocking shoulder. Similarly, the unlocking shoulder will not extend uninterrupted across the thickness of the key but will be bounded on at least one side by material extending forwardly of the unlocking shoulder to form the stop shoulder. Accordingly, the unlocking shoulder will effectively be provided within a portion of the stop shoulder and, as such, it is believed that this will make the key significantly more difficult to copy since it will not be possible to simply file back a stop shoulder across its entire width in order to provide the unlocking shoulder. Instead, it will be necessary to file back or cut-out only a portion of a stop shoulder to the appropriate distance and this will be much more difficult to accurately achieve.

[0038] The unlocking shoulder may be closer to the handle than the stop shoulder so that the unlocking shoulder can mate with a locking member projecting from the lock when the key is inserted in a keyway.

[0039] The unlocking shoulder may be configured to mate with a similarly sized portion of a locking member, such as those described above. In certain embodiments, the locking shoulder may be of substantially the same size (i.e. width) along its entire length. In other embodiments, the locking member may also include a cut-out or stepped end surface. The cut-out may be provided such that the portion of the locking member extending out of the lock in the locked position is arranged to abut the unlocking shoulder of the key such that further insertion of the key into the lock can move the locking member to an unlocked position when the stop shoulder abuts an end of the plug and/or casing. The cut-out in the locking member may also provide a surface to abut a retaining means to hold the locking member in the lock. For example, the surface may abut an inner face of a projection or clip provided on the plug and/or casing to prevent the locking member from being extracted from the lock in the locked position.

[0040] In some embodiments, only a portion of an end surface protruding from the lock may be configured to mate with the unlocking shoulder.

[0041] The first transverse cut-out may be provided at one side of the stop shoulder, at the other side of the stop shoulder or part-way (e.g. half-way) through the stop shoulder. Thus, the first transverse cut-out may be constituted by a hole or slot in the stop shoulder or one side/edge of the stop shoulder may be cut away to form the cut-out.

[0042] In some embodiments, the second partial transverse cut-out is provided along a diagonally opposite corner of the shaft from the first partial transverse cut-out. In some embodiments, portions from both sides of the stop shoulder may be cut away, just leaving a substantially central portion of material forming the stop shoulder.

A further partial transverse cut-out may therefore be formed in the stop shoulder and may be configured for use with a second locking member. Thus, the same key may be configured for use in two different locks (i.e. having differently sized locking members). This may be useful in providing a master key facility.

[0043] The key may have only one stop shoulder or it may have two stop shoulders, one on each side of the key. Similarly, the key may have only one unlocking shoulder or it may have two unlocking shoulders, one on each side of the key. In an embodiment in which the key has two unlocking shoulders, the key may be configured for insertion into the keyway of the lock in either of two orientations. Accordingly, partial transverse cut-outs may be provided in diagonally opposite corners of the two stop shoulders. This feature may be employed where the lock is configured for the key to be insertable and retractable in one orientation (e.g. at 0°) and in the opposite orientation (e.g. after the key has been rotated through 180°). In which case, the lock may be provided with a second retention means (e.g. projection or clip provided on the casing) arranged to retain the locking member after it has been rotated by 180°.

[0044] It will be understood that the profile of the key may be asymmetrical by providing a partial transverse cut-out at only one side of the (or each) stop shoulder, or providing partial transverse cut-outs in diagonally opposite corners of the two stop shoulders.

[0045] In one embodiment, partial transverse cut-outs may be provided in both diagonally opposite corners (i.e. in all four corners) of the two stop shoulders. As above, these cut-outs could enable the key to be inserted in either orientation in a first lock and to be inserted in either orientation in a second lock (i.e. having a differently sized locking member), thereby providing a master key facility.

[0046] Each partial transverse cut-out may be such that the resulting unlocking shoulders are aligned in a common vertical plane to act on a common locking member. However, in other embodiments, one or more of the unlocking shoulders may not be aligned in a common vertical plane. For example, a first set of diagonally opposite unlocking shoulders may be provided in a first plane for use with a first locking member and a second set of diagonally opposite unlocking shoulders may be provided in a second plane for use with a second locking member.

[0047] The (or each) partial transverse cut-out may be bounded by one or more straight or curved surfaces. In specific embodiments, the (or each) unlocking shoulder (or end surface of the cut-out) may be constituted by a planar surface. Advantageously, the (or each) unlocking shoulder (or end surface of the cut-out) may be constituted by a curved surface for mating with a similarly curved nose provided on a free end of the locking member. This allows the unlocking shoulder to be formed by a simple counter-boring operation as opposed to traversing a cutter blade. The forming of such unlocking shoulders can therefore be carried out more quickly and more

accurately while also providing a greater contact area between the unlocking shoulder and the locking member. A side surface and/or a bottom surface of the (or each) transverse cut-out may be curved or planar. In practice, a curved bottom surface may be preferred as it may be easier to manoeuvre a cutter blade into and out of the stop shoulder during manufacture by creating a curved surface.

[0048] The (or each) second (shaft) cut-out may be aligned in a horizontal plane with the (or each) first (stop shoulder) cut-out. These features may allow the key to be inserted and withdrawn from the keyway, past an obstruction such as that which may be provided to hold the locking member in the lock. The gap may allow the key to turn in the keyway, for example, past an obstruction such as that which may be provided to hold the plug in the casing and/or to hold the locking member in the lock.

[0049] The lock may be configured such that the locking member is substantially accommodated within the shaft cut-out (e.g. so that no additional space, outside of the key profile, is required within the lock to accommodate the locking member). In other embodiments, at least one shaft cut-out is provided to simplify the manufacture of the (or each) partial transverse cut-outs.

[0050] The unlocking shoulder may engage with the locking member inside the plug and/or casing of the lock, or it may engage with the locking member outside of the plug and/or casing of the lock.

[0051] In a particular embodiment, the key is of the type described in European patent No. 0892130 B1, for use with a lock of the type described in European patent No. 0892130 B1. In an embodiment, the shaft has at least one row of recesses on a first major surface and at least one row of recesses on an opposite major surface such that said recesses on the first and opposite major surfaces are aligned in pairs. In a particular embodiment, first and second rows of recesses are provided on each major surface such that the key can operate the lock irrespective of the orientation of the shank in the keyway.

[0052] In another embodiment, the key is a conventional type of key for use with a conventional pin-tumbler lock mechanism. The shaft has a series of ridges and recesses along at least one side of the key shaft for movement of the pins in a complementary lock.

[0053] It will be noted that an aim of the present invention is to allow the manufacture of a larger number of different lock combinations and improved master keying by better utilising the space available within a lock. As an example, we can consider the case where there are 165,000 different combinations in an existing lock mechanism (e.g. such as that described in European patent No.0892130 B1). By altering each of these locks to include the first aspect of the present invention we can associate a number of different locking members/locking means to each existing combination to thereby multiply the number of combinations accordingly. In practice, it may be convenient for the locking member to extend from the plug/casing by approximately 1 mm to 2mm when

the lock is locked. It may also be convenient for each different unlocking shoulder to be spaced at least 0.5mm from any other. Accordingly, this can provide three different locking member/unlocking shoulder positions (i.e. 0.5mm, 1.0mm, 1.5mm) for each existing lock combination wherein the locking member protrudes by 2mm in its locked position, therefore trebling the number of unique locks possible. If we then consider the case where the key can have an unlocking shoulder on one side or the other of the stop shoulder (e.g. permitting two different sets of diagonal unlocking shoulders) and we can relocate the relative position of the protruding portion of the locking member to mate with either side of the key, we can further double the number of combinations available. Thus, in this example alone, six times the original number of lock combinations can very simply be achieved and master keying facility is considerably improved.

[0054] Traditional master keying involves use of fixed obstructions along a key shank, which can easily be filed away so that the key can enter a different lock. Aspects of the present invention make use of a moveable obstruction that has to be placed in the correct position in order to allow the key to enter a particular lock. Accordingly, it is believed that the present invention can offer even greater security in relation to master keying, than that traditionally employed.

[0055] According to a third aspect of the present invention there is provided a method of manufacturing a key according to the second aspect of the present invention, comprising the steps of:

- Providing a key blank;
- Forming ridges and/or recesses in a shaft of the key blank for engagement with pins inside the lock;
- Forming an unlocking shoulder on the key, by providing a first partial transverse cut-out in a stop shoulder, such that the unlocking shoulder is a predetermined axial distance from the stop shoulder; and wherein a second partial transverse cut-out is arranged to extend along the length of the shaft, to allow the shaft to by-pass a partial obstruction in a keyway, and wherein the width of the shaft is narrowed to produce a gap in the cut-out, said gap being provided to permit the key to turn past the obstruction to unlock a lock.

[0056] It will be understood that the steps of forming the unlocking shoulder and forming the ridges and/or recesses in the key can be carried out in any order.

[0057] In one embodiment, the key blank may comprise the stop shoulder. In an alternative embodiment, the method may further comprise the step of forming the stop shoulder on the key.

[0058] The axial spacing between the stop shoulder and the unlocking shoulder on a specific key will be selected to correlate to the distance by which the locking member must be moved into a complementary lock in order to move the locking member into the unlocked po-

sition.

[0059] In an embodiment, a key is manufactured with a shallow unlocking shoulder (i.e. the axial distance between the stop shoulder and the unlocking shoulder is relatively small) for operation of a particular lock. The key may then be further processed to form a deeper unlocking shoulder (i.e. the axial distance between the stop shoulder and the unlocking shoulder is increased), so that the key operates a different lock. Advantageously, a set of identical keys with the same combination of ridges/recesses may be manufactured with the same shallow unlocking shoulder. One or more of the keys may then be further processed so that they have a different unlocking shoulder depth, corresponding to a different lock.

[0060] It will therefore be appreciated that in addition to the extra security provided by the lock mechanism of the present invention, the invention also provides an advantage in the manufacture of keys and locks. For each combination of the pins inside the lock, there is usually only one key. In the case of the present invention, for each combination of pins, a number of different locks can be produced by varying the distance the locking member must move in order to place the locking means in its unlocked position. Complementary keys to the different locks can easily be manufactured by altering the spacing between the stop shoulders and the unlocking shoulders. Thus the present invention facilitates the manufacture of a greater number of keys and locks, with increased security and much improved master keying.

[0061] According to a fourth aspect of the invention there is provided a locking assembly, comprising a key-operable lock according to the first aspect of the invention and a complementary key according to the second aspect of the invention.

[0062] According to a further aspect of the invention there is provided a locking assembly, said locking assembly comprising a key-operable lock and a complementary key, said lock comprising a casing, a plug having a keyway therein, the plug being rotatably housed within the casing, a locking member arranged for axial movement, and a locking means, said key comprising a handle, a shaft and an unlocking shoulder, the lock having a locked position wherein the locking means projects across an interface between the plug and the casing such that the plug is prevented from relative rotation within the casing, and an unlocked position wherein the locking means is relocated to permit rotation of the plug within the casing, the locking member being axially movable by the unlocking shoulder when said key is inserted into the keyway, so as to cause the locking means to relocate, characterised by the locking member extending out of the plug and/or casing in the locked position of the lock.

[0063] It will be understood that the key in the further aspect of the invention may be constituted by a key according to the second aspect of the invention and the optional features of the first and second aspects of the invention can apply equally to the further aspect of the invention.

[0064] The movement of the locking member may directly cause the locking means to move to an unlocked position. Alternatively, the movement of the locking member may allow the locking means to relocate into an unlocked position.

[0065] In an embodiment, the locking member causes the locking means to move to one of a first or a second unlocked position. The provision of first and second unlocked positions provides a master key facility. The locking means may move into the first unlocked position upon insertion of a complementary standard key into the lock, and into the second unlocked position by insertion of a complementary master key into the lock. The master key may be able to unlock a number of different locks according to the invention. The master key may have, in addition to an unlocking shoulder, a stop shoulder which abuts the lock when the key is fully inserted. Alternatively, the master key may have only one shoulder which functions as both the unlocking shoulder and the stop shoulder.

[0066] The present invention is therefore advantageous since it provides a lock cylinder with enhanced security, an increased number of combinations and a master keying facility.

Detailed Description

[0067] Embodiments of the invention will now be described by way of example only, with reference to the accompanying figures, in which:

Figure 1 is a part sectional side view of an embodiment of a lock cylinder according to the present invention, taken through line B-B of Figure 2;

Figure 2 is an end cross-sectional view of the lock cylinder shown in Figure 1, taken through line A-A;

Figure 3a shows a side view of the lock cylinder shown in Figures 1 and 2;

Figure 3b shows a side view of a key, for use in a lock according to an embodiment of the present invention;

Figure 4 is a part sectional side view of the lock cylinder of Figure 1 with the key of

Figure 3B inserted, taken through line B-B of Figure 5;

Figure 5 is an end cross-sectional view of the lock cylinder of Figure 4 with the key inserted, taken through line A-A;

Figures 6a to 6d show part sectional side views of the combinations of two different locks with two different keys;

Figure 6a shows a part sectional side view of a lock A in combination with its complementary key A;

Figure 6b shows a part sectional side view of a lock B in combination with its complementary key B;

Figure 6c shows a part sectional side view of a lock A in combination with a non-complementary key B;

Figure 6d shows a part sectional side view of a lock B in combination with a non-complementary key B;

Figure 7 shows a part sectional side view of an alternative embodiment of a part of the lock of the present invention;

Figure 8 shows a part sectional side view of another embodiment of a lock cylinder according to the present invention, without a key inserted;

Figure 9 shows a part sectional side view of the lock cylinder of Figure 8, with a complementary key inserted;

Figure 10 shows a part sectional side view of the lock cylinder of Figure 8, with a non-complementary key inserted;

Figure 11 shows a part sectional side view of a further embodiment of a lock cylinder according to the present invention, without a key inserted;

Figure 12 shows an end cross-sectional view of the lock cylinder shown in Figure 11;

Figure 13 shows a part sectional side view of the lock cylinder shown in Figure 11, with a complementary key inserted; and

Figure 14 shows an end cross-sectional view of the lock cylinder shown in Figure 13.

Figures 15a to 15d show part sectional side views of another embodiment of a lock cylinder according to the present invention;

Figure 15a shows a part sectional side view of a lock A with a master key facility, in combination with a complementary standard key A;

Figure 15b shows a part sectional side view of a lock B with a master key facility, in combination with a complementary standard key B;

Figure 15c shows a part sectional side view of the lock A of Figure 15a, in combination with a complementary master key M;

Figure 15d shows a part sectional side view of the lock B of Figure 15b, in combination with complementary master key M;

Figures 16A through F show a further embodiment of a lock according to the present invention;

More specifically, Figure 16A shows a part sectional side view of a further embodiment of a lock cylinder according to the present invention, in a locked position;

Figure 16B shows a view similar to that of Figure 16A, but with a key inserted in the lock so as to place it in an unlocked position;

Figure 16C shows a perspective view of the locking member of Figures 16A and B;

Figure 16D shows an end view of the lock of Figure 16A in the locked position;

Figure 16E shows a top view of the plug from the lock of Figure 16D prior to insertion of the locking member;

Figure 16F shows a cross-sectional view taken through lines AA of Figure 16E;

Figure 17A shows a part sectional side view of a further lock according to an embodiment of the invention, having a key according to an embodiment

of the present invention inserted therein;

Figure 17B shows a part sectional horizontal view of the arrangement of Figure 17A;

Figure 17C shows a partial perspective view of the key in Figures 17A and B;

Figure 18A shows a side view of a key according to another embodiment of the present invention;

Figure 18B shows a vertical cross-section taken along lines AA of Figure 18A;

Figure 19 shows a view from the front exterior of a lock according to another embodiment of the present invention, prior to insertion of a key into the keyway;

Figure 19A shows an end cross-sectional view through the lock of Figure 19;

Figure 19B shows a top cross-sectional view through the lock of Figure 19 when a key in accordance with an embodiment of the present invention is inserted;

Figure 19C shows a side cross-sectional view of the lock of Figure 19 in the locked position;

Figure 19D shows a side cross-sectional view of the lock of Figure 19B, with the key inserted and the lock in the unlocked position;

Figure 19E shows a partial side view of the key in Figures 19B and 19D;

Figure 19F shows a cross-sectional view taken alone lines AA in Figure 19E;

Figure 19G shows a partial side view of the top a key similar to that shown in Figure 19E, where a cut-out is provided to a slightly shallower depth; and

Figure 19H shows a partial side view of the top a key similar to that shown in Figure 19G, where a cut-out is provided to an even shallower depth.

[0068] Referring to Figure 1, the lock 10 comprises a rotatable cylindrical plug 12 which is housed in a non-rotatable casing 14 of annular cross section. Extending axially into the plug 12 is a keyway 16. Also extending axially into the plug 12, and in parallel with the keyway 16, is a slot 18. An opening 20 in the plug 12 connects the slot 18 with a transverse aperture 22 in the casing. The slot 18 houses a locking member in the form of a cylindrical locking rod 24 having a front end 26, a rear end 28, and an upper longitudinal surface 30. A spring biasing means 32 is situated in the slot 18 and abuts the rear end of the locking rod 24. In the locked position of the lock 10, with no key inserted, as shown in Figure 1, the front end 26 of the locking rod 24 extends out of the plug 12 due to a biasing force provided by the spring 32.

[0069] In the upper surface of the locking rod there is a cut-out 34 with a front wall 36, a rear wall 38 and a base 40. In the base 40 of the cut-out 34 there is a recess 42. A locking means in the form of a ball 44 is seated in the cut-out 34. In the locked position of the lock 10, as shown in Fig. 1, the locking rod 24 is biased outwards. The ball 44 extends through the opening 20 in the plug 12 to engage with the aperture 22 in the casing 14, such that the ball 44 spans the interface between the plug 12 and the casing 14 which prevents the plug 12 from rotating within

the casing 14. In the locked position of the lock 10 the ball 44 also contacts the rear wall 38 of the cut-out 34 in the locking rod 24, which serves as a retaining means and prevents the locking rod 24 from moving further out of the lock 10. As the locking rod 24 is moved in and out of the slot 18 in the plug 12, the distance of travel of the locking rod 24 is limited by the position of the ball 44 relative to the walls 36, 38 of the cut-out.

[0070] The lock cylinder described above can be used in combination with any known lock mechanism, such as a pin-tumbler type lock mechanism. In particular, the lock cylinder of the present invention can be used in combination with the lock mechanism described in European patent No. 0892130 B1, as shown in Figs 2 and 3. In this type of lock mechanism, a row of transverse passages 50 transect the plug 12 and casing 14, and extend through the keyway 16. Each passage contains a shorter first pin 52 and a longer second pin 54 (although equal length pins may also be used), each pin 52, 54 having a tapered inner end 56. The pins 52, 54 are respectively biased towards each other by a first 58 and a second 60 compression spring. In the absence of a key, the second pin 54 projects across the interface 62 between the plug 12 and the casing 14, preventing the plug 12 from rotating. Fig. 2 also shows the ball 44 extending between the locking rod 24 in the plug 12 and the aperture 22 in the casing 14. The ball 44 also prevents the plug 12 from rotating in the locked position of the lock 10, and thus provides an additional level of security to the pin mechanism.

[0071] Referring to Figure 3a, the lock 10 comprises a row of six transverse passages 50 which extend through the plug 12 and the casing 14 to the surface of the lock cylinder. The dashed lines on the Figure indicate the internal boundaries of the plug 12 and the axial keyway 16 inside the lock. A locking rod 24 extends axially from the plug 12.

[0072] A complementary key for use with the lock 10 is shown in Figure 3b. The key 70 comprises an integrally formed handle 72 and a shank 74. The shank 74 has a first surface 76 and an opposite surface (not shown). On each surface of the shank, a first 78 and a second 80 row of six recesses 82 are provided either side of a centre line. For each row position on the first row 78 of the first surface 76, the depth of the recess matches the depth of the recess in the same row position on the second row 80 of the opposite side of the shank 74, as described more fully in EP0892130 B1. The key also comprises two stop shoulders 84 and two unlocking shoulders 86. The key 70 thus has a C_2 -axis of rotational symmetry, which means that it can operate the lock 10 irrespective of the orientation of the key 70 when it is inserted into the lock 10.

[0073] Figures 4 and 5 show the lock 10 with a complementary key 70 inserted into the keyway. The key comprises a shank 74 with a stop shoulder 84 and an unlocking shoulder 86. The stop shoulder 84 abuts the plug 12 when the key 70 is fully inserted into the keyway.

The shank 74 of the key has a set of recesses 82 along its length (shown in Fig. 3b), as described more fully in EP 0892130 B1. When the key 70 is inserted into the keyway, as shown in Fig. 5, the shank 74 of the key moves the first 52 and second 54 pins apart, compressing the first 58 and second 60 springs. The tapered ends 56 of the pins are received in the recesses 82 in the shank 74 of the key 70, so that the second pin 54 no longer projects across the interface 62 between the plug 12 and the casing 14.

[0074] As shown in Fig. 4, the unlocking shoulder 86 of the key 70 abuts the front end 26 of the locking rod 24. The unlocking shoulder 86 is cut to a specified depth (d) so that when the key 70 is inserted into the lock 10, the unlocking shoulder 86 moves the locking rod 24 into the plug 12 by a predetermined distance. This aligns the recess 42 in the cut-out 34 of the locking rod 24 with the aperture 22 in the casing 14, so that the ball 44 is received in the recess 42. In this position of the lock, as shown in Figs. 4 and 5, the ball 44 is completely received within the confines of the plug 12 so that the plug 12 is allowed to rotate within the casing 14 (provided, of course, that each of the transverse pins 52, 54 are also moved into the confines of the plug 12 by alignment of the recesses 82 in the key shank 74). From Figure 4 it can also be seen that in the unlocked position, an upper portion of the ball 44 projects into the opening 20 within the plug 12. This prevents axial movement of the ball 44 relative to the plug 12 so that the locking rod 24 cannot be removed from the plug 12 when the ball 44 is in the unlocked position.

[0075] Figures 6a to 6d illustrate that the depth of the unlocking shoulder on the key must be complementary to the configuration of the locking rod, otherwise rotation of the plug (and therefore unlocking of the lock) is prevented.

[0076] Fig. 6a shows a lock A in combination with a complementary key A. The key A has an unlocking shoulder 86 of depth x (with respect to a first stop shoulder) which moves the locking rod 24 into the plug 12 by a distance which aligns the recess 42 in the locking rod 24 with the aperture 22 in the casing 14. The ball 44 is received in the recess 42 and no longer blocks rotation of the plug 12 so that the lock A may be unlocked. Fig. 6b shows a different lock B in combination with a complementary key B. The key B has an unlocking shoulder 86 of depth y (with respect to a first stop shoulder) which moves the locking rod 24 into the plug 12 by a different distance to align the recess 42 with the aperture 22. In Fig. 6c, key B is inserted into lock A. The depth y of key B is too great for the unlocking shoulder 86 to make contact with the front end 26 of the locking rod 24, so that the key B cannot move the locking rod 24 into the plug 12 to align the ball 44 with the recess 42. The ball 44 is therefore retained across the interface between the plug 12 and the casing 14, preventing rotation of the plug 12. In Fig. 6d, key A is inserted into lock B. Because the depth x of key A is too small, the unlocking shoulder 86

moves the locking rod 24 too far into the plug 12 to align the ball 44 with the recess 42. Lock B can therefore not be unlocked by key A.

[0077] The shapes of the cut-out and the recess in the locking rod may take a number of different forms. In the embodiment shown in Figure 7, the cut-out and recess are replaced by an angular depression 90 with sloped sides 92. The sloped sides 92 abut at least part of the ball 44 as it extends through an opening 20 in the plug and into the aperture 22 and this serves to retain the locking rod 24 within the slot 18. When the ball 44 is received in the deepest part of the depression 90, the ball 44 does not extend beyond the confines of the plug 12 such that the plug 12 is allowed to rotate within the casing 14. However, in this position a portion of the ball 44 will still be received in the opening 20 in the plug 12 so that the locking rod 24 cannot be removed from the plug 12 in the unlocked position. In the unlocked position the key can also serve to retain the locking rod 24 within the slot 18.

[0078] Figures 8 to 10 show another embodiment of the invention in which the recess 42 is not formed within the cut-out 34, but instead is formed in a different part of the locking rod 24. The cut-out 34 and the recess 42 respectively receive a first 44a and a second 44b ball. The first ball 44a is held within the confines of the plug 12, in an opening 20 provided in the outer portion of the plug 12, and is retained in the opening in all positions of the lock 10. As the locking rod 24 is moved in and out of the plug 12, the cut-out 34 moves relative to the ball 44a so that the ball 44a effectively travels between a front 36 and a rear 38 sloped wall, of the cut-out 34. This serves to retain the locking rod 24 within the plug 12.

[0079] In the locked position of the lock 10 with no key inserted, as shown in Fig. 8, the second ball 44b sits on the locking rod 24 and engages with the aperture 22 in the casing 14. The first ball 44a abuts the rear sloped wall 38 of the cut-out 34 such that the locking rod 24 cannot be removed from the plug 12. When the complementary key A is inserted into the lock 10, as shown in Fig. 9, the unlocking shoulder 86 of the key A contacts the locking rod 24 and moves the locking rod 24 into the plug 12 until the stop shoulder 84 of the key A abuts the plug 12. The inward movement of the locking rod 24 aligns the recess 42 with the aperture 22. The second ball 44b is ejected into the recess 42 so that it no longer engages with the aperture 22 in the casing 14, allowing the plug 12 to rotate. At the same time, the front sloped wall 36 of the cut-out 34 is moved towards the first ball 44a. In the embodiment shown in Figure 9, when the recess 42 is aligned with the aperture 22, the sloped wall 36 abuts the first ball 44a. However, it will be understood that in other embodiments, the spacing of the recess 42 and the cut-out 34 may be such that the sloped wall 36 does not engage the first ball 44a when the recess 42 is aligned with the aperture 22. The locking rod 24 can therefore be moved further into the plug 12 and past the unlocked position (for example by insertion of a non-com-

plementary key), until the sloped wall 36 engages the first ball 44a in a further locked position.

[0080] The embodiments shown in the Figures depict the lock in a particular orientation, with the locking rod 24 provided towards the top of the lock 10 and the recess 42 in an upper surface of the locking rod 24. However, it will be understood that the locking mechanism could be placed in any orientation. For example, if the locking rod 24 was positioned at the bottom of the lock 10 and the recess was provided in the lower surface of the locking rod 24 (i.e. Figure 9 viewed upside-down), the lock 10 would still work in the same way. When the recess 42 and the aperture 22 are aligned in this orientation, rotation of the plug 12 by the key causes the ball 44 to be ejected from the aperture 22 and thereby move into the recess 42. If the recess 42 is not aligned with the aperture 22, the ball cannot move into the recess and remains across the interface between the plug 12 and the casing 14 such that rotation of the plug 12 is prevented.

[0081] When a non-complementary key B is inserted into the lock 10, as shown in Figure 10, the locking rod 24 is not moved into the plug 12 by a distance sufficient to align the recess 42 with the aperture 22. The second ball 44b therefore remains engaged with the aperture 22 and prevents rotation of the plug 12.

[0082] Figures 11 to 14 show a further embodiment of the invention. Referring to Figures 11 and 12, the casing 14 of the lock comprises an arced section 100 with an inner surface 102. The arced section 100 is thicker than the casing 14 so that the inner surface 102 of the arc protrudes into the plug 12 and forms a fixed obstruction. At the mid-point of the inner surface 102 of the arced section there is an aperture in the form of a notch 104. In the locked position of the lock 10, a part 105 (which constitutes the locking means) of the locking rod 24 is engaged with the notch 104 which prevents the plug 12 from rotating, but permits axial movement of the locking rod 24. When the locking rod 24 is moved axially into the plug 12 by insertion of a complementary key 70, as shown in Figs. 13 and 14, a reduced diameter portion 106 of the locking rod 24 aligns with the notch 104. Since the reduced-diameter portion 106 of the locking rod 24 does not extend beyond the inner surface 102 of the arced section 100, the plug 12 is free to rotate. A channel (not shown) around the circumference of the plug 12 receives the arced section 100 and allows the plug 12 to rotate.

[0083] In this embodiment of the invention, alignment of the reduced diameter portion 106 with the notch 104 constitutes the unlocked position of the lock. In another embodiment (not shown), first and second reduced diameter portions may be provided in the locking rod, which provide first and second unlocked positions of the lock. This provides a master key facility, wherein a master key is able to align the second reduced diameter portion of the locking rod with the notch to enable rotation of the plug.

[0084] Figures 15a to 15d show a lock similar to that shown in Figure 4 but further including a master key fa-

cility. Referring to Figure 15a, a lock A comprises first 42a and second 42b recesses in the surface of the locking rod 24. The first recess 42a is spaced from the front end 26 of the locking rod 24 by a distance x. When a complementary key A is inserted into the lock A, the unlocking shoulder 86 pushes the locking rod 24 into the plug 12 until the stop shoulder 84 abuts the plug 12, such that the first recess 42a is aligned with the aperture 22 and the ball 44 moves into the first recess 42a.

[0085] Similarly, Figure 15b shows a different lock B with a complementary key B inserted. In lock B, the first recess 42a is spaced from the front end 26 of the locking rod 24 by a distance y, which is greater than the corresponding distance x in lock A. Thus key A can only unlock lock A and key B can only unlock lock B. In the embodiment shown in Figure 15b, the first 42a and second 42b recesses have a curved profile, and are separated by a flat section 110 of the locking rod 24. The flat section 110 makes the lock more secure, since the ball 44 cannot easily be forced into one of the recesses in the absence of a complementary key. However, it will be understood that in alternative embodiments, a flat section is not provided between the recesses, and the recesses may adopt an angular or square profile.

[0086] Figures 15c and 15d respectively show the locks A and B with a master key M inserted. The master key M has an unlocking shoulder 86. When the master key M is fully inserted into the plug 12, the second recess 42b is aligned with the aperture 22 so that the ball 44 is moved into the second recess 42b. The second recess 42b is spaced apart from the front end 26 of the locking rod 24 by the same distance z in each of the locks A and B, so that the master key M is able to unlock both locks. Thus the first 42a and second 42b recesses provide first and second unlocked position of the locks A and B, enabling both locks to be operated by a master key M. In the embodiment shown, the master key has an unlocking shoulder 86, which also provides the function of a stop shoulder. The master key M is pushed into the lock until the shoulder 86 abuts the lock, which aligns the second recess 42b in the second unlocked position. However, it will be appreciated that the master key M could be provided with separate unlocking and stop shoulders which are spaced apart by a distance such that when the master key M is inserted into the lock until the stop shoulder abuts the lock, the locking rod 24 is pushed into the lock by a distance which aligns the second recess 42b with the aperture 22.

[0087] Figures 16A through F show a further embodiment of a lock 120 according to the present invention. The lock 120 is similar in construction to the lock shown in Figures 11 to 14 and so like reference numerals will be employed as appropriate. The lock 120 therefore has a casing 14 comprising an arced section 100 with an inner surface 102. The arced section 100 is thicker than the casing 14 so that the inner surface 102 of the arc protrudes into the plug 12 and forms a fixed obstruction. At the mid-point of the inner surface 102 of the arced

section 100 there is an aperture in the form of a notch 104. In the locked position of the lock 120, a part 105 (which constitutes the locking means) of a rectangular locking rod 122 is engaged with the notch 104 which prevents the plug 12 from rotating, but permits axial movement of the locking rod 122. When the locking rod 122 is moved axially into the plug 12 by insertion of a complementary key 70, as shown in Figure 16B, a reduced height portion 106 of the locking rod 122 aligns with the notch 104. Since the reduced height portion 106 of the locking rod 122 does not extend beyond the inner surface 102 of the arced section 100, the plug 12 is free to rotate. As before, a channel (not shown) around the circumference of the plug 12 receives the arced section 100 and allows the plug 12 to rotate. In this embodiment of the invention, alignment of the reduced height portion 106 with the notch 104 constitutes the unlocked position of the lock 122.

[0088] As best shown in Figures 16E and 16F, in this particular embodiment, the locking rod 122 is provided in a channel 124 cut along the upper surface of the plug 12. For ease of manufacture, the channel 124 has a curved portion 126 gradually sloping inwardly from the upper surface of the plug 12 before extending in a generally flat portion 128 towards the free end of the plug 12. As the locking rod 122 is generally rectangular it will be permitted to travel along the flat portion 128. In order to retain the locking rod 122 in the lock 120, the plug 12 includes a cylindrical aperture 130 disposed part-way along the flat portion 128, having a width greater than the flat portion 128 and extending from the upper surface of the plug 12 to the flat portion 128.

[0089] As shown in Figure 16C, the locking rod 122 of the present invention has a stepped end 132 protruding from the lock 120. The stepped end 132 comprises a transverse cut-out in the lower portion of the rod 122 to accommodate the stop shoulder 84 of the key 70 when the unlocking shoulder 86 is in contact with the protruding end of the locking rod 122 so as to move the lock to its unlocked position, shown in Figure 16B. The locking rod 122 also includes a rectangular recess 134 along a portion of its lower surface.

[0090] In use, a retainer in the form of a cylinder 136 is provided to fill the cylindrical aperture 130, the locking rod 122 is placed in the channel 124 such that the cylinder 136 is located within the recess 134 and a spring 138 is also provided within the recess 134 to act between the cylinder 136 and the front face of the recess 134. As the cylinder 136 is wider than the rest of the channel 124 it is held in a fixed position within the channel 124. When in a relaxed (i.e. locked) position, the spring 138 will urge the locking rod 122 out of the plug 12 until the rear of the locking rod 122 abuts the cylinder 136 and as such the cylinder 136 will serve to retain the locking rod 122 in the lock 120. When the locking rod 122 is urged by a suitable key 70 into the lock 120, the spring 138 will be compressed and the locking rod 122 will move along the channel 124 and will thereby move the part 105 out of the

notch 104 so as to align the reduced height portion 106 with the notch 104 so that the plug 12 is not prevented from rotating. In this position, the lock 120 will be unlocked and the key 70 will be permitted to rotate the plug 12 within the casing 14.

[0091] Figure 17A and 17B shows a lock 140, that is a variant of the lock 120 shown in Figures 16A through 16F, having a key 150 according to another embodiment of the present invention inserted therein. In this case, only a portion of the lock 140 is shown but the only difference between the lock 120 and the present lock 140 is that instead of the stepped end 132 of the locking rod 122 having a transverse cut-out in the lower portion of the rod 122, the stepped end 132 now comprises a partial transverse cut-out 142 down one side of the rod 122.

[0092] The key 150, best shown in Figure 17C, is substantially the same as the key 70 shown in previous figures but in this case the key includes an unlocking shoulder 152 provided by a partial transverse side cut-out in the stop shoulder 154. The cut-out is bounded by a curved bottom surface 156, a vertical side surface 158 and a vertical end surface constituted by the unlocking shoulder 152. Although not shown in full in Figure 17C, the handle 72 and shaft 74 of the key 150 are identical to those shown in Figure 3b.

[0093] Figures 18A and 18B show a key 160 that is a variant of the key 150 shown in Figures 17A through 17C. The differences between the key 160 and key 150 are that the partial transverse cut-out in the key 160 is bounded by a planar bottom surface 162 and that a corner cut-out 164 is provided along the length of the shaft 74. Although a gap 166 is provided between the shaft 74 and the stop shoulder 154 in which the unlocking shoulder 152 is provided, the bottom surface of the corner cut-out 164 is aligned with the bottom surface 162 of the transverse cut-out and therefore acts an extension thereto. Similarly, the side surface of the corner cut-out 164 is aligned with the side surface 158 of the transverse cut-out and therefore acts an extension thereto. In addition, the diagonally opposite corner of the shaft 74 is provided with an identical corner cut-out 164 and the diagonally opposite corner of the stop shoulder 154 also includes an identical partial transverse cut-out to form a diagonally opposite unlocking shoulder 152. Thus, it will be possible to insert the key 160 in a lock according to the present invention, either way up.

[0094] Figures 19 through 19D show a lock 170 that is a further variant of the lock 140 shown in Figures 17A and 17B. In this embodiment, the locking rod 122 terminates at the end of the rectangular recess 134 so that the rear end of the locking rod 122 no longer abuts the cylinder 136 to retain the locking rod 122 in the lock 170. Instead, the locking rod 122 is retained in the lock 170 by the arced section 100 of the casing 14 having an off-centre notch 104 such that a portion of the arced section 100 adjacent the notch 104 serves to retain the locking rod 122 in the lock 170. This embodiment is advantageous since it allows the locking rod 122 to be inserted,

removed or replaced without having to remove the entire lock 170 or plug 12 - all that is required is that the plug 12 is rotated so that the channel 124 is no longer partly obstructed by the arced section 100 and the locking rod 122 can be accessed.

[0095] This embodiment also comprises a second arced section 172 provided in the casing 14, opposite to the first arced section 100. The second arced section 172 is identical to the first arced section 100 and is orientated such that the notch 174 in the second arced section 172 is diagonally opposite to the notch 104 in the first arced section 100.

[0096] The lock of Figures 19 through 19D may be configured for use with the key 160 of Figures 18A and 18B. However, as shown in Figures 19B, 19D and 19E to 19H, a key 180 is employed which is substantially similar to the key 170 but includes curved (rather than planar) bottom surfaces 182 bounding each opposite partial transverse cut-out. As shown in Figures 19E, 19G and 19H, the partial transverse cut-outs 184 are provided on a first set of diagonally opposite corners of the key 180, while the corner cut-outs 164 along the shaft 74 are provided on the other set of diagonally opposite corners of the key 180. This allows the key 180 to be inserted into the keyway of the lock 170 so that the shaft 74 is not obstructed by the portions of the arced section 100 and second arced section 172 that extend into the keyway when the plug is orientated at 0° and 180°.

[0097] An advantage of the lock 170 is that the key 180 can be extracted after the plug 12 has been rotated through 180° since, in this position, the second arced section 172 will serve to retain the locking rod 122 in the lock 170.

[0098] It will be appreciated by persons skilled in the art that various modifications may be made to the above embodiments without departing from the scope of the present invention.

Claims

1. A key comprising:

a handle;
a shaft;
a stop shoulder; and
an unlocking shoulder,
the stop shoulder and the unlocking shoulder being axially spaced apart by a predetermined distance such that when the shaft is inserted into the keyway of a complementary lock, the unlocking shoulder serves to move the lock into an unlocked position when the stop shoulder abuts the lock to denote that the shaft is fully inserted in the keyway and wherein the unlocking shoulder is provided by a first partial transverse cut-out in the stop shoulder,
the key further comprising a second partial

transverse cut-out extending along the length of the shaft to allow the shaft to by-pass a partial obstruction in the keyway, and wherein the width of the shaft narrows to produce a gap, said gap being provided to permit the key to turn past the obstruction to unlock the lock.

2. The key according to any preceding claim wherein the second partial transverse cut-out is provided along a diagonally opposite corner of the shaft from the first partial transverse cut-out.

3. The key according to any preceding claim, wherein the key is configured for insertion into the keyway of a lock in two orientations.

4. The key according to any preceding claim, wherein the key has a first unlocking shoulder and a first stop shoulder on one surface of the key and a second unlocking shoulder and a second stop shoulder on an opposite surface of the key.

5. The key according to claim 4, wherein partial transverse cut-outs are provided in diagonally opposite corners of the first and second stop shoulders.

6. The key according to claim 4, wherein partial transverse cut-outs are provided in both diagonally opposite corners of the first and second stop shoulders.

7. The key according to claim 5 or claim 6, wherein one or more of the unlocking shoulders is not aligned in a common vertical plane.

8. The key according to any preceding claim, wherein the shaft comprises at least one row of recesses on a first major surface and at least one row of recessed on an opposite major surface such that said recesses on the first and opposite major surfaces are aligned in pairs.

9. A key-operable lock for use with a key according to any preceding claim comprising:

a casing;
a plug having a keyway therein, the plug being rotatably housed within the casing;
a locking member; and
a locking means,

the lock having a locked position wherein the locking means projects across an interface between the plug and the casing such that the plug is prevented from relative rotation within the casing, and an unlocked position wherein the locking means is relocated so as to permit rotation of the plug within the casing; and wherein the locking member is arranged for axial movement to cause the locking means to relocate,

the lock further comprising a retaining means to retain at least a part of the locking member in the lock, and wherein the retaining means forms a partial obstruction in the keyway.

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10. The lock according to claim 9 wherein the locking member extends out of the plug and/or casing in the locked position of the lock.

11. The lock according to claim 9 or claim 10, wherein the locking member is moveable from a first position corresponding to a locked position of the lock to a second position corresponding to an unlocked position of the lock and beyond to a third position corresponding to a further locked position of the lock.

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12. The lock according to any one of claims 9 to 11, having a first and a second unlocked position, wherein in the first unlocked position the locking means is relocated into a first location so as to permit rotation of the plug within the casing, and in the second unlocked position the locking means is relocated into a second location so as to permit rotation of the plug within the casing.

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13. The lock according to any one of claims 9 to 12 wherein the locking member is constituted by a rod which comprises a first diameter portion forming the locking means and a second diameter portion, having a smaller diameter than the first diameter portion, arranged to align with the retaining means so as to allow the key to turn past the retaining means when the lock is in its unlocked position.

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14. A method of manufacturing a key according to any one of claims 1 to 8, comprising the steps of:

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providing a key blank;
forming ridges and/or recesses in a shaft of the key blank for engagement with pins inside the lock;

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forming an unlocking shoulder on the key, by providing a first partial transverse cut-out in a stop shoulder, such that the unlocking shoulder is a predetermined axial distance from the stop shoulder; and

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wherein a second partial transverse cut-out is arranged to extend along the length of the shaft, to allow the shaft to by-pass a partial obstruction in a keyway, and wherein the width of the shaft is narrowed to produce a gap, said gap being provided to permit the key to turn past the obstruction to unlock the lock.

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15. A locking assembly, said locking assembly comprising a key-operable lock according to any one of claims 9 to 13 and a complementary key according to any one of claims 1 to 8.

55

Figure 1

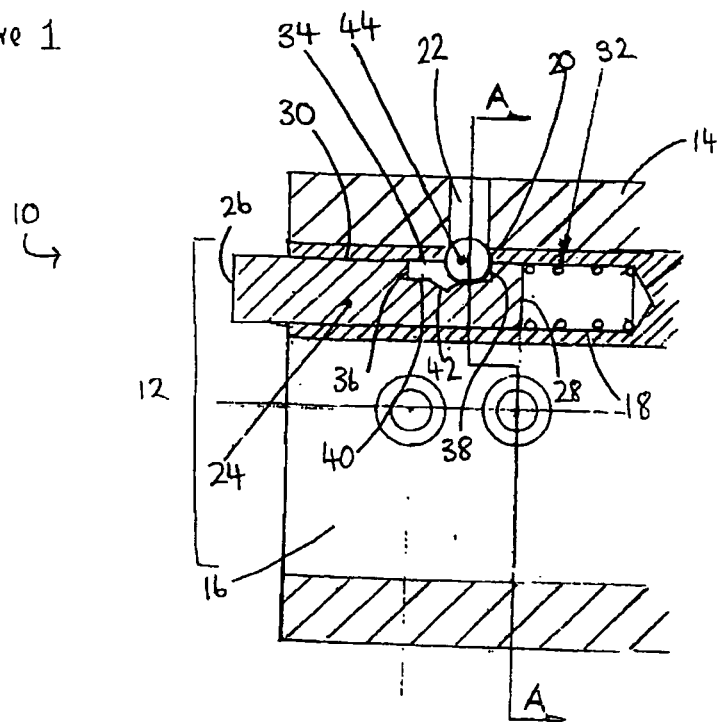


Figure 2

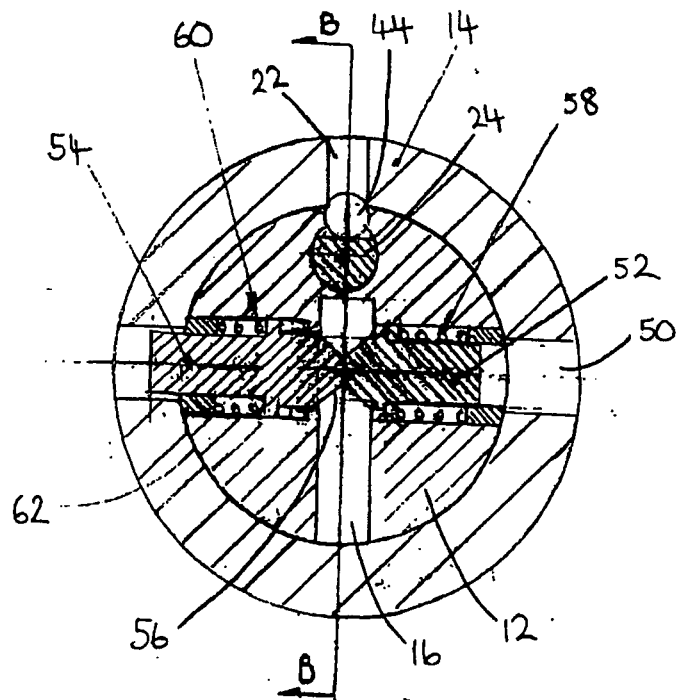


Figure 3a

Figure 3b

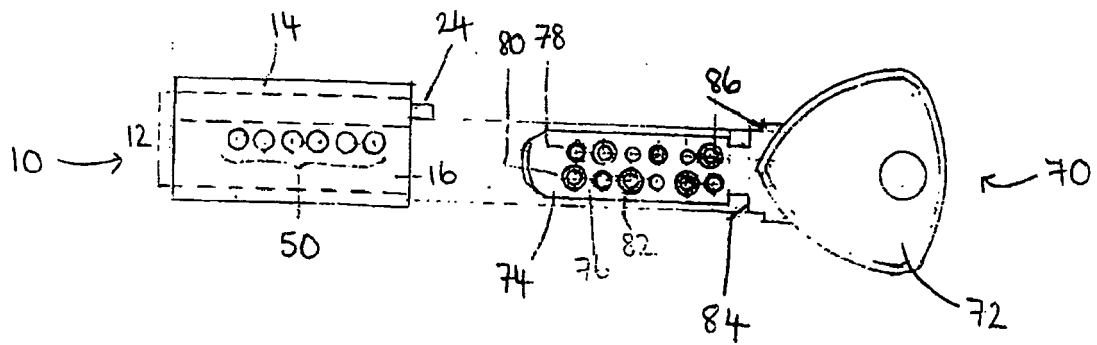


Figure 4

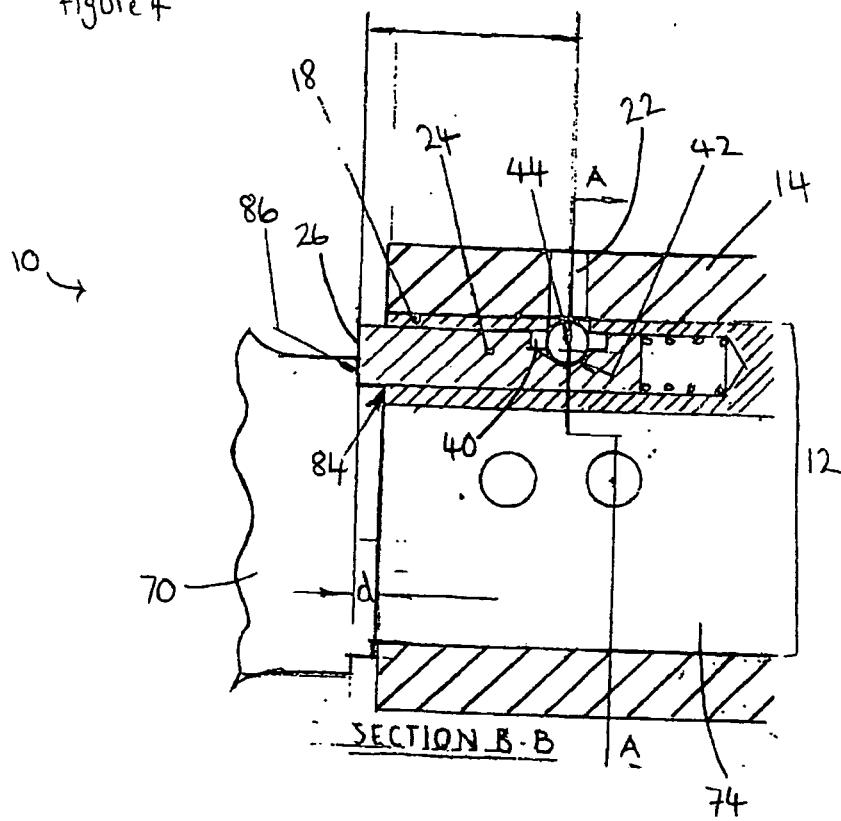


Figure 5

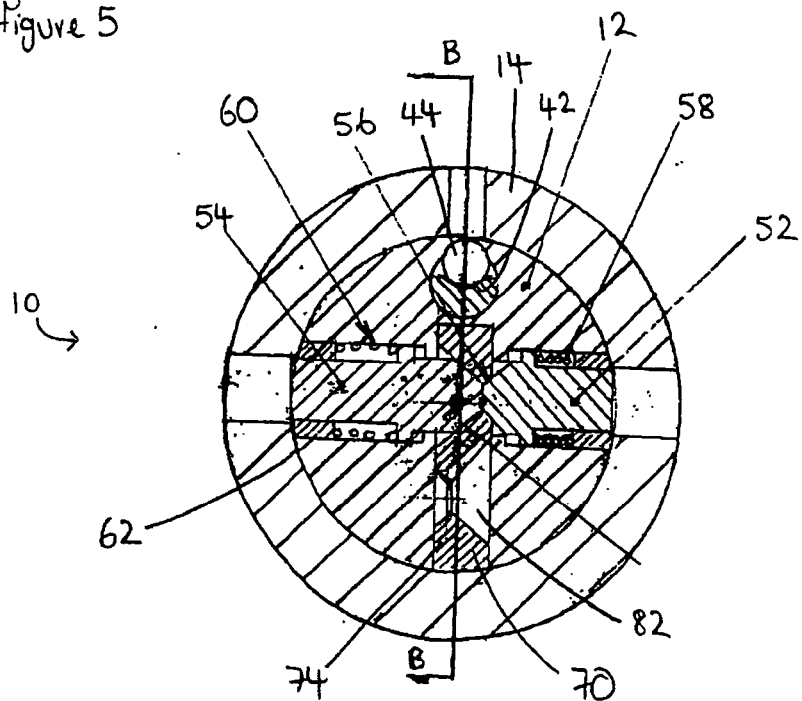


Figure 6a

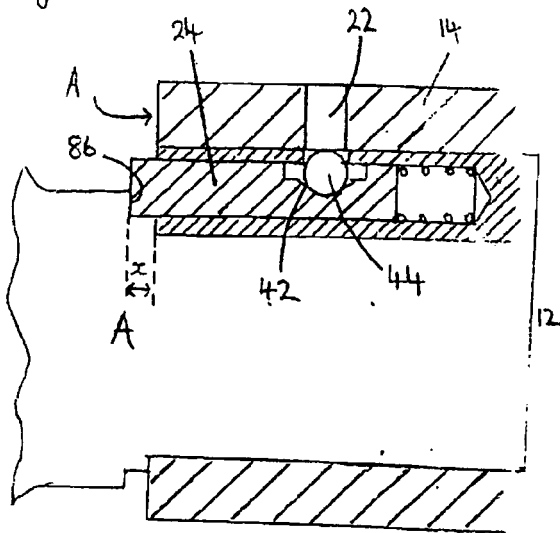


Figure 6b

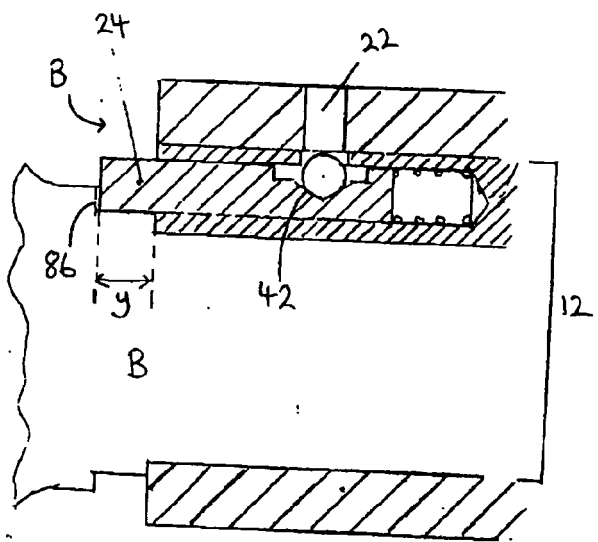


Figure 6c

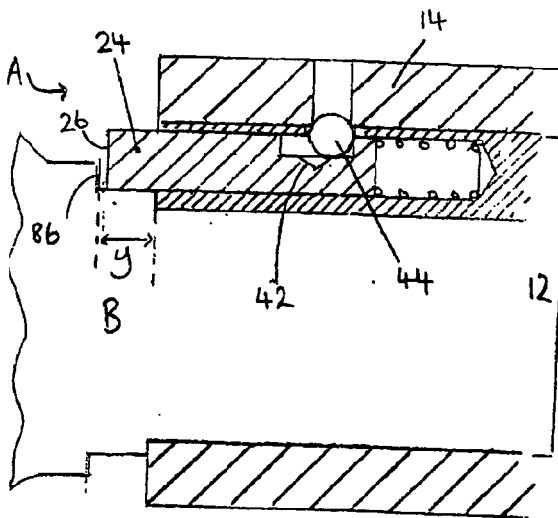


Figure 6d

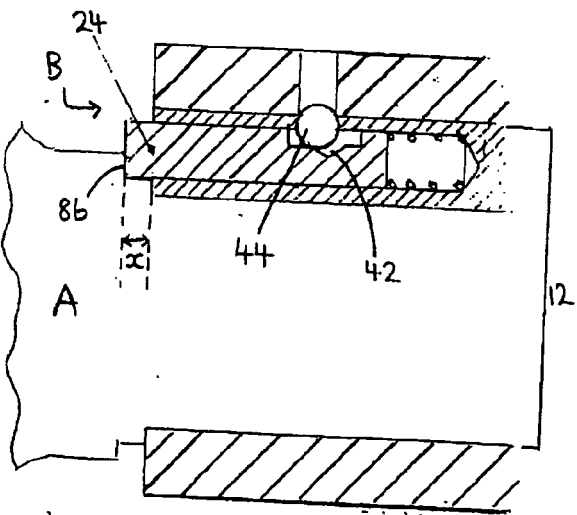


Figure 7

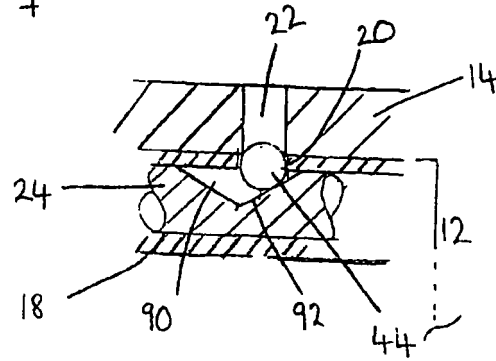


Figure 8

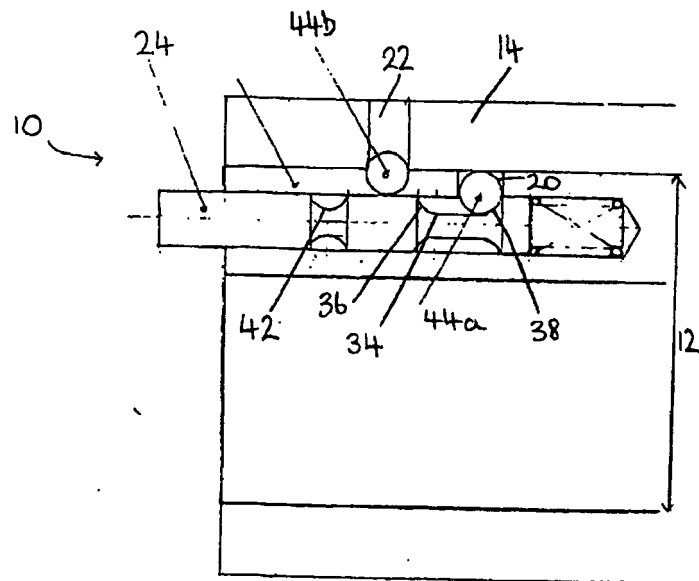


Figure 9

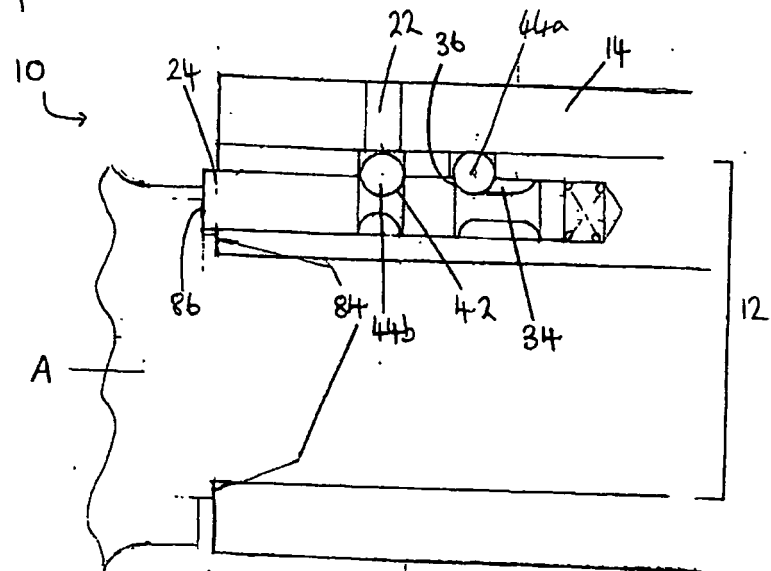


Figure 10

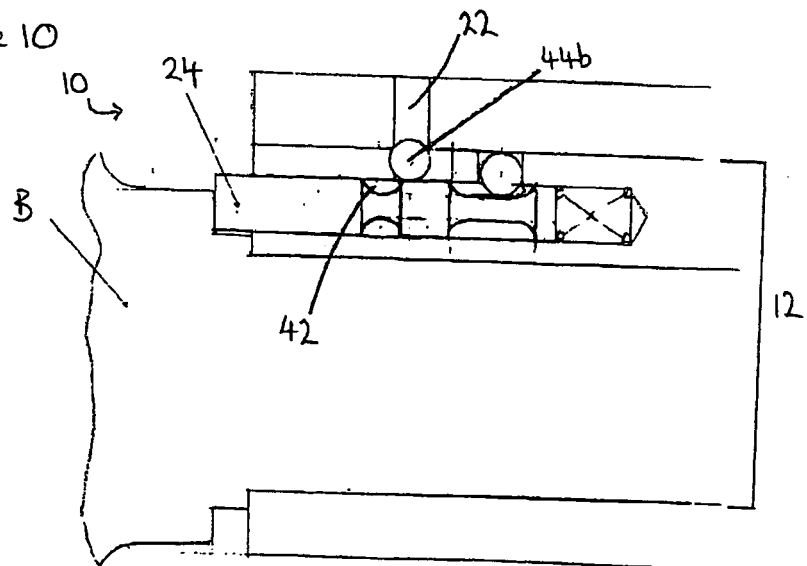


Figure 11

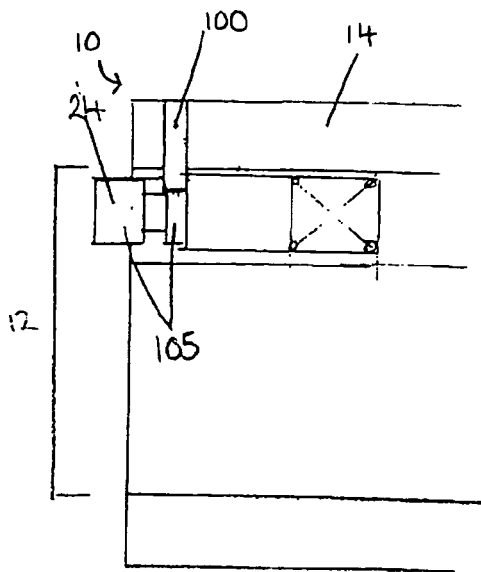


Figure 12

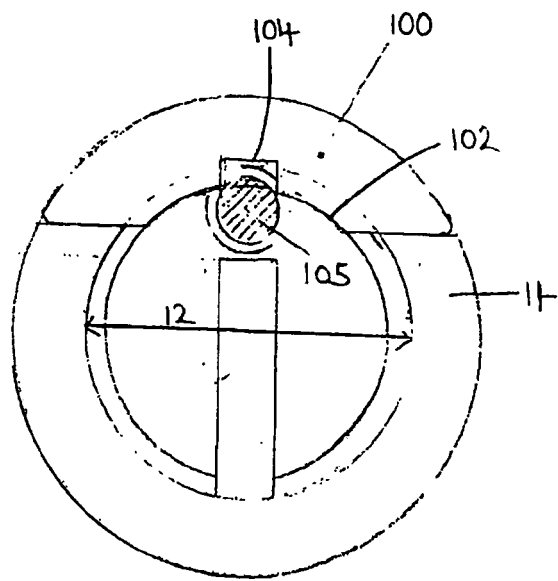


Figure 13

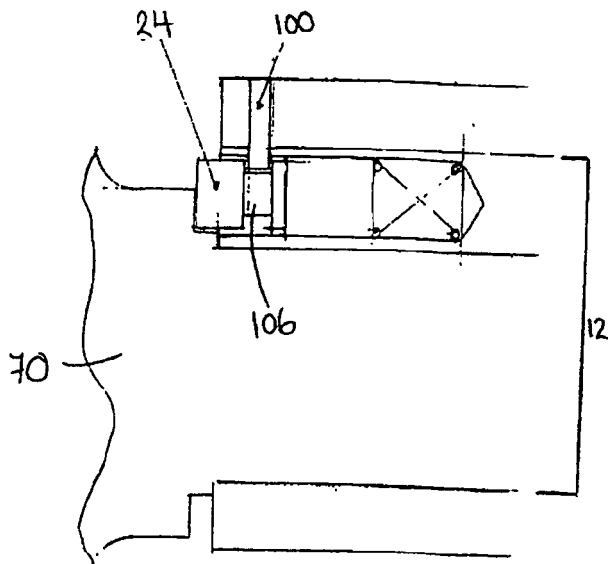


Figure 14

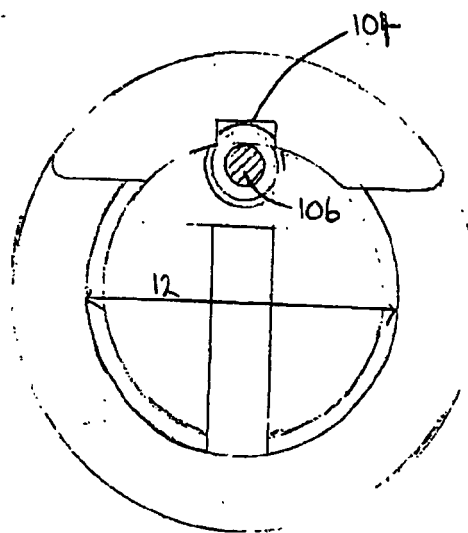


Figure 15a

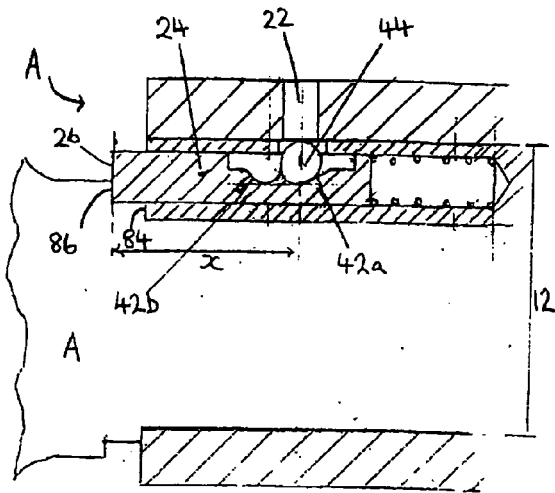


Figure 15b

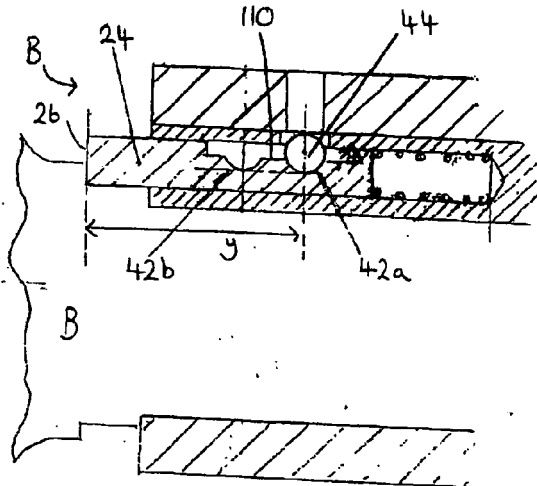


Figure 15c

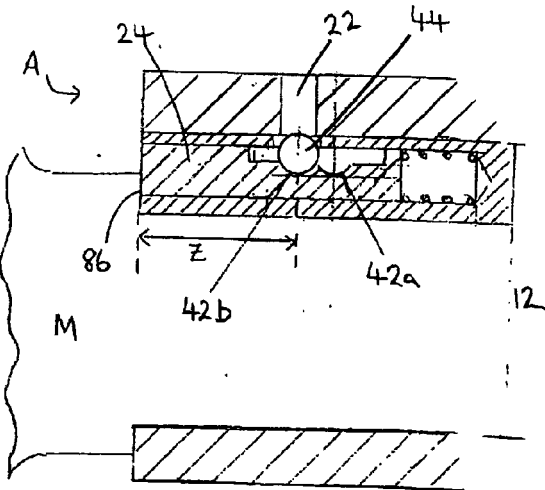
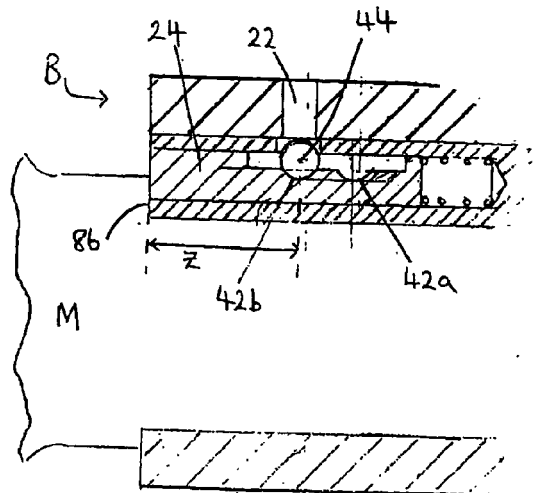
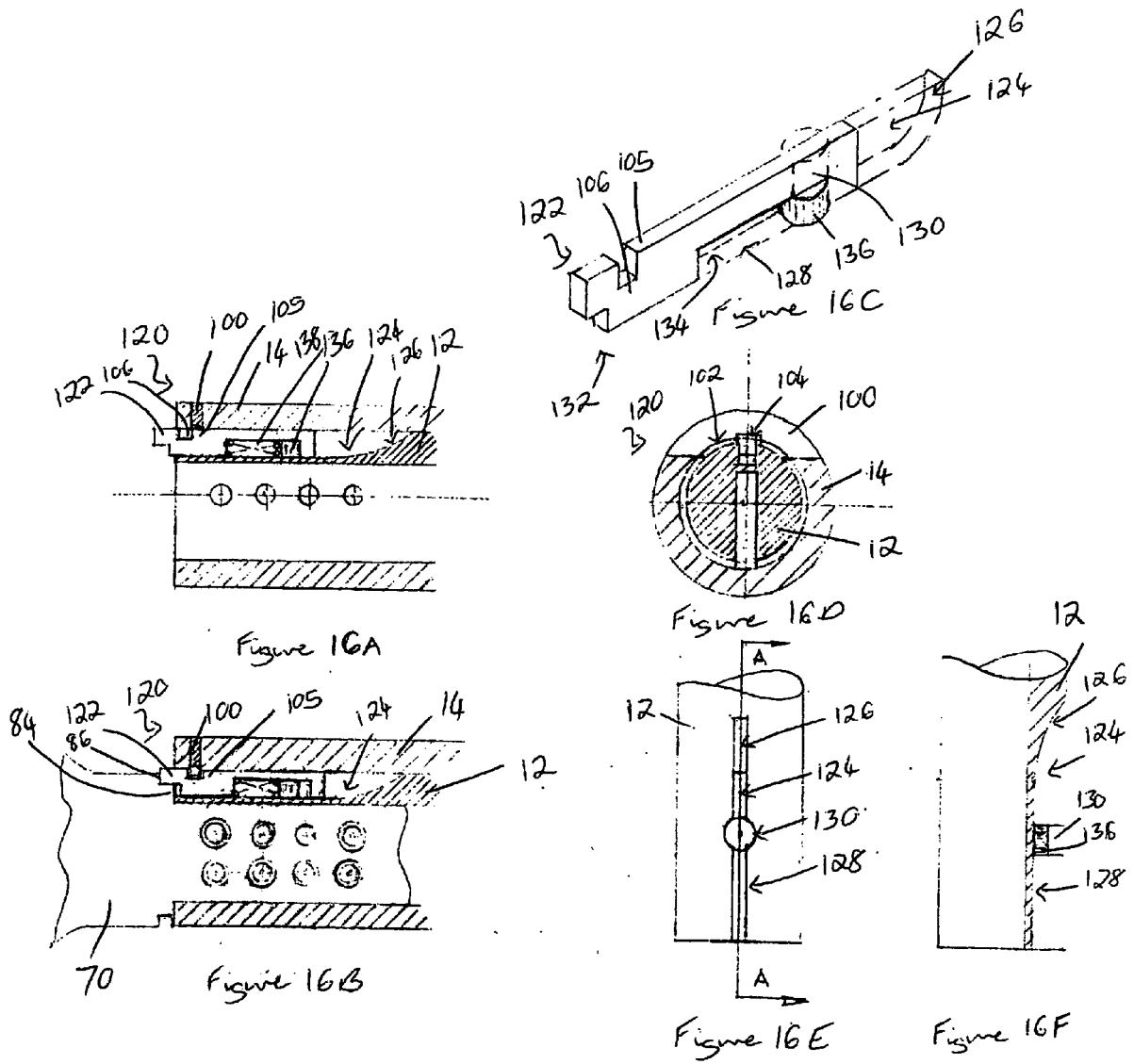


Figure 15d





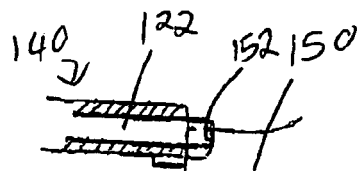


Figure 17.A

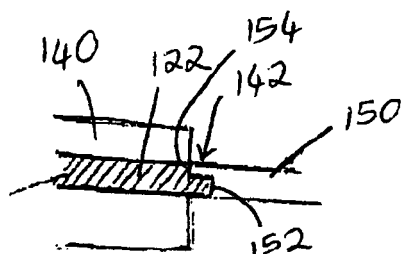
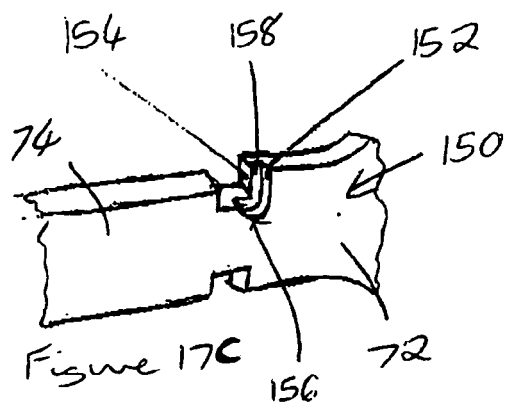


Figure 17B

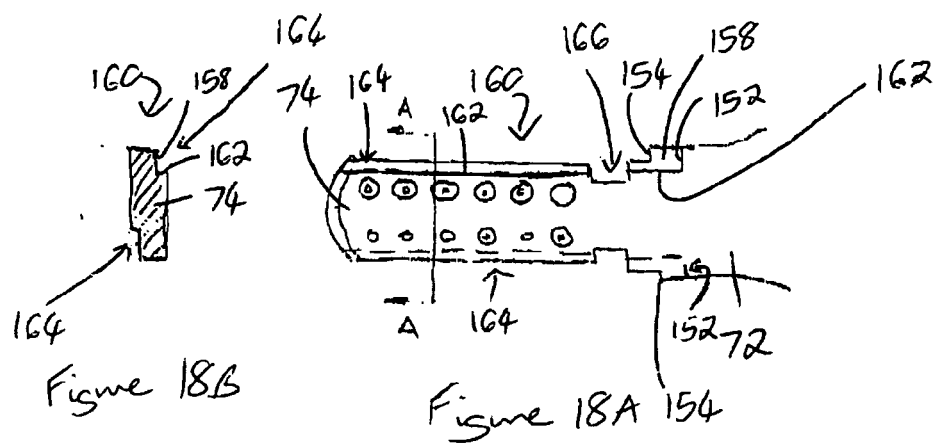
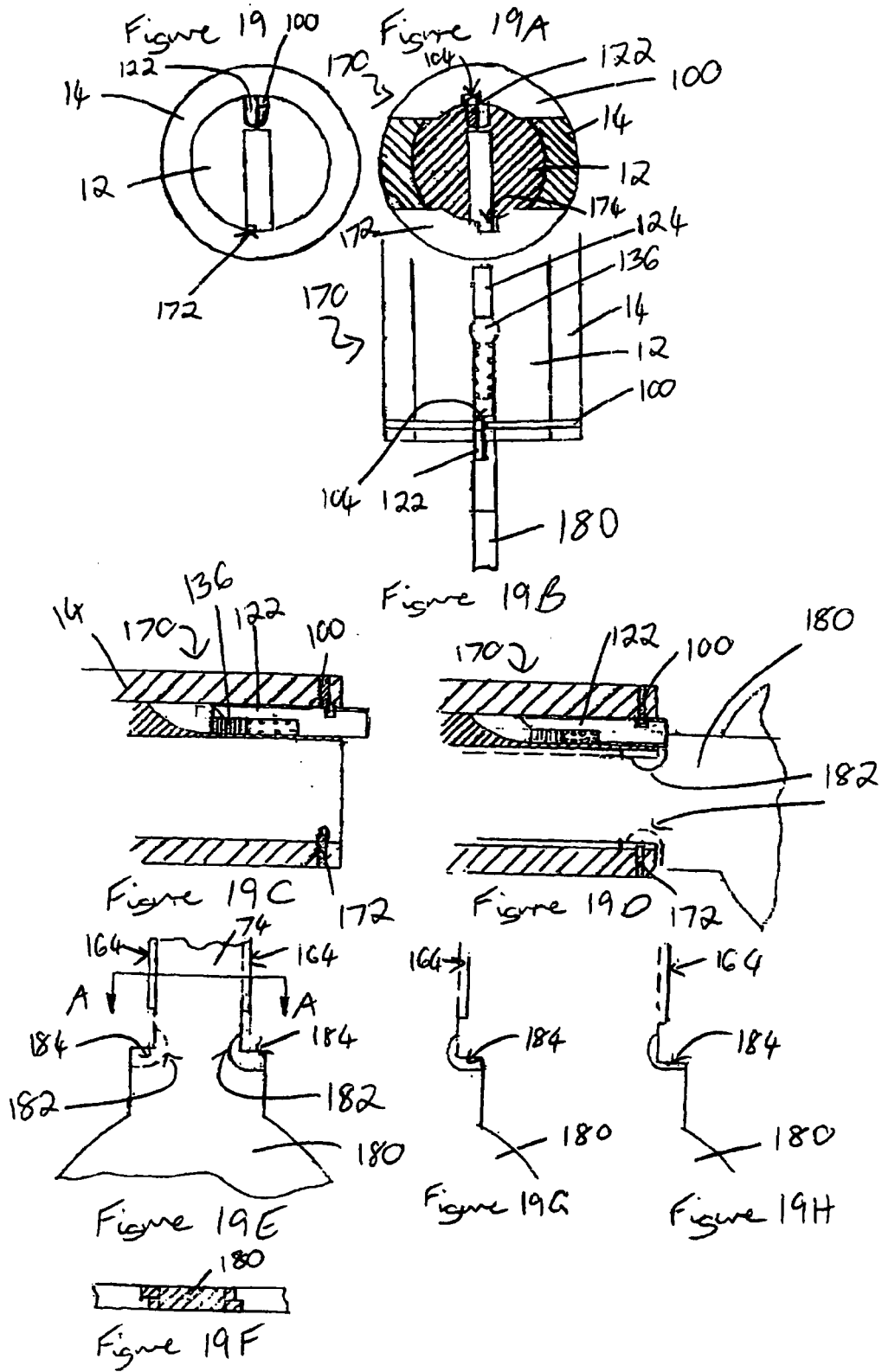


Figure 18A 154



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 0892130 B1 [0003] [0033] [0051] [0053] [0070]
[0072] [0073]