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LOCKING DEVICE

The invention relates to a locking device according to the preamble of claim 1, which is particularly suitable for locking systems in buildings, vehicles, furniture, safes, switchgear cabinets, key-operated switches, etc. The invention also relates to a method for preventing the opening of a locking device according to the preamble of a further independent claim.

Locking devices with mechanically and electronically controlled blocking or inhibiting elements are known. They have all the properties of conventional, purely mechanical locking devices. The additional, electronically controlled locking system also provides the possibility of individually activating and inhibiting keys. Thus, such mechanical-electronic locking devices lead to an additional flexibility in the locking organization.

The electronically controlled locking is based on a data transmission between a key-side electronic module and a lock-side electronic module. This data transmission can take place by contact, e.g. by electrical contacts on the key and lock, or in non-contacting manner, e.g. by electromagnetic induction. Data can be transmitted in only one or in both directions. By means of the transmitted data a check is made in the lock-side electronic module as to whether the inserted key is access-authorized. If this is the case, a lock-side motor is activated, which moves an additional, electronically controlled inhibiting element in such a way that it frees or releases the lock cylinder.

Known mechanical-electronic locking devices are in particular susceptible to vibration and/or shock effects, or to magnetic effects. By suitable external actions of such a type, it is possible to transfer the electronically controlled inhibiting element from its inhibit position into the free or release position. Thus, the electronically controlled locking means can be opened with purely mechanical and/or magnetic means, without it being necessary to insert an appropriately electronically coded key. For this purpose a constant frequency vibration can be externally applied to the locking mechanism. If the frequency is appropriately chosen, the electronically controlled inhibiting element resonantly vibrates and modifies its position as a result of scarcely foreseeable interactions with other elements. A further unblocking action can be obtained by impacts or blows on

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the locking mechanism. As is known, a pulse can be formed from monochromatic vibrations, so that the vibration can be looked upon as a special impact case. Vibrations or impulses are propagated as sound waves in the lock cylinder. As a result of the complicated internal structure of the lock cylinder, it is scarcely possible to calculate beforehand its propagation and action on individual elements within the lock cylinder. Further external influences can take place with magnetic forces. A bypassing of the electronically controlled locking system by external influences is naturally undesired.

The problem of the invention is to provide a mechanical-electronic locking device, which is resistant to external influences, particularly vibration and/or shock effects or magnetic actions and which ensures a reliable operation.

The problem is solved by the locking device and the method, as defined in the independent claims.

The solution according to the invention is based on an analysis of the mechanical processes taking place on opening an inhibiting or blocking element by vibration and/or shock effects. As a result of these external influences the inhibiting element preferably resonantly vibrates and the necessary restoring forces are exerted by its fixing to the motor. In the case of resonant vibrations, parasitic forces act intermittently on the inhibiting element and on the motor. Mechanisms can come into effect, which aid a movement of the inhibiting element in one direction and prevent it in the other, in the manner of a ratchet. Such mechanisms can result from asymmetric damping, feedback of other oscillating or vibrating elements, etc. As a result, during its external action, the inhibiting element can be moved in one direction and in the worse case towards the "free position", i.e. the position in which it releases the lock cylinder. Thus, a sufficiently large number of parasitic impulses of force is enough to transfer the inhibiting element from its inhibit position into the free position.

To prevent the locking device being opened in this way, according to the



invention, at least in the area round the free position an additional force, namely a "restoring force", is exerted on the inhibiting element and is opposed to the parasitic forces. If the amount of said additional force is greater than the critical force, e.g. the maximum parasitic force occurring during an impulse of force, the inhibiting element can no longer move in uncontrolled manner towards the free position.

However, an additional risk is inherent in the exerting of a restoring force on the inhibiting element. As is known, a mobile mass on which a restoring force acts forms an oscillator with at least one resonant frequency. Such an oscillator can be resonantly vibrated by excitation with a suitable frequency and the amplitude of said vibrations, as a function of the damping present, can be very considerable. Under this effect the locking device could be undesirably opened by external influences.

In order to prevent this, freely vibrating masses are avoided to the greatest possible extent in the locking device and method according to the invention. For this purpose, the position of the inhibiting element is clearly predetermined by suitable guidance means, which prevents resonant vibrations of the mass of the inhibiting element.

The locking device according to the invention has at least one electronically controlled inhibiting element, hereinafter simply referred to as "inhibiting element", having at least one degree of freedom of movement. As a result of said inhibiting element a rotor and stator of the lock cylinder are mutually lockable. If the inhibiting element is to block the locking cylinder, it should be in a specific, first position, hereinafter called the "inhibit position". In a second position, hereinafter called the "free position", the inhibiting element releases or frees the lock cylinder.

The locking device according to the invention has drive means for exerting a working force on the inhibiting element. By means of the working force the inhibiting element can be reversibly transferred from the inhibiting position into the free position and vice versa.

The locking device according to the invention also has guidance means, which are connected to the drive means and clearly determine the inhibiting element position, at least outside the free position.

The locking device according to the invention also has restoring means, which are on the one hand connected to a support immovable relative to the stator and on the other to the inhibiting element. The restoring means exert a restoring force on the inhibiting element which is directed away from the free position if said inhibiting element is in the area round the free position. According to the invention, the inhibiting element must inhibit or block in the vicinity of the free position.

Besides the inhibit position and the free position, the inhibiting element preferably also has a third, defined position, known as the "rest position", in which the restoring means exert no force on the inhibiting element. The inhibiting element inhibits the lock cylinder in the rest position. The restoring means exert on the inhibiting element a restoring force directed away from the free position, when said inhibiting element is between the free position and the rest position and the inhibiting element inhibits the lock cylinder in the rest position and in positions between the rest position and the free position.

The free position is preferably located in such a way that a maximum working force and/or a maximum distance or travel, i.e. a maximum energy is required in order to transfer the inhibiting element from the rest position into the free position. It is then substantially impossible to open the locking device solely with vibration and/or shock actions, without operating the drive means. The drive means are able to exert a working force on the inhibiting element, which is higher than the particular restoring force.

The resistance to vibration and/or shock action is additionally increased if the inhibiting position is so positioned that a maximum distance or travel is required, in order to transfer the inhibiting element from the inhibit position into the free position. If e.g. the inhibiting element can perform linear translations along a given path, then preferably the free position is at the first end of said path, the inhibit position at

the second end of said path and the rest position in the centre of said path. The driving back force always acts towards the centre of the path, i.e. towards the rest position, where, according to the invention, the inhibiting element is already exerting an inhibiting action. However, in other embodiments the rest position can coincide with the inhibit position or can be omitted.

In the method of the invention for preventing an opening of a locking device by parasitic forces caused by vibration and/or shock effects, to avoid freely vibrating or oscillating masses the position of the inhibiting element is clearly predetermined by guidance means. At least in the vicinity of the free position a restoring force is exerted on the inhibiting element, which is opposed to the parasitic forces.

Hereinafter the locking device according to the invention and, for comparison purposes, also the prior art are described in detail relative to the attached, diagrammatic drawings, wherein show:

- Fig. 1 A force/distance diagram for a locking device according to the prior art.
- Fig. 2 A force/distance diagram for a locking device according to the invention.
- Fig. 3 A work/distance diagram for a locking device according to the invention and a prior art locking device.
- Fig. 4 A diagrammatic representation of part of an inventive locking device.
- Fig. 5 A first, preferred embodiment of the inventive locking device.
- Figs. 6 to 8 Perspective views of part of the embodiment of fig. 5 in different positions.

Figs. 9 and 10 Two variants for the embodiment of fig. 5.

Fig. 11 to 13 Further embodiments of the inventive locking device.

Fig. 14 A detail of a further embodiment of the inventive device.

Figs. 15 & 16 Two different embodiments of a lock module with a locking device according to the invention in a perspective, partly exposed view.

Fig. 17 A cross-section through a collar of the lock module shown in figs. 15 or 16.

In figs. 1 and 2 are in each case plotted forces $F(x)$ on an inhibiting or blocking element as a function of a space coordinate x , along which said element can move and in which:

x_s is an inhibit position, i.e. the position of the inhibiting element intended for the latter when it blocks or inhibits the lock cylinder, i.e. the rotor and stator are mutually locked,

x_f a release or free position, i.e. the inhibiting element position in which it releases or frees the lock cylinder,

x_0 a rest position, i.e. the inhibiting element position in which, in the locking device according to the invention, no restoring force acts on the inhibiting element.

The inhibiting element must only release the lock cylinder in the free position $x = x_f$, whereas it must inhibit the same in positions $x < x_f$, particularly also for $x = x_s$ and $x = x_0$. The convention applies in figs. 1 and 2 that positive forces $F > 0$ act in the positive x -direction and negative forces $F < 0$ in the negative x -direction.

Fig. 1 is a force/distance diagram for a prior art locking device. An undesired, parasitic force $F_p > 0$, directed towards the free position x_f , acts on the inhibiting element. The parasitic force F_p is e.g. a maximum

force acting on the inhibiting element when it is resonantly vibrated by external effects. It is assumed in this example that F_P is independent of x . The locking system opposes the parasitic force F_P with a maximum opposing force $F_G < 0$. The resulting force on the inhibiting element is consequently $F_{res} = F_G + F_P$. If now, as in the simple example of fig. 1, $F_P > |F_G|$, then $F_{res} > 0$. This means that the inhibiting element is accelerated towards the free position x_F . In other words, if the external action persists long enough, it is able to open the locking device.

The conditions are completely different in fig. 2, which is a force/distance diagram for a locking device according to the invention. According to the invention, an additional restoring force $F_R(x)$, exerted by restoring means, acts on the inhibiting element. The restoring force $F_R(x)$ is directed towards the rest position x_0 , i.e. $F_R(x < x_0) > 0$, $F_R(x > x_0) < 0$, and disappears in the rest position, i.e. $F_R(x_0) = 0$. In the example of fig. 2 Hooke's law $F_R(x) = kx$ applies, k being a spring constant. The resulting force on the inhibiting element is now $F_{res} = F_G + F_P + F_R$. Fig. 2 shows that F_{res} is only directed towards the free position x_F up to a reversal point x_U , i.e. $F_{res}(x < x_U) > 0$. Between the reversal point x_U and the free position x_F , F_{res} is directed away from the free position x_F , i.e. $F_{res}(x > x_U) < 0$. When a parasitic force F_P is applied, at the most the inhibiting element moves up to the reversal point x_U , where the inhibiting element is still inhibiting the lock cylinder and moves no further. Thus, the locking device according to the invention cannot be opened by vibration and/or shock effects.

Whereas figs. 1 and 2 consider the forces acting on the inhibiting element, fig. 3 shows the work $W(x)$ required in order to move the inhibiting element from a place $x < x_F$ to the free position x_F . The same assumptions are made as in figs. 1 and 2 with respect to the acting forces. The curve $W_1(x)$ corresponds to the situation of fig. 1, i.e. to the prior art, where F_{res} is independent of x . In this case, the work $W_1(x)$ necessary for opening decreases linearly with x . Curve $W_2(x)$ corresponds to the situation of fig. 2, i.e. the present invention, where F_{res} is linearly dependent on x . In this case, the work $W_2(x)$ necessary for opening is quadratically dependent on x . The most important information provided by fig. 3 is that

the work $W(x)$ necessary for opening purposes in the case of the locking device according to the invention is higher (or at the most the same) than in the prior art locking device: $W_2(x) > W_1(x)$ for $x_S < x < x_F$. For certain x , in the case of a locking device according to the invention, a two to three times higher work is required for opening than in the known locking devices. This once again shows that the invention prevents an undesired opening by external influences.

If it is found that the threshold given by curve $W_2(x)$ is too low for certain parasitic forces, the curve $W_2(x)$ can be further raised by suitable measures.

Figs. 2 and 3 show a special case, because the rest position x_0 is in the centre between the inhibit position x_S and the free position x_F . Naturally, this need not be the case. The locking device according to the invention could e.g. be designed in such a way that the rest position x_0 is beyond the inhibit position x_S , i.e. $x_0 < x_S$. In this case, the restoring force F_R would be directed away from the free position in all positions of the inhibiting element, i.e. $F_R(x < x_F) < 0$. The reversal point x_U in fig. 2 would be even further removed from the free position x_F and the difference between the necessary works $W_1(x)$, $W_2(x)$ in fig. 3 would be even greater, so that such an embodiment could be advantageous.

Fig. 4 diagrammatically shows part of a locking device according to the invention. A lock cylinder 12 incorporates a rotor 1 and a stator 6 surrounding the latter. The rotor 1 is provided with a bore 11.1, with which communicates a passage opening 11.2 of the stator 6. An inhibiting element 2 constructed as a tumbler pin traverses the bore 11.1 and passage opening 11.2 and is substantially movable in the radial direction x . For as long as an end piece 21 of the inhibiting element 2 is located in the bore 11.1, the rotor 1 is inhibited, i.e. rotor 1 and stator 6 are mutually locked by the inhibiting element. This applies for all positions $x < x_F$ of the inhibiting element 2. Only in a free position x_F is the inhibiting element 2 outside the rotor 1, so that the latter is freely movable relative to the stator 6.

Fig. 4 diagrammatically shows drive means 9, which can exert a working force F_A on the inhibiting element 2, by means of which the latter can be reversibly transferred from the inhibit position x_S into the free position x_F and vice versa. Such drive means 9 can e.g. be constructed as an electric motor, electric magnet, etc. They are preferably electrically operated, their function being activated by the insertion or removal of an access-authorized key (not shown in fig. 4). A not shown battery can e.g. be provided as the power supply for the drive means 9.

In fig. 4 a spring symbolizes the restoring means 3. The restoring means are on the one hand connected to a support 31 immovable relative to the stator 6 and on the other to the inhibiting element 2. They exert a restoring force F_R , directed away from the free position x_F , on the inhibiting element 2, which is located between the free position x_F and a rest position x_0 . Drive means 9 can act on the inhibiting element 2 with a working force F_A , in order to transfer the element 2 in controlled manner from the inhibit position x_S into the free position x_F or vice versa.

To the drive means 9 are connected guidance means 5, which guide the inhibiting element 2, by clearly defining its position. This prevents the inhibiting element 2 being resonantly vibrated on the restoring means 3 under the action of vibrations externally applied to the lock. In other words, the guidance means 5 prevent freely vibrating masses.

Figs. 5 and 11 to 13 diagrammatically show different embodiments of the locking device according to the invention and mainly differ through their guidance means.

Fig. 5 shows a first, preferred embodiment of the locking device according to the invention. The inhibiting element 2 is constructed as a tumbler pin, which is substantially radially movable in a lock cylinder. The inhibiting element 2 traverses a passage opening 11.2 of the stator 6 communicating with a bore 11.1 of the rotor 1 and in the inhibit position is inserted in said bore 11.1. However, if the end piece 21 of the tumbler pin 2 is further out and completely within the stator 6, the rotor 1 can rotate in unhindered manner (provided that any mechanically controlled

inhibiting elements free the rotor).

In this embodiment the drive means are constituted by an electric motor 9 with a drive shaft 91. The torque generated by the electric motor 9 and transmitted by the drive shaft 91 can be converted into the working force F_A required for the reversible movement of the tumbler pin 2. This conversion is brought about by a thread 53 connected in non-rotary manner to the drive shaft.

In this embodiment, to the tumbler pin 2 is connected a force transfer means 4, through which it is possible to transfer the working force F_A and/or the restoring force F_R from the drive means 9 or restoring means 3 to the tumbler pin 2. The force transfer means 4 is e.g. constructed as a lever. The connection between the tumbler pin 2 and lever 4 can be implemented positively, e.g. by means of a hole 22 in the tumbler pin 2, through which the lever 4 is substantially vertically guided.

In this embodiment, the restoring means is a helical spring 3, which presses a first end 41 of the lever 4 onto a support 31. The lever 4 is rotatable about a fulcrum P of the support 31, but is not necessarily fixed in said fulcrum P, so that as a two-sided lever it transfers the restoring force F_R of the helical spring 3 to the tumbler pin 2.

A second, guided end 42 of the lever 4 is held or guided substantially without clearance and in a positive manner by the thread 53 constituting a guidance means. In this embodiment, the thread 53 is a single-start, external thread with several turns surrounding the drive shaft 91. By rotating the thread 53 with several revolutions, the guided end 42 of the lever 4 can be moved towards the first end 53.1 or second end 53.2 of the thread 53. Correspondingly, by lever action the tumbler pin 2 is radially moved and as a function of its position the rotor 1 is blocked or free with respect to the stator 6. Fig. 5 shows the tumbler pin 2 in a position where it inhibits the rotor 1. If the thread 53 rotates in the arrow direction 92, the tumbler pin moves in the arrow direction 23 substantially radially outwards against the free position.

In the inhibit position, the guided end 42 of the lever 4 is on the first end 53.1 of the thread 53 and the tumbler pin 2 is embedded far into the rotor 1. In the rest position the guided end 42 of the lever 4 is in the centre of the thread 53 and the tumbler pin 2 still blocks the rotor 1. In the free position the guided end 42 of the lever 4 is on the second end 53.2 of the thread 53 and the rotor 1 is now free. Thus, the ends 53.1, 53.2 of the thread 53 are associated with the inhibit position or the free position.

In both the inhibit and free positions, the thread 53 can continue to rotate, without it having any consequences for the position of the tumbler pin 2. This offers the advantage that the drive motor does not have to be stopped precisely on reaching the particular end position. The guided end 42 of the lever 4 remains on the particular end 53.1, 53.2 of the thread and during a thread revolution at the most performs a small upward and downward movement. However, if the rotation direction of the thread 53 or drive motor is reversed in such a position 53.1, 53.2, the guided end 42 of the lever 4 is forced by the restoring force F_R back into the thread 53. To bring about this advantageous effect, the rest position must be between the inhibit position and the free position.

As a result of external vibration and/or shock effects the tumbler pin 2 can admittedly in certain circumstances be brought from the inhibit position into the rest position, but even then the rotor 1 remains blocked. It is not possible with the locking device according to the invention to bring the tumbler pin 2 further out of the rest position into the free position by vibration or shock effects, because the force F_R of the restoring means 3 counteracts in restoring manner such a movement. The restoring force F_R is higher the further the tumbler pin 2 moves from the rest position towards the free position, which further increases security.

Figs. 6, 7 and 8 perspectively show a drive motor 9, the thread 53 with its ends 53.1, 53.2, the drive shaft 91 and the lever 4 with its guided end 42 of the embodiment of fig. 5 in the inhibit position, rest position and free position.

Figs. 9 and 10 show details of variants of the embodiment of fig. 5, namely slightly different ways of guiding the guided end 42 of the lever 4 along a thread.

In fig. 9 the guided end 42 of the lever 4 does not directly engage in a thread, but is instead positively guided and held by a groove 54.1 in a nut 54. The nut 54 is moved up and down by a corresponding screw thread 52. The remaining elements of the locking device of fig. 6 can have the same construction and same positioning as in fig. 5.

In fig. 10 the thread 53 is replaced by the turns 53' surrounding the drive shaft 91 and which are connected to the latter, e.g. only at a first end 53.1' and a second end 53.2'. The turns 53' can e.g. be bounded by boundaries 51.1, 51.2 constructed in plate form.

Fig. 11 shows another embodiment of the locking device according to the invention. The lever 4, as the force transfer means, is guided by a perspectively shown helix or spiral 55 as the guidance means, in that the second end 42 of the lever 4 engages positively between the spiral turns. By means of a shaft 91, the spiral 55 is rotated by a not shown motor. In the inhibit position the guided end 42 of the lever 4 is in the vicinity of shaft 91. If the spiral 55 is rotated by the motor in the corresponding direction (indicated by an arrow 92), it presses the guided end 42 of the lever 4 outwards and away from the shaft 91. The free position is reached after several motor revolutions. In the free position, the guided end 42 of the lever 4 is on the outer circumference of the spiral 55. Here again the motor does not immediately have to stop rotating when the sought position is reached.

In the embodiment of fig. 12 the guidance means for the lever 4 or electronically controlled tumbler pin 2 are a toothed gear or pinion 56.1 with a gear segment or segment gear 56.2. The gear or pinion 56.1 is meshed with a gear segment 56.2 fixed to the guided end 42 of the lever 4. A motor (not shown in fig. 12), by means of a shaft 91 drives the gears 56.1 and consequently moves or controls the tumbler pin 2. The transmission ratio of gear 56.1 to gear segment 56.2 is preferably large, so

that several motor revolutions are required for transferring the tumbler pin 2 from the inhibit position into the free position.

Another embodiment of the locking device according to the invention is diagrammatically shown in fig. 13. Here the guidance means are constituted by a tension belt or wire 57.1, to which is fixed the guided end 42 of the lever 4. The tension belt or wire 57.1 is wound one or more times round a roll 57.2 and is forced to participate in the rotations of roll 57.2 by static friction. The roll 57.2 is driven by a not shown motor by means of a shaft 57.3. The circumference of the roll 57.2 is preferably small compared with the length of the tension belt or wire 57.1, so that several roll revolutions are required for transferring the tumbler pin 2 from the inhibit position into the free position.

In fig. 13 the force transfer means 4 are themselves resilient, e.g. constructed as a leaf spring. The first end 41 of the lever 4 is fixed in the support 31. In this case, the leaf spring or lever 4 simultaneously acts as a force transfer means and as a restoring means. Obviously it is possible to combine this embodiment with the restoring means of figs. 5, 11 or 12 constructed as a helical spring. Such a variant is shown in fig. 14, where the first end 41 of the lever 4 is firmly fixed in the support 31 and two helical springs 3.1, 3.2 act as restoring means on the lever 4.

Fig. 15 is a perspective, partly exposed view of a first embodiment of a lock module 10 or part of a lock with a locking device according to the invention, installed in a not shown door. The lock module 10 has a double lock cylinder 12, a first partial cylinder 12.1 being directed against a door outside 61 and a second partial cylinder 12.2 against a door inside 62. The first partial cylinder 12.1 contains a mechanical section 13.1 and an electronic section 13.2, said two sections 13.1, 13.2 also being able to pass into one another and need not be clearly mutually defined. A key opening or keyhole 14 directed against a door outside 61 is formed in a rotor 1. An electric cable 16 connects the lock module 10 with a not shown, lock-side electronic module and serves to electrically transmit power for operating the drive means 9 and/or information. Between the first partial cylinder 12.1 and the second partial cylinder 12.2 is provided a lock bit

17 for operating a not shown door lock. From the door inside 62 can e.g. project a rotary knob 18. However, in another variant the door inside 62 can be provided with a keyhole. The lock can be protected by a lock plate 63 fitted to the door outside 61.

The lock module shown in fig. 15 also has a collar 15, in which can be housed the inventive, electronically controlled locking device. In this variant, the electric motor 9 (shown in broken line form) is positioned on the circumference of the lock cylinder 12 and its drive shaft 91 runs substantially perpendicularly to the longitudinal direction of the lock cylinder 12. In another variant, the electric motor 9' or 9" can be housed in a web 19, e.g. in the vicinity of the first partial cylinder 12.1 or second partial cylinder 12.2. The electric motor 9', 9" is then also located on the circumference of the lock cylinder 12, but its drive shaft 91' or 91" is substantially parallel to the longitudinal direction of lock cylinder 12. For reasons of simplicity, fig. 15 does not show some of the elements of the electronically controlled locking device.

A key 7 with a key head 73 and a key bit 75 can be inserted in the keyhole 14. It e.g. contains on the key bit 75 electric contacts 71 for data transmission from the key 7 into the electronic section 13.2 of the first partial cylinder 12.1. Any electronic components and/or integrated circuits 74 can e.g. be located in the key bit 75 or key head 73. The key 7 can also have mechanical coding means 72 on the key bit 75.

Fig. 16 shows an embodiment of a lock module 10 differing slightly from fig. 15. Here the web 19 is short, so that the lock module 10 complies with other installation standards.

Fig. 17 shows a cross-section through the collar 15 of figs. 15 or 16. The embodiment of the inventive locking device shown in fig. 15 essentially corresponds to that of fig. 5. The lock cylinder 12 comprises a stator 6 and a rotor 1 mounted in rotary manner therein. An electronically controlled tumbler pin 2 is moved by an electric motor 9 via a thread 53 acting as a guidance means and a lever 4. Between the electric motor 9 and thread 53 is provided a back gear 93 with e.g. two interlocking gears

93.1, 93.2. Such a back gear 93 can be advantageous if, for geometrical reasons, e.g. due to confined space circumstances, the thread 53 cannot be directly fixed to a drive shaft 91.1 of the electric motor and instead has its own drive shaft 91.2. It can also adapt in a manner suitable for the thread 53 the force or speed of the electric motor 9.

The lever 4 serves as a force transfer means and at its unguided end 41 is pressed by a helical spring 3 onto the casing 31 of the lock module 15. The helical spring 3 serves as a restoring means. The electronically controlled tumbler pin 2 is shown roughly in the rest position.

Besides being shown in the rest position, the lever 4 is shown in dot-dash line form in the free position (4') and the extreme position (4'') outside the free position. In the free position the tumbler pin 2 releases the rotor 1 from the stator 6. If the rotor 1 is then rotated, it presses the tumbler pin 2, having a conical end 2.1, still further outwards, so that the lever 4 reaches its extreme position 4'', where the second end 42 of the lever 4 is at a distance from the thread 53, so that the thread 53 cannot reach the end 42, if the electric motor 9 rotates the thread 53. As a result of this construction principle the malfunction is avoided in which although the second end 42 of the lever 4 is guided by the thread 53 towards the first thread end 53.1, the rotor 1 would still be in a position which would not allow the tumbler pin 2 to be inserted in the bore 11.1 and consequently follow the movement of the lever 4.

In the lock cylinder 12 there can also be at least one mechanically controlled tumbler pin 8, on which acts a pretensioned pin spring 81. The mechanically controlled tumbler pin 8 with a corresponding mechanical coding system 72 acts on a key 7 inserted in the lock cylinder 12. It is obviously possible to have several mechanically controlled tumbler pins. There can also be several electronically controlled locking elements.

Exerting a working force for transferring the inhibiting element 2 from the inhibit position into the free position is initiated by inserting a key 7, associated with the lock cylinder 12, in the rotor 1 or a rotary movement in or with the rotor 1. Conversely the exerting of the working force for

transferring the inhibiting element 2 from the free position into the inhibit position is initiated by extracting the key from the rotor 1.



CLAIMS

1. Locking device for a lock cylinder (12) incorporating a rotor (1) and a stator (6),
with at least one electronically controlled inhibiting element (2), through which the rotor (1) and stator (6) can be mutually locked, the electronically controlled inhibiting element (2) having at least one degree of freedom of movement (x), inhibits the rotor (1) with respect to the stator (6) in an inhibit position (x_S) and frees the rotor (1) in a free position (x_F),
with drive means (9) for exerting a working force (F_A) on at least one electronically controlled inhibiting element (2), which working force (F_A) transfers in reversible manner the at least one electronically controlled inhibiting element (2) from the inhibit position (x_S) into the free position (x_F) and vice versa,
with guidance means (52-57), which are connected to the drive means (9) and, at least outside the free position (x_F), clearly define the position of the at least one electronically controlled inhibiting element (2) and
with restoring means (3), which are on the one hand connected to a support (31) immovable relative to the stator (6) and on the other to the at least one electronically controlled inhibiting element (2) and exert a restoring force (F_R) directed away from the free position (x_F) on the at least one electronically controlled inhibiting element (2), if the at least one electronically controlled inhibiting element (2) is in the vicinity of the free position (x_F), the at least one electronically controlled inhibiting element (2) inhibiting in the vicinity of the free position (x_F).
2. Locking device according to claim 1, characterized in that the at least one electronically controlled inhibiting element (2) has a rest position (x_0), in which the restoring means (3) exert no force on the at least one electronically controlled inhibiting element (2) and in which the at least one electronically controlled inhibiting element (2) inhibits the lock cylinder (12).
3. Locking device according to claim 2, characterized in that the restoring means (3) exert a restoring force (F_R) directed away from the free

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position (x_F) on the at least one electronically controlled inhibiting element (2), if the at least one electronically controlled inhibiting element (2) is located between the free position (x_F) and the rest position (x_0) and that the at least one electronically controlled inhibiting element (2) inhibits the lock cylinder (12) in the rest position (x_0) and in positions between the rest position (x_0) and the free position (x_F).

4. Locking device according to one of the claims 1 to 3, characterized in that the at least one electronically controlled inhibiting element (2) traverses a passage opening (11.2) of the stator (6) communicating with a bore (11.1) of the rotor (1) and is inserted in the bore (11.1) in the inhibit position (x_S).

5. Locking device according to claim 4, characterized in that the at least one electronically controlled inhibiting element (2) is constructed as a tumbler pin movable substantially radially in the lock cylinder (12).

6. Locking device according to one of the claims 1 to 5, characterized in that the drive means are constructed as an electric motor (9) with a drive shaft (91), whose torque can be converted into the working force (F_A) necessary for the reversible movement of the at least one electronically controlled inhibiting element (2).

7. Locking device according to claim 6, characterized in that the electric motor (9) is located on the circumference of the lock cylinder (12) and its drive shaft (91) is substantially perpendicular to the longitudinal direction of the lock cylinder (12).

8. Locking device according to claim 6, characterized in that the electric motor (9) is located on the circumference of the lock cylinder (12) and its drive shaft (91) is substantially parallel to the longitudinal direction of the lock cylinder (12).

9. Locking device according to one of the claims 1 to 8, characterized in that the guidance means are constructed as a thread (53) or turns (53'), as a screw thread (52) with a corresponding nut (54), as a spiral (55), as



a toothed gear or pinion (56.1) or as a tension belt or wire (57.1).

10. Locking device according to claim 9, characterized in that the guidance means as a thread (53) or turns (53') are constructed with several turns surrounding the drive shaft (91) and that the ends (53.1, 53.2) of the thread (53) or turns (53') are associated with the inhibit position (x_S) or free position (x_F).

11. Locking device according to one of the claims 1 to 10, characterized by force transfer means (4) connected to the at least one electronically controlled inhibiting element (2) and through which the working force (F_A) and/or restoring force (F_R) can be transferred from the drive means (9) or restoring means (3) to the at least one electronically controlled inhibiting element (2).

12. Locking device according to claim 11, characterized in that the force transfer means are constructed as levers (4), one end (42) of the lever (4) being guided by guidance means (52-57).

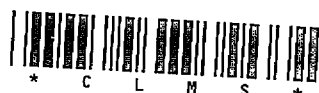
13. Locking device according to claims 10 and 12, characterized in that one end (42) of the lever (4) is guided, substantially without clearance, between two turns of the thread (53) or the turns (53').

14. Locking device according to one of the claims 11 to 13, characterized in that the force transfer means (4) are resiliently constructed and act as restoring means (3).

15. Locking device according to one of the claims 1 to 14, characterized in that it has restoring means constructed as at least one helical spring (3).

16. Locking device according to one of the claims 1 to 15, characterized in that a back gear (93) is located between the drive means (9) and guidance means (52-57).

17. Locking device according to one of the claims 1 to 16, characterized by



at least one mechanically controlled inhibiting element (8).

18. Locking device according to one of the claims 1 to 17, characterized in that the exerting of the working force (F_A) by the drive means (9) for transferring the at least one electronically controlled inhibiting element (2) from the inhibit position (x_S) into the free position (x_F) is initiatable by inserting a key (7), associated with the lock cylinder (12), in the rotor (1), or a rotary movement in or with the rotor (1) and for transferring the at least one electronically controlled inhibiting element (2) from the free position (x_F) into the inhibit position (x_S) is initiatable by extracting the key (7) from the rotor (1).

19. Method for preventing an opening of a locking device by parasitic forces (F_P) caused by vibration and/or shock effects or magnetic action, performable with a device according to one of the claims 1 to 18, characterized in that for avoiding freely oscillating masses, the position of the at least one electronically controlled inhibiting element (2) is clearly predetermined by guidance means (52-57) and that at least in the vicinity of the free position (x_F) a restoring force (F_R) is exerted on at least one electronically controlled inhibiting element (2), which opposes the parasitic forces (F_P).

