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(54) LOCK SYSTEM

(71) We, OY WARTSILA AB, a Finnish Company of Box 230, SF-00101 Helsinki 10, Finland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a lock system comprising a plurality of disc cylinder lock mechanisms. In this specification, the term "disc cylinder lock mechanism" means a cylinder lock mechanism with a series of turnable locking discs each having an opening for the passage of a key, which discs are turned by turning a key from an initial insertion position to a position releasing the lock mechanism.

In particular, the invention relates to a lock system of the kind comprising a plurality of disc cylinder lock mechanisms forming lock families, each comprising at least one of said disc cylinder lock mechanisms, the lock mechanism(s) of each family being operable with a key or keys having an at least partly different key profile, as hereinafter defined, compared with the key(s) of any other of said lock families, the lock mechanism(s) of each family compared with the lock mechanisms of the other family or families having the key openings of the locking discs in a different arrangement as regards the shape of the key openings and/or the position in the series of locking discs of key openings of the same shape, and all the keys of the system having a key profile which is includable within the border line of a basic key blank profile. In this specification, the term "key profile" means the cross-sectional configuration of the blade of a key blank before any individualizing key combination cuts have been made therein.

A lock system has a certain number of key combinations which can be very great, but, nevertheless, is limited. To multiply this limited number of key combinations it is known to use new key profiles, the use possibilities of which are completely separate from each other. In other words, keys with a certain key profile fit only into lock mechanisms made for this key profile. To some

extent it has been known to combine the use range of different key profiles to create certain mastered lock systems. This, however, has been accomplished only to the extent that there has been one large profile into the lock mechanism of which some smaller key profiles have fitted, while the lock mechanisms made for the small key profiles have been functionally completely separate from each other.

The present invention aims to create a lock system of the kind referred to, the use of possibilities of which are considerably larger and the fitness of which, especially for different mastered systems, is considerably better than in known lock systems.

According to the invention, a lock system of the kind referred to is characterised in that apart from said locking discs the respective common elements of the different lock mechanisms are formed substantially the same as one another, in that at least one of said keys operates one of said lock mechanisms which itself is operable by another of said keys having a different key profile from said at least one key, and in that at least one of said keys cannot operate one of said lock mechanisms which is operable by another of said keys. This lock system creates an almost ideal basis for the creation of highly developed mastered systems.

A lock system according to the invention gives the possibility of keeping certain profiles functionally apart from the other profiles of the same system. This idea can be further developed by using two different profile series so that the profiles of the one series do not fit into lock mechanisms made for the profiles of the other series.

A lock system comprising keys of several profile series can, by suitably forming the profiles, be provided with a key of a general profile which fits at least the majority of the lock mechanisms operable by the keys of the different profile series. This is of special importance in those mastered systems in which there is an extensive master key locking.

The lock system according to the invention can be further developed in a very simple

way so that in the same key there are at least two different profiles arranged axially one after the other, of which the profile of the front end of the key, that is the end which first is inserted into the lock mechanism, can be included within the border line of a profile closer to the opposite end of the key. This system allows for the building up of a large lock system. No complicated changes in a lock mechanism are necessary when two different profiles are used in the same key, the only necessary step is that two or several different key opening forms are used in the locking discs of the same lock mechanism so that restricting elements corresponding to the key profiles are formed in the keyway of the lock mechanism. The manufacture of a key fitting into a lock mechanism of this type should be so organised that key blanks with a different profile at different sections are made at the lock factory and only there and the key blanks are then distributed to locksmiths who then only take care of the milling of the key combinations.

The invention will now be described in more detail, by way of example, with reference to the accompanying drawings, in which

Figure 1 shows an expanded general perspective view of a disc cylinder lock mechanism,

Figures 2, 10, 15—22 and 24—27 show key blanks for different lock mechanisms of lock systems according to the invention and their profiles,

Figures 3—7 show locking discs for different key profiles,

Figures 8 and 9 show principal schemes of lock systems according to the invention,

Figures 11—14 show locking discs for key profiles according to Figure 10 and corresponding key profiles, and

Figure 23 shows a principal scheme of a mastered locking system.

In Figure 1, the numeral 1 indicates a key with a special profile key blade more clearly shown in Figure 2. The member 2 is the cylinder housing of the lock mechanism and the member 3 the rotatable cylinder of the lock mechanism. The cylinder is filled with a pile of discs comprising locking discs 4, 5, 6 and 7 and intermediate discs 8. The disc 4, the outermost locking disc of the disc pile, is shown more clearly in Figure 3. The disc 5, a locking disc in the interior of the disc pile, is more clearly shown in Figure 4. The disc 6, the innermost locking disc of the disc pile, is more clearly shown in Figure 5. The discs 7 are the other locking discs of the lock mechanism and they are more clearly shown in Figures 6 and 7. A locking bar 51 is movable in a slot 50 and locks the cylinder 3 to the cylinder housing 2. In the unlocking position of the lock mechanism, the locking bar 51 is able to move radially inwardly into

a groove formed by peripheral recesses 46 in the locking discs (Figures 3—7), thereby freeing the cylinder 3.

Figure 2 shows in greater detail a key blank for a cylinder lock mechanism according to Figure 1, from which key blank the sectors characteristic for the key combination have not yet been milled off to form the necessary combination surfaces 52 (Figure 1). The key blank has a different profile at different sections of the key blade. Section I—I shows the profile of the back end of the key blade, section II—II the profile of the middle portion of the key blade, and section III—III the profile of the front end of the key blade. In the lock mechanism there are locking discs functionally corresponding to these profiles. The locking disc 4 of Figure 1 corresponds functionally to profile I—I, locking disc 5 corresponds to profile II—II, and locking disc 6 corresponds to profile III—III. The locking discs 7 are general locking discs with a central opening corresponding to the basic profile of the key without grooves. Consequently, it is not necessary to use locking discs 7 exactly corresponding to the key profile. Rather, such locking discs are used as a first locking disc in the sections where the key must have a certain profile. Of course, this does not prevent the use of locking discs 7 corresponding to the actual key profile all over the section of this profile, but this is not necessary, because the central opening of the first locking disc of the section in question determines the maximum size of the key profile which can be used.

The first locking disc 4 of the lock shown in Figure 1, which disc is intended for the key profile I—I shown in Figure 2, is shown more clearly in Figure 3. Correspondingly, the locking disc 5, in the middle of the locking disc pile, is shown more clearly in Figure 4, and the innermost locking disc 6 in Figure 5. In Figures 3 and 4, the key opening 40 of the locking disc corresponds roughly to the key profiles I—I and II—II, respectively, but the key opening of the locking disc 6 is larger in its upper portion, than the key profile III—III in order to facilitate manufacture. This is quite possible, because at the opposite side of the key opening there is a radially inwardly extending projection 41 due to which it is not possible to use, in the shown lock mechanism, a key which does not have the groove 42 shown in Figure 2.

The lock mechanism shown in Figure 1, has the general locking discs 7 shown in Figures 6 and 7. The key opening 40 of a locking disc comprises two functionally important portions, namely both ends 44 and 45 of the linear edge 43 of the opening. One of these portions is influenced by the combination surface 52 (Figure 1) for turning the locking disc into its unlocking position, while the opposite end of the linear edge 43 is

influenced by the reset surface 53 (Figure 1) for turning the locking disc into its initial position, that is, the key insertion and withdrawal position. Since only the ends of the linear edge 43 act as force transmitting surfaces, the middle portion of the linear edge 43 is not needed and the key opening may also correspond to the embodiment shown in Figure 7. In Figures 3—7, also the peripheral recess 46 of the locking discs is shown, into which the locking bar 51 (Figure 1) moves in the unlocking position of the lock mechanism, and in Figures 6 and 7 there are also shown a number of false recesses 47, the object of which is to complicate picking of the lock mechanism.

The combination surfaces 52 (Figure 1) of the key are made by removing, in a key milling machine or the like, sectors of different sizes from one half of the key blade at positions corresponding to the different locking discs. Usually, six different combination surface millings are used, zero milling and the milling of 1 to 5 sector steps. In this case zero milling, which means that no milling is made at all, turns a locking disc through the greatest angle, and a five-step milling, that is, the maximum milling, does not turn the locking disc at this position at all. The millings can, principally, be made in the same way irrespective of the form of the key profile. Due to this, and because milling of key combination surfaces as described is known *per se*, it is not explained here in greater detail.

In Figure 8 a lock system according to the invention is shown schematically, which lock system comprises nine lock families, the lock mechanism or mechanisms of each family housing locking discs *a—i*, respectively, which, for example may be the locking disc 4 in Figure 1. The system also comprises nine sets of keys belonging to the lock mechanism(s) of the nine lock families, the key or keys of each set having a profile A—I at the position, for example at the section I—I in Figure 2, corresponding to the openings in the locking discs *a—i*, respectively. In Figure 8 the arrows indicate into which key opening each profile fits. All profiles fit into the key opening *a* of the basic profile and the general profile E fits into almost all the key openings of this system but not into the openings *h* and *i*. It is always possible to build up a lock system so that it is not even theoretically possible to devise a general profile which would fit into all the lock mechanisms of the system. The space available to form a general profile is determined in principle by placing all the key openings of the system one above another to ascertain the shape of the remaining light opening. The general profile has to fit into this light opening. If the openings have such a form that no continuous light opening is formed, there is no general profile

which would fit into all the lock mechanisms of the system.

A system with a certain resemblance to the system shown in Figure 8 is shown in Figure 9; however it contains a greater number (i.e. eleven) of key profiles and eleven families of lock mechanisms. In this system, the profile J fits into the openings *a, b, f* and *j*, the profile K fits into the openings *a, b, f, c, d* and *k*, and correspondingly, the profile E fits into the openings *a, b, f, j, c, d* and *g*. All these possibilities can with advantage be used in the design of different mastered lock systems.

Figure 10 shows a key blank with a rectangular basic profile. Within the shape of this basic profile it is also possible to form a great number of smaller profiles belonging to the same profile family, as sections IV—IV, V—V and VI—VI show. A profile family based on a rectangular shape may fall within the outer borders of the semicircular basic profile shown in Figure 2 or the situation may be the opposite. In both cases these two profile families and their lock systems can under certain circumstances be combined. It is also possible that the two profile families in question form two completely separate systems.

Figures 11—14 show other profiles belonging to the rectangular profile family, and corresponding locking discs. In comparison with the locking discs shown in Figures 3—7, the locking discs of Figures 11—14 are different in that the member limiting the turning movement of the locking discs is not formed by the side surfaces 49 of the tongue 48, but by inwardly extending surfaces 49*a* to which correspond radial stop surfaces at the inside of the lock cylinder 3.

Figures 15 and 16 show how, from a certain basic profile, two keys are made which cannot be used in the same lock mechanism due to the fact that in the front end of the one key there is a left-hand additional groove and in the other key a right-hand additional groove.

Figures 17 and 18 show an example where a key according to Figure 18 functionally fits into a lock mechanism made for a key according to Figure 17, but a key according to Figure 17 does not fit into a lock mechanism made for a key according to Figure 18. In the example shown, an additional groove is made only in the front end of the key on its convex side, but it should be realised that the additional groove could also have extended along the whole length of the key blade.

Figures 19 and 20 show other examples of key profiles. In the embodiment shown in Figure 19, there is a basic groove on the convex side of the key and an additional shallow groove in the flat surface of the key blank. In the embodiment shown in Figure 20, the main groove as well as the additional groove are on the convex side of the key.

Figures 21 and 22 show additional examples of how different key profiles are formed at different portions of the key blade by means of grooves. The groove systems can be easily understood from the drawing.

In a lock system according to the invention it is possible, by using only ten locking disc types with a different key opening, to make lock mechanisms for more than 40 different key profiles in which the key profile form alters only once over the length of the key blade. Theoretically it is possible to obtain a still greater number of different profiles, but if the number of used profiles is limited so that no key profile combination fits into lock mechanisms made for any of the other key profiles used and also the limitations of the manufacturing technique for making locking discs and keys are taken into account, the number of useful key profile combinations is still 52. By using profile combinations altering the profile twice over the length of the key blade, the number of useful key profile combinations can be raised several times higher.

Figure 23 shows schematically a master key system. The system shown is so small that it is not usually necessary to use different key profiles but, in practice, considerably larger master key systems occur in which it is very advantageous to use different key profiles to obtain greater security. This is due to the fact that a system of this kind based on only one profile covers a considerably greater number of key combinations than the number of keys in the system, so that there are a great number of key combinations outside the system which cannot be used in other lock mechanisms because of the risk of an occasional occurrence of a foreign key, a so-called ghost key, which would fit into the master key system in question.

Figures 24 and 25, as well as Figures 26 and 27, show two cases in which, of two keys shown side by side, the second one always functionally fits into a lock mechanism made for the first key but not *vice versa*. This has been obtained merely by using different basic profiles without altering the profile over the length of the key blade.

WHAT WE CLAIM IS:—

1. A lock system comprising a plurality of disc cylinder lock mechanisms, as hereinbefore defined, said lock mechanisms forming a plurality of lock families, each comprising at least one of said disc cylinder lock mechanisms, the lock mechanism(s) of each family being operable with a key or keys having an at least partly different key profile, as hereinbefore defined, compared with the key(s) of any other of said lock families, the lock mechanism(s) of each family compared with the lock mechanism(s) of the other family or families having the key openings of

the locking discs in a different arrangement as regards the shape of the key openings and/or the position in the series of locking discs of key openings of the same shape, and all the keys of the system having a key profile which is includable within the border line of a basic key blank profile, characterised in that apart from said locking discs the respective common elements of the different lock mechanisms are formed substantially the same as one another, in that at least one of said keys operates one of said lock mechanisms which itself is operable by another of said keys having a different key profile from said at least one key, and in that at least one of said keys cannot operate one of said lock mechanisms which is operable by another of said keys.

2. A system according to claim 1, comprising keys having two different profile series, the profiles of one series not fitting into lock mechanisms made for profiles of the other series.

3. A system according to claim 2, including a key with a general profile which fits into at least the majority of the lock mechanisms made for the different profiles of the different profile series.

4. A system according to any of the preceding claims, comprising keys having several different profile series, in each series there being at least one profile which also fits into lock mechanisms made for at least some of the profiles of another of said profile series.

5. A system according to any of the preceding claims, in which in the same key there are at least two different profiles arranged axially one after the other, of which the profile of the front end of the key can be included within the border line of a profile closer to the back end of the key.

6. A system according to any of the preceding claims, comprising a locking mechanism in the locking discs of which at least two different key opening forms are used.

7. A system according to any of the preceding claims, comprising a key having a different basic profile in different portions.

8. A lock system substantially as herein described with reference to, and as illustrated in, Figure 8, Figure 9 or Figure 23 of the accompanying drawings.

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the locking discs in a different arrangement as regards the shape of the key openings and/or the position in the series of locking discs of key openings of the same shape, and all the keys of the system having a key profile which is includable within the border line of a basic key blank profile, characterised in that apart from said locking discs the respective common elements of the different lock mechanisms are formed substantially the same as one another, in that at least one of said keys operates one of said lock mechanisms which itself is operable by another of said keys having a different key profile from said at least one key, and in that at least one of said keys cannot operate one of said lock mechanisms which is operable by another of said keys.

2. A system according to claim 1, comprising keys having two different profile series, the profiles of one series not fitting into lock mechanisms made for profiles of the other series.

3. A system according to claim 2, including a key with a general profile which fits into at least the majority of the lock mechanisms made for the different profiles of the different profile series.

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