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(54) **ELECTRIC STRIKE**

(57) The electric strike comprises a keeper (15) having a projecting portion (19) which pivots about a first pivot axis (18) and which is arranged to co-operate with a latch bolt, a spring (20) for urging the keeper to its door-locking position, a lock lever (23) which pivots about a second pivot axis (25) and which comprises a hook-shaped retention element (27) for locking the keeper (15) in its door-locking position, and an actuator for actuating the lock lever (23) which comprises a compression spring (31) urging the lock lever (23) to its locking position and an electromagnet (42) exerting, when energized, a counter force onto the lock lever (23) to move it to its unlocking position. To enable a compact and reliable construction notwithstanding the fail-secure arrangement of the electric strike, the first and second pivot axes (18, 25) are substantially parallel, the electromagnet (42) has a fixed core (44) which is arranged to directly attract the lock lever (23) and the outermost edge (21) of the keeper (15) is situated on the other side of a plane β which comprises the second pivot axis (25) and which passes through the engagement element (28) for the lock lever (23) on the keeper (15) than the first pivot axis (18)

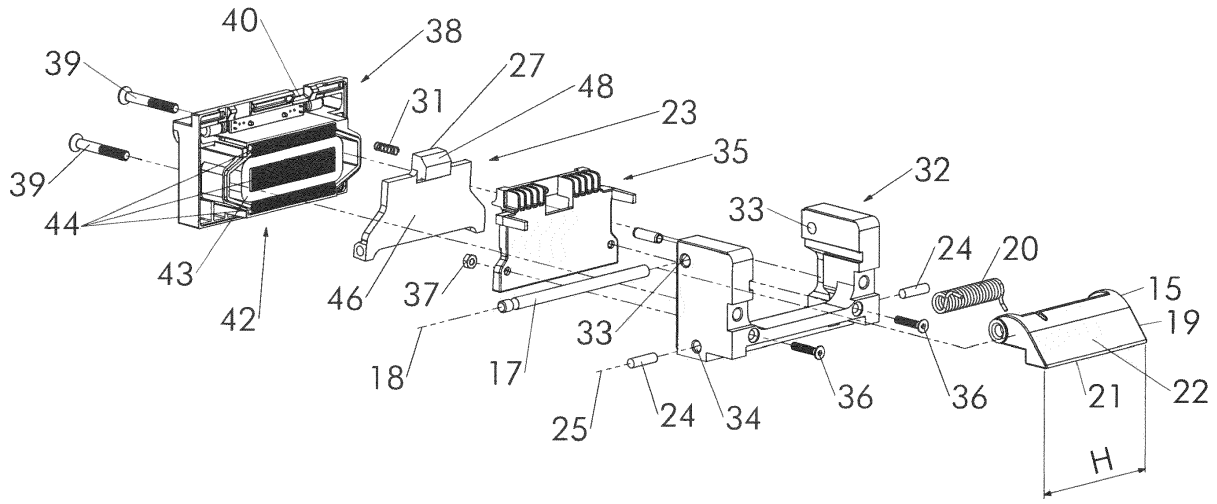

Fig. 5

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Description

[0001] The present invention relates to an electric strike having a bolt cavity arranged to receive at least one bolt of a door lock and comprising a strike frame; a keeper having a projecting portion which forms a side wall of the bolt cavity and which is carried by the frame for pivoting about a first pivot axis between a door-locking position, wherein the keeper is arranged to withhold said bolt to prevent door opening, and a door-releasing position, wherein the keeper is arranged to release the bolt to allow door opening, the keeper being arranged to be pivoted, in a first rotational direction, from the door-locking position to the door-releasing position by a door opening force transmitted thereto by said bolt and to be returned to said door-locking position by means of at least one first spring upon release of the bolt by the keeper when the keeper has been moved by said bolt to said door-releasing position; a lock lever for locking the keeper in said door-locking position, which lock lever is carried by the frame for pivoting about a second pivot axis between a locking position and an unlocking position and is provided with a hook-shaped retention element arranged to hook behind an engagement element on the keeper in the locking position of the lock lever, when the keeper is in said door-locking position, to prevent rotation of the keeper in said first rotational direction and to release the keeper in the unlocking position of the lock lever to enable rotation of the keeper in said first rotational direction; and an actuator for actuating the lock lever, which actuator comprises at least one further spring exerting a force onto the lock lever to urge it to said locking position and at least one electromagnet arranged to exert a counter force onto the lock lever upon energization of the electromagnet to move the lock lever against the spring force to said unlocking position.

[0002] Different types of electric strikes are already disclosed in a number of patent publications.

[0003] FR-A-2 711 715 discloses for example an electric strike, the keeper of which is arranged to co-operate with a dead bolt of a door lock. When opening the door, the keeper is pivoted by the dead bolt to the door-releasing position and, when closing the door, the keeper is pivoted back by the dead bolt to its door-locking position. The lever by means of which the keeper is locked in its door-locking position extends in a substantially vertical direction above the keeper. To unlock the keeper, the lock lever is pivoted by means of an electromagnet about a horizontal pivot axis so that the abutment element on the lower extremity of the lock lever is displaced horizontally out of engagement with the abutment element on the keeper. When the keeper is subsequently pivoted to its door-releasing position, the lock lever is moreover lifted upwards by a cam element provided on its lower extremity. The lock lever is maintained in this lifted position when the keeper pivots further to its door-releasing position and also when it pivots back to its door-locking position. In this way, the electromagnet needs only to be energized very shortly since the lock lever is maintained in its unlocking position until the keeper has returned to its door-locking position. For maintaining the lock lever in its lifted or unlocked position during the pivoting of the keeper, the keeper is provided opposite its projecting portion, i.e. opposite its portion which engages the dead bolt, with a further keeper portion having a top surface which slides underneath the lower extremity of the lock lever so that the lock lever is continuously supported by this portion of the keeper.

[0004] A drawback of the electric strike disclosed in FR-A-2 711 715 is that the lock lever and the electromagnet require quite a lot of space above the keeper. Consequently, a relatively large recess has to be provided in the door frame or in the upright wherein the strike is to be mounted to receive the strike. Moreover, the electric strike cannot be used for left and right turning doors. A strike which is provided for a left turning door has indeed to be mounted upside down onto the door frame when it is used for a right turning door. However, due to the fact that a door lock usually contains a latch bolt and a dead bolt, the strike disclosed in FR-A-2 711 715 cannot be used upside down. In practice, there is indeed only a limited distance between both bolts of a lock so that the lock lever and the electromagnet cannot be arranged between both bolts.

[0005] A further drawback of the electric strike disclosed in FR-A-2 711 715 is that is that the lock lever has to co-operate with a portion of the keeper that is situated opposite the projecting portion of the keeper which forms a side wall of the bolt cavity. As a result thereof, the keeper and thus the electric strike are quite voluminous.

[0006] Also the electric strike disclosed in US-A-3 910 617 is quite voluminous. In the embodiments illustrated in this patent, the lock lever and the electromagnet acting on this lock lever are indeed either arranged above the keeper, increasing thus again the height of the electric strike and making it impossible to use it both for left and right turning doors, or behind the keeper resulting in an electric strike with a large depth so that it cannot be mounted in a tubular post of for example a fence which is usually either square or round. When the lock lever and the electromagnet are arranged behind the keeper, a lever is indeed provided on the keeper which projects backwards to co-operate with the lock lever and the electromagnet is situated in its turn behind the lock lever thus contributing also to the quite large depth of the electric strike. A further drawback of the electric strike disclosed in US-A-3 910 617 is that the electromagnet comprises a movable core which is prone to malfunctions, in particular when used outdoors, than an electromagnet with a fixed core. An electromagnet with a fixed core is easy to be made watertight whereas a solenoid with a movable core is not watertight. The core of a solenoid is moreover made of iron which is electroplated to avoid oxidation. However, after a while the electroplated coating is worn off and the iron core still starts to oxidise. After some while, the movable core gets thus stuck in the solenoid

[0007] Another electric strike is disclosed in US-A-5 735 559. This electric strike also comprises an electromagnet with a movable metal core. This electromagnet is again prone to malfunctions and occupies in this case quite a lot of space underneath the keeper. A further drawback of the electric strike disclosed in US-A-5 735 559 is that it requires a number of micro-switches. One of these micro-switches is used to control whether the keeper has returned to its door-locking position. Only when the return of the keeper to its door-locking position has been detected, the necessary control signals are given to lock the keeper by means of the lock lever. Micro-switches are however quite sensitive to malfunctions, especially when the electric strike is used outdoors, and in particular for garden gates or doors. Moreover, a complex electronic circuit has to be provided for controlling the operation of the electric strike.

[0008] In the electric strike disclosed in US-A-4 917 425 the actuator also comprise an electromagnet with a movable core. The electromagnet is moreover not used to actuate the lock lever to move it to its unlocking position but it is used to displace a blocking arm enabling the keeper to push the lock lever to its unlocking position. An advantage of the electric strike disclosed in US-A-4 917 425 is that the height thereof can be reduced due to the fact that the solenoid is arranged next to instead of above or underneath the keeper. By being situated next to the keeper, the width of the electric strike increase however to such an extent that it is not suitable to be mounted in tubular posts which are usually square or round. Moreover, due to this location of the electromagnet, the actuation of the lock lever requires a number of additional actuation arms which renders the lock more complex and more sensitive to malfunctions.

[0009] An electric strike which can be mounted in tubular posts, and which is suited both for left and right turning doors (including gates), is disclosed in EP-B-1 788 169. This electric strike comprises two lock levers which pivot about a horizontal axis, one lock lever being arranged above and the other one underneath the keeper. Two electromagnets are arranged between the lock levers behind the bolt cavity. For fail-safe applications, wherein the keeper is released upon a power failure, this patent provides a reliable and compact arrangement. However, for applications wherein the electromagnet has to be actuated to release the keeper, i.e. for so-called fail-secure applications, the electric strike disclosed in EP-B-1 788 169 is not so reliable and is more prone to malfunctions after some time. Indeed, in order to be able to keep the position of the electromagnets between the two lock levers, instead of having to position them above and below these lock levers so that the height of the electric strike would be increased considerably, a vertically movable pin is slidably arranged in a longitudinal hole in the core of the electromagnet. One extremity of this pin is provided with an metal plate that is intended to be attracted by the electromagnet whilst the other extremity of the pin engages the lock lever so that it is pushed the lock lever away from the electromagnet upon actuation thereof. A drawback of this arrangement is that the pin may get stuck in the core of the electromagnet, for example due to rust formation or due to dirt which may accumulate in the longitudinal hole in the core of the electromagnet. Another drawback is that the gap between the metal plate and the core of the electromagnet has a uniform width, the distance between this metal plate and the core being moreover the largest when the metal plate starts to be attracted by the electromagnet, i.e. at the moment the hooks on the lock levers have to be released from the keeper and the pin has to put into movement to slide along the inner wall of the hole in the electromagnet. At this moment, the largest force is required to get the pin moving whilst the magnetic force is minimal due to the relatively large width of the gap between the iron plate and the electromagnet. When the friction between the pin and the core has increased somewhat, for example due to rust formation, the pin can thus get stuck so that the keeper can no longer be released. In the arrangement of EP-B-1 788 169 the size of the electromagnet, more particularly the surface of the core which attracts the lock lever, is limited due to the limited space which is available behind the keeper and the horizontal arrangement of the surface of the core which attracts the lock lever.

[0010] An object of the present invention is therefore to provide a new fail-secure electric strike which can be constructed in such a manner that it is reliable, even after having been used for a quite long period of time in the outside weather conditions. The electric strike should moreover be sufficiently compact so that it is in particular suitable for being mounted in a tubular post and should preferably be mountable upside down so as to be suitable for left and right turning doors (including gates or other pivoting closure members).

[0011] To this end, the electric strike according to the invention is characterised in that said second pivot axis is substantially parallel to said first pivot axis, or forms an angle with said first pivot axis, when projected perpendicularly onto any plane which comprises said first pivot axis, which is smaller than 30°;

in that said electromagnet has a fixed core and said lock lever has a portion situated between said second pivot axis and said hook-shaped retention element which is arranged to be attracted directly by the electromagnet when being energized and which is situated between said bolt cavity and said electromagnet; and

in that an outermost edge of said projecting portion of the keeper, i.e. a free edge thereof, is situated on a first side of a plane which comprises said second pivot axis and which passes through said engagement element on the keeper when the keeper is in said door-locking position whilst said first pivot axis is situated on a second side of said plane which is opposite to said first side.

[0012] Due to the fact that the second pivot axis is parallel to, or forms only a small angle with the first pivot axis, the lock lever does not have to be arranged above and/or underneath the keeper but it can be arranged be-

hind the keeper. By providing a hook-shaped retention element on the lock lever, which acts upon the keeper between the free extremity of its projecting portion and the pivot axis of the keeper, and by arranging the lock lever further between the bolt cavity and the electromagnet which directly attracts the lock lever, a quite compact construction can be achieved for a fail-secure application. Indeed, upon being energized, the electromagnet directly attracts the lock lever to pull the hook-shaped retention element thereof out of engagement with the keeper so that the keeper can rotate about its pivot axis. The portion of the lock lever which is situated between the electromagnet and the bolt cavity, and which is attracted by the electromagnet, can be plate-shaped to occupy only a minimum of space so that the depth of the electric strike is thus mainly determined by the depth of the bolt cavity and the depth of the electromagnet. Only one electromagnet has to be provided since the hook-shaped retention element of the lock lever can engage a middle portion of the keeper. Moreover, the surface of the core which attracts the lock lever can extend over a large part of the height and the width of the electric strike so that the electromagnet can exert a relatively large magnetic attraction force on the lock lever. Since the lock lever moves by pivoting about its pivot axis, the gap between the lock lever and the electromagnet has not a uniform width but comprises preferably at least one area where there is nearly no gap between the electromagnet and the lock lever so that in this area the magnetic force is quite large. As a matter of fact, the magnitude of the magnetic force increases exponentially with a decreasing distance between the magnet and the attracted surface. The electromagnet has no movable core, and also the lock lever doesn't slide but pivots, so that there is no risk that the core or the lock lever may become stuck. Even when used for a long time outdoors, the electric strike therefore remains reliable.

[0013] In a preferred embodiment of the electric strike according to the invention, the first and second pivot axes are arranged in such a position in the electric strike that said plane, which comprises said second pivot axis and which passes through said engagement element on the keeper when the keeper is in said door-locking position, forms an angle of between 60 and 90°, preferably between 70 and 90°, with a further plane comprising said first pivot axis and passing through said outermost edge of said projecting portion of the keeper.

[0014] In this way, although relatively large tensile stresses may be generated in the lock lever when said door-opening force is relatively large, the magnitude of these stresses can be reduced.

[0015] In a further preferred embodiment of the electric strike according to the invention, said lock lever is arranged in such a direction in the electric strike that when a door opening force is transmitted by the bolt onto the keeper in the door-locking position of the keeper, said door opening force generates a pulling force in said lock lever, a perpendicular projection of which onto a plane which is perpendicular to said first pivot axis forms an angle with a perpendicular projection of said door opening force onto said plane which is smaller than 30° and preferably smaller than 20°.

[0016] Also in this embodiment, the tensile stresses which can be generated in the lock lever can be reduced.

[0017] In an advantageous embodiment of the electric strike according to the invention, said bolt cavity has a height and the surface of the core of the electromagnet, which is directed towards said portion of the lock lever which is attracted directly by the electromagnet, extends over at least 60%, preferably over at least 70% of the height of said bolt cavity.

[0018] In this way, the electromagnet has a relatively large surface for attracting the lock lever so that a relatively large magnetic force can be exerted thereon.

[0019] In a further advantageous embodiment of the electric strike according to the invention, the lock lever is provided with a first cam element and the keeper, in particular the projecting portion thereof, with a second cam element, the first and second cam elements being arranged to co-operate with one-another to move the lock lever to said unlocking position and back to said locking position upon return of the keeper to the door-locking position after the lock lever has already been returned by said actuator to the locking position before the keeper has returned to said door-locking position.

[0020] By the presence of the cam elements on the lock lever and the keeper, the keeper has not to be provided with arms or further portions to keep the lock lever in its unlocking position until the keeper has returned to its door-locking position. Such arms or further keeper portions do not only occupy additional space but, since they rotate together with the keeper, they also prevent the electromagnet from being arranged close to the keeper. In the electric strike according to this advantageous embodiment of the present invention, the electromagnet can on the contrary be arranged next to the keeper on a small distance therefrom.

[0021] Other particularities and advantages of the invention will become apparent from the following description of a preferred embodiment of the electric strike according to the present invention. The reference numerals used in this description relate to the annexed drawings wherein:

Figure 1 shows an exploded view of an electric strike for a right turning door mounted in a tubular post;
Figure 2 shows a top plan view on the electric strike illustrated in Figure 1 and mounted in a tubular post and on the door lock co-operating therewith and mounted against the upright of a garden gate;
Figures 3 and 4 illustrate the same electric strike as illustrated in Figures 1 and 2 but mounted now on the post for a left turning door;
Figure 5 shows an exploded view of the electric strike;
Figure 6 shows a horizontal cross-sectional view

through the electric strike at the location of the hook-shaped retention element of the lock lever with the keeper in its door-locking position and the lock lever in its locking position;

Figure 7 is a same view as Figure 6 with the lock lever attracted by the electromagnet to its unlocking position;

Figure 8 is a same view as Figure 7 with the keeper rotated to its door-releasing position;

Figure 9 is a same view as Figure 8 with the lock lever released by the electromagnet so that it has returned to its locking position;

Figure 10 is a same view as Figure 9 with the keeper in an intermediate position between its door-locking and door-releasing position and returning to its door-locking position thereby pushing the lock lever towards its unlocking position; and

Figure 11 is a same view as Figure 10 with the keeper returned completely to its door-locking position and the lock lever latched back to its locking position.

[0022] The invention relates to an electric strike, i.e. a strike comprising a keeper which can be operated electrically. This can be done from a distance, for example from within the house, or it can be done by means of a code system. The electric strike is arranged to co-operate with a door lock 1 having at least a latch bolt 2 and optionally a dead bolt. The door lock has on at least one side of the door no handle or otherwise a fixed handle so that from that side the latch bolt 2 can only be released by unlocking the keeper of the electric strike. Optionally, the latch bolt can also be opened by means of a second turn of the key used to unlock the dead bolt. In the embodiment illustrated in Figures 2 and 4, the door lock 1 has two fixed handles, i.e. handles which cannot be rotated.

[0023] The electric strike illustrated in the drawings is arranged to be mounted onto a tubular post 4 which is for example part of a garden fence and which is often placed in the ground. The door or gate 5 (called hereinafter in general door) onto which the door lock 1 is mounted is hinged on a post situated opposite the tubular post 4. This post is also often placed in the ground. A problem of such an arrangement is that the posts may start to sag so that the relative positions of the electric strike and the door lock may change. In order to assure the functioning of the lock, the electric strike has to show an elongate bolt cavity 6 having a minimum height for the latch bolt 2 and also an elongate bolt cavity 7 having a minimum height for the dead bolt.

[0024] Instead of mounting the electric strike in a tubular post 4, it can also be mounted in a door frame which is either formed of a hollow metal extrusion but which may also be constructed of wood or other materials and mortised to define a cavity for the electric strike. Moreover, the electric strike can also be mounted in a cavity made in a wall. In practice, the electric strike is however usually mounted onto a tubular post.

[0025] As illustrated in Figures 1 to 4 the electric strike shown in the figures can be used for left and for right turning doors 5. It comprises two parts 8, 9 which are arranged to be mounted onto one another. The first part 8 forms the latch bolt cavity 6 and the second part 9 the dead bolt cavity 7. Both electric strike parts 8 and 9 are mounted onto one another by means of a cover plate 10 which is fixed by means of bolts 11 onto both parts 8 and 9. The cover plate 10 is subsequently fixed by means of bolts 12 and plugs 3 to the tubular post 4 so that the electric strike extends through a hole 13 into the tubular post 4. An angular abutment plate 14 is preferably fixed between the cover plate 10 and the post 4 to form a stop for the door. The first strike part 8 is preferably constructed in such a manner that it can be mounted upside down onto the second strike part 9. In this way the electric strike can be used for both a left and a right turning door 5. It is clear that in order to be able to mount the first strike part 8 upside down, it may have only a limited height above and below the keeper.

[0026] The embodiment illustrated in Figures 1 to 4 is suitable for posts having different thicknesses and is even suitable for mounting the electric strike in a cavity made in a wall. The cover plate 10 provides indeed a raised part onto the side of the post or wall providing the necessary space for the latch bolt when closing the door. In an alternative embodiment, the hole 13 could also be made in the corner of the tubular post, which is especially advantageous in case the post has a relatively small thickness.

[0027] In the embodiment of the electric strike according to the invention illustrated in Figures 5 to 11, the electric strike comprises a frame having a size and a shape enabling the strike to be mounted in the tubular post 4. The frame comprises three main parts. A first part or member 32 defines one longitudinal side wall of the bolt cavity 6 and comprises two pairs of holes 33, 34 arranged to receive pivot shafts. A second frame member 35 is inserted from the back side of the first frame member 32 into this frame member 32 and is fixed therein by means of bolts 36 and nuts 37. The second frame member 35 comprises a plate-like portion which forms the bottom of the bolt cavity 6. A third frame member 38 carries the electromagnet and is inserted behind the second frame member 35 into the first frame member 32 forming a cover closing off the back thereof. The third frame member 38 is fixed by means of bolts 39 to the first frame member 32.

[0028] By means of a first shaft 17 a keeper 15 is mounted onto the first frame member 32, in the first pair of holes 33 thereof, so that it can pivot about a first pivot axis 18 which is substantially vertical in the mounted state of the strike. The keeper 15 has a projecting portion 19 which forms a longitudinal side wall of the latch bolt cavity 6, opposite to the longitudinal side wall which is formed by the first frame member 32, and which has an outermost edge 21 which is substantially parallel to the first pivot axis 18. The keeper 15 can pivot between a door-

locking position, wherein the projecting portion 19 of the keeper 15 withholds the latch bolt 2, and a door-releasing position, wherein the projecting portion 19 releases the latch bolt to allow door opening. A torsion spring 20 is applied over the first shaft 17, one of the extremities of the torsion spring 20 engaging the third frame member 38, in a groove 40 provided therein, and the other extremity the keeper 15 to urge this keeper towards its door-locking position. When exerting a door opening force onto the closed door, this force is transmitted by the latch bolt 2 onto the projecting portion 19 of the keeper so that the keeper can be pivoted, as illustrated in Figure 7, against the pressure exerted thereon in a first rotational direction 26 by the torsion spring 20 to its door-releasing position. On its back side the projecting portion 19 of the keeper 15 has an inclined surface 22 arranged to co-operate with the latch bolt 2 so that the door can be closed without having to retract the latch bolt by means of the handles. In the embodiment illustrated in the drawings retracting the latch bolt by means of the handles is even not possible as they are not operative, i.e. since they are fixed.

[0029] In order to be able to lock the keeper 15 in its door-locking position, the electric strike further comprises a lock lever 23 which is mounted by means of a second shaft 24 on the first frame member 32 so that it can pivot about a second pivot axis 25, which is preferably also substantially vertical in the mounted state of the electric strike. The second shaft 24 consists of two shaft portions, each of which is inserted in a hole of the second pair of holes 34 provided in the first frame member 32. By rotation about these shaft portions, the lock lever 23 can pivot between a locking position wherein, as illustrated in Figure 6, the keeper 15 is locked by means of the lock lever and an unlocking position wherein, as illustrated in Figure 7, the keeper 15 is unlocked.

[0030] The lock lever 23 comprises a hook-shaped retention element 27 which projects on the free extremity of the lock lever 23 on the opposite side of the pivot axis 25. This retention element 27 is arranged to hook behind an engagement element 28 on the keeper 15 to prevent rotation of the keeper 15 from its door-locking to its door-releasing position. Upon rotation of the lock lever 23 to its unlocking position, illustrated in Figure 7, the retention element 27 moves out of engagement with the engagement element 28 and releases thereby the keeper 15 so that it can rotate towards its door-unlocking position. The engagement element 28 on the keeper 15 is formed by a wall portion 30 of a recess 29 in the back of the keeper 15. The retention element 27 preferably engages the keeper 15 substantially in the middle of the height of the keeper 15.

[0031] The electric strike comprises an actuator for actuating the lock lever 23, i.e. for displacing the lock lever 23 between its locking and unlocking positions. This actuator comprises first of all a helical compression spring 31 which urges the lock lever 23 towards the bolt cavity 6, i.e. towards the back of the keeper 15 when the keeper 15 is in its door-locking position. The spring 31 is arranged with one extremity in a recess 41 in the back of the hook-shaped retention element 27, which forms a thickened portion of the lock lever 23, and engages with its other extremity the second frame member 35 in the vicinity of the first pivot axis 18. The actuator further comprises an electromagnet 42 which is arranged in the third frame member 38 and which exerts, when actuated, a counter force onto the lock lever 23 to move the lock lever 23 against the action of the helical compression spring 31 towards its unlocking position. This electromagnet 42 extends along the elongated bolt cavity 6 in the mounted state of the electric strike, i.e. it extends next to the bolt cavity instead of above or underneath this bolt cavity. When it has a larger height as the bolt cavity, it may project above and/or below the bolt cavity.

[0032] The electromagnet 31 comprises a solenoid (coil) 43 which is wound around a fixed core 44. The core 44 has a surface 45 which is directed towards the lock lever 23 whilst the lock lever 23 has a plate-shaped portion 46 which is situated between the second pivot axis 25 and the hook-shaped retention element 27 and which is directly attracted by the electromagnet 42. The plate-shaped portion 46 is located between the electromagnet 42 and the bottom of the bolt cavity 6, i.e. between core surface 45 of the electromagnet 42 and the plate-like portion of the second frame member 35.

[0033] The position of the second pivot axis 25 is chosen so that when the electromagnet 42 is energized so that the lock levers 23 is moved as illustrated in Figure 8 to its unlocking position, the surface 45 of the core 44 of the electromagnet 42 sticks substantially entirely to the plate-shaped portion 46 of the lock lever 23. In this way, the lock lever 23 is strongly attracted by the electromagnet 42 in its unlocking position. In the locking position of the lock lever 23, which is illustrated in Figure 6, the lock lever 23 has been pushed away by the spring 31 from the electromagnet 42 towards the bolt cavity 6 so that a gap 47 is formed between the surface 45 of the electromagnet 42 and the portion 46 of the lock lever 23 which is attracted by the electromagnet 42 (when energized). The presence of this gap 47 reduces the magnetic attraction forces which can be exerted by the electromagnet 42 onto the lock lever 23. The position of the second pivot axis 25 is however preferably chosen so that, in the locking position of the lock lever 23, the surface 45 of the core 44 of the electromagnet 42 engages the lock lever 23 along a line which coincides with the second pivot axis 25. In this way, due to the very small gap 47 between the electromagnet 42 and the lock lever 23 in the area near the second pivot axis 25, a sufficiently large moment of force can be exerted by the electromagnet on the lock lever to pivot it towards its unlocking position and this notwithstanding the fact that this area is situated close to the second pivot axis 25. This is due to the fact that the magnetic attraction force increases exponentially with a decreasing width of the gap 47 whilst the distance from this force to the second pivot axis decreases only linearly. An electromagnet with a movable core can thus

be avoided.

[0034] The arrangement of the electromagnet 42 and the lock lever 23 with respect to the bolt cavity 6 also enables to provide a strong electromagnet in the electric strike. In this respect, the surface 45 of the core 44 of the electromagnet 42 extends preferably over at least 60%, more preferably over at least 70% of the height H of the bolt cavity 6 (which is equal to the height H of the outermost edge 21 of the keeper 15). In the example illustrated in the drawings, the core surface 45 has a height h which comprises about 85% of the height H of the bolt cavity 6. The larger the height h of the core of the electromagnet, the larger the magnetic forces that can be generated.

[0035] An essential feature of the electric strike according to the present invention is that the second pivot axis 25, i.e. the pivot axis of the lock lever 23, is either parallel to the first pivot axis 18, i.e. the pivot axis of the keeper 15, or it forms an angle with the first pivot axis 18, when projected perpendicularly onto any plane α which comprises the first pivot axis 18, which is smaller than 30°, preferably smaller than 20° and more preferably smaller than 10°. In other words, for each plane α that comprises the first pivot axis 18, i.e. for all of these planes, the angle between the first pivot axis 18 and the perpendicular projections of the second pivot axis 25 on these planes should all be smaller than the above mentioned values. Most preferably, the first pivot axis 18 is substantially parallel to the second pivot axis 25, as is the case in the embodiment illustrated in the drawings.

[0036] A further essential feature of the electric strike according to the present invention is that the outermost edge 21 of the projecting portion 19 of the keeper 15 is situated on one side of a plane β which comprises the second pivot axis 25 and which passes through the engagement element 28 on the keeper 15 when the keeper 15 is in its door-locking position whilst the first pivot axis 18 is situated on the other side of the plane β. In other words, the lock lever 23 engages the keeper 15 between the pivot axis 18 of the keeper 15 and the outermost edge 21 or free extremity thereof. The lock lever 23 which is located between the electromagnet 42 and the bolt cavity 6 can thus keep the keeper 15 in its door-locking position by exerting a pulling force F1 thereon when the door opening force F, exerted by the latch bolt 2 on the keeper 15, generates a pulling force F2 onto the lock lever 23.

[0037] The lock lever 23 is preferably directed in such a manner in the electric strike that the pulling force F2 generated by the door opening force F in the lock lever 23 forms an angle γ with the door opening force F, when projected both perpendicularly on a plane which is perpendicular to the first pivot axis 18, i.e. the plane of Figures 6 to 11, which is smaller than 30° and preferably smaller than 20°. In this way, the pulling force F2 which is generated in the lock lever 23 can be kept to a minimum. In other words, the locking lever 23 and its shaft 24 don't have to be too strong, and thus voluminous or heavy, to be able to keep the keeper 15 in its door-locking position for example when somebody who is not authorised to enter tries to push/force the door open. For the same purpose, the engagement element 28 on the keeper 15 is located in the door-locking position of the keeper 15 on the same side of a plane δ which is tangent to the bottom surface of said bolt cavity 6 as the bolt cavity 6. Indeed, in this way, the projection portion 19 of the keeper 15 provide no or only a small leverage of the door opening force F exerted onto the keeper 15.

[0038] A small angle between the door opening force F and the pulling force F2 generated thereby in the lock lever 23 can be obtained by arranging the first and second pivot axes 18 and 25 in such a position in the electric strike that the plane β, which comprises said second pivot axis 25 and which passes through said engagement element 28 on the keeper 15 when the keeper 15 is in said door-locking position, forms an angle ε of between 60 and 90°, preferably between 70 and 90°, with a plane $\alpha 1$ which comprises the first pivot axis 18 and which passes through the outermost edge 21 of the projecting portion 19 of the keeper 18. In the preferred embodiment illustrated in the drawings, the angle ε is substantially equal to 90° so that the planes $\alpha 1$ and β are substantially perpendicular.

[0039] The functioning of the electric strike appears clearly from Figures 6 to 11.

[0040] In Figure 6, the keeper 15 is in its door-locking position and is locked therein by the lock lever 23 which is pushed by the helical compression spring 31 into its locking position.

[0041] To release the bolt 2 which is caught in the bolt cavity 6, the electromagnet 42 is energized so that it attracts the lock lever 23 and forces it into its unlocking position by rotation about its pivot axis 25. This position is illustrated in Figure 7. In this position, the keeper 15 is no longer locked and can be pivoted against the force of the torsion spring 20 about its pivot axis 18 towards its door-releasing position, illustrated in Figure 8.

[0042] Normally, when swiftly opening the door, the keeper 15 is first returned by the torsion spring 20 towards its door-locking position before the electromagnet 42 is de-energized so that the lock lever 23 returns under the action of the compressing spring 31 towards its locking position (illustrated in Figure 11).

[0043] In order to enable the torsion spring 20 to still return the keeper 15 to its door-locking position in case the electromagnet 42 would be de-energized before the keeper 15 has returned to its door-locking position, the lock lever 23 is provided with a first cam element 48 and the keeper 15, in particular the projecting portion 19 thereof, with a second cam element 49 which co-operates with the first cam element 48 to move the lock lever 23 to its unlocking position and back to its locking position upon return of the keeper 15 to its door-locking position. This movement is illustrated in Figure 10. An important advantage of the presence of the cam elements 48 and 49 on the lock lever 23 and on the keeper 15 is that the keeper 15 has not to comprise additional portions which continuously support the lock lever 23 when the keeper

15 is rotated out of its door-locking position to keep the lock lever in its unlocking position until the keeper 15 has returned to its door-locking position. In this way, more room is available in the electric strike for the electromagnet 42 so that either a stronger electromagnet can be provided or so that the dimensions of the electric strike can be reduced.

Claims

1. An electric strike having a bolt cavity (6) arranged to receive at least one bolt (2) of a door lock (1) and comprising:

   - a strike frame (32, 35, 38);
   - a keeper (15) having a projecting portion (19) which forms a side wall of the bolt cavity (6) and which is carried by the frame (32) for pivoting about a first pivot axis (18) between a door-locking position, wherein the keeper (15) is arranged to withhold said bolt (2) to prevent door opening, and a door-releasing position, wherein the keeper (15) is arranged to release the bolt (2) to allow door opening, the keeper (15) being arranged to be pivoted, in a first rotational direction (26), from the door-locking position to the door-releasing position by a door opening force (F) transmitted thereto by said bolt (2) and to be returned to said door-locking position by means of at least one first spring (20) upon release of the bolt (2) by the keeper (15) when the keeper (15) has been moved by said bolt (2) to said door-releasing position;
   - a lock lever (23) for locking the keeper (15) in said door-locking position, which lock lever (23) is carried by the frame (32) for pivoting about a second pivot axis (25) between a locking position and an unlocking position and is provided with a hook-shaped retention element (27) arranged to hook behind an engagement element (28) on the keeper (15) in the locking position of the lock lever (15), when the keeper (15) is in said door-locking position, to prevent rotation of the keeper (15) in said first rotational direction (26) and to release the keeper (15) in the unlocking position of the lock lever (23) to enable rotation of the keeper (15) in said first rotational direction (26); and
   - an actuator for actuating the lock lever (23), which actuator comprises at least one further spring (31) exerting a force onto the lock lever (23) to urge it to said locking position and at least one electromagnet (42) arranged to exert a counter force onto the lock lever (23) upon energization of the electromagnet (42) to move the lock lever (23) against the spring force to said unlocking position,

   characterised in that
   said second pivot axis (25) is substantially parallel to said first pivot axis (18), or forms an angle with said first pivot axis (18), when projected perpendicularly onto any plane (α) which comprises said first pivot axis (18), which is smaller than 30°;
   in that said electromagnet (42) has a fixed core (44) and said lock lever (23) has a portion (46) situated between said second pivot axis (25) and said hook-shaped retention element (27) which is arranged to be attracted directly by the electromagnet (42) when being energized and which is situated between said bolt cavity (6) and said electromagnet (42); and
   in that an outermost edge (21) of said projecting portion (19) of the keeper (15) is situated on a first side of a plane (β) which comprises said second pivot axis (25) and which passes through said engagement element (28) on the keeper (15) when the keeper (15) is in said door-locking position whilst said first pivot axis (18) is situated on a second side of said plane (β) which is opposite to said first side.

2. An electric strike according to claim 1, **characterised in that** the first and second pivot axes (18, 25) are arranged in such a position in the electric strike that said plane (β), which comprises said second pivot axis (25) and which passes through said engagement element (28) on the keeper (15) when the keeper (15) is in said door-locking position, forms an angle (ε) of between 60 and 90°, preferably between 70 and 90°, with a further plane ($\alpha 1$) comprising said first pivot axis (18) and passing through said outermost edge (21) of said projecting portion (19) of the keeper (15).

3. An electric strike according to claim 1 or 2, **characterised in that** when a door opening force (F) is transmitted by the bolt (2) onto the keeper (15) in the door-locking position of the keeper (15), said door opening force (F) generates a pulling force (F2) in said lock lever (23), a perpendicular projection of which onto a plane which is perpendicular to said first pivot axis (18) forms an angle (γ) with a perpendicular projection of said door opening force (F) onto said plane which is smaller than 30° and preferably smaller than 20°.

4. An electric strike according to any one of the claims 1 to 3, **characterised in that** in the door-locking position of the keeper (15), the engagement element (28) on the keeper (15) is located on a same side of a plane (δ) which is tangent to the bottom surface of said bolt cavity (6) as the bolt cavity (6).

5. An electric strike according to any one of the claims

1 to 4, **characterised in that** when the electromagnet (42) is energized, the surface (45) of the core (44) directed towards said portion (46) of the lock lever (23) which is attracted directly by the electromagnet (42) sticks substantially entirely to this portion (46) of the lock lever (23).

6. An electric strike according to any one of the claims 1 to 5, **characterised in that**, in the locking position of the lock lever (15), the surface (45) of the core (44) of the electromagnet (42) which is directed towards said portion (46) of the lock lever (23) which is attracted directly by the electromagnet (42) engages said portion (46) of the lock lever (23) along a line which coincides with said second pivot axis (25).

7. An electric strike according to any one of the claims 1 to 6, **characterised in that** said bolt cavity (6) has a height (H) and the surface (45) of the core (44) of the electromagnet (42), which is directed towards said portion (46) of the lock lever (23) which is attracted directly by the electromagnet (42), extends over at least 60%, preferably over at least 70% of the height (H) of said bolt cavity (6).

8. An electric strike according to any one of the claims 1 to 7, **characterised in that** said bolt cavity (6) is elongated and the electromagnet (42) extends along said bolt cavity (6) in the mounted state of the electric strike.

9. An electric strike according to any one of the claims 1 to 8, **characterised in that** said second pivot axis (25) is substantially parallel to said first pivot axis (18) or forms an angle with said first pivot axis (18), when projected perpendicularly onto any plane (α) which comprises said first pivot axis (18), which is smaller than 20°, preferably smaller than 10°, the second pivot axis (25) being more preferably substantially parallel to the first pivot axis (18).

10. An electric strike according to any one of the claims 1 to 9, **characterised in that** it comprises two parts (8, 9) which can be mounted onto one another, a first part (8) comprising said keeper (15) and forming together with the keeper (15) said bolt cavity (6) which is arranged to receive a latch bolt (2) of said door lock (1) and a second part (9) forming a further bolt cavity (7) which is arranged to receive a dead bolt of said door lock (1), the first part (8) being mountable in a first position and in an upside down position onto the second part (9) to enable to adjust the electric strike to a left and to a right turning door.

11. An electric strike according to any one of the claims 1 to 10, **characterised in that** the lock lever (23) is provided with a first cam element (48) and the keeper (15), in particular the projecting portion (19) thereof, with a second cam element (49), the first and second cam elements (48, 49) being arranged to co-operate with one-another to move the lock lever (23) to said unlocking position and back to said locking position upon return of the keeper (15) to the door-locking position after the lock lever (23) has already been returned by said actuator to the locking position before the keeper (15) has returned to said door-locking position.

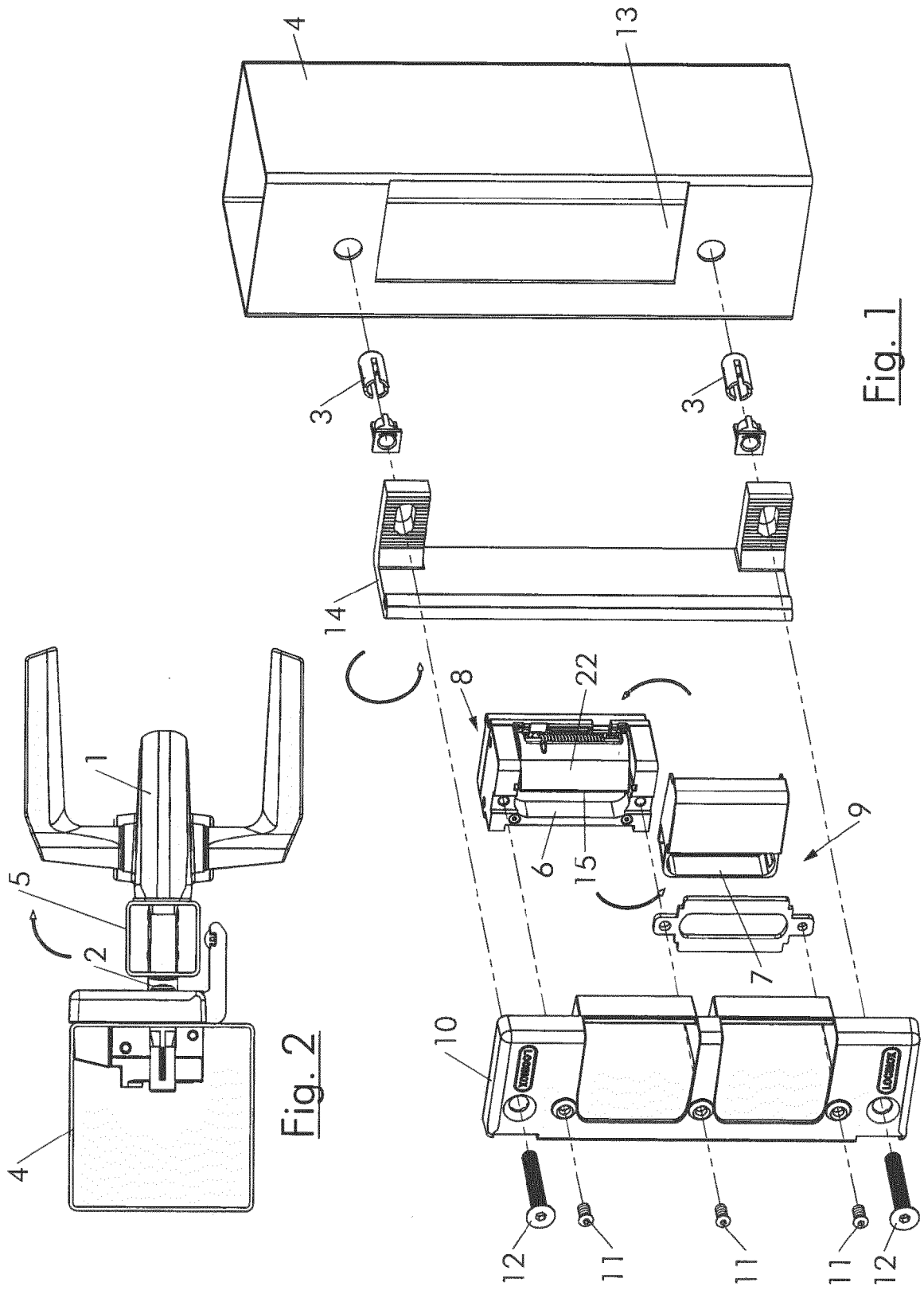

Fig. 1

Fig. 2

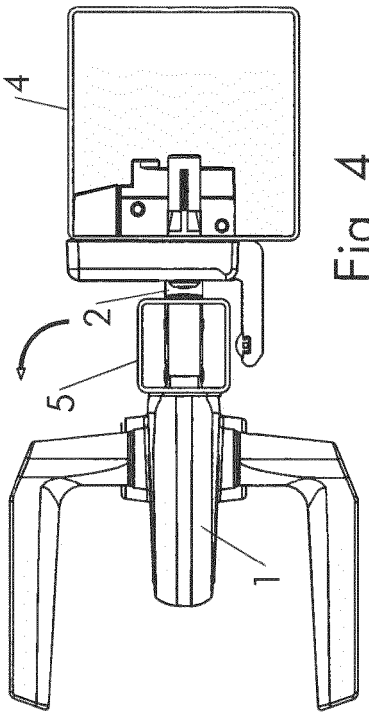

Fig. 4

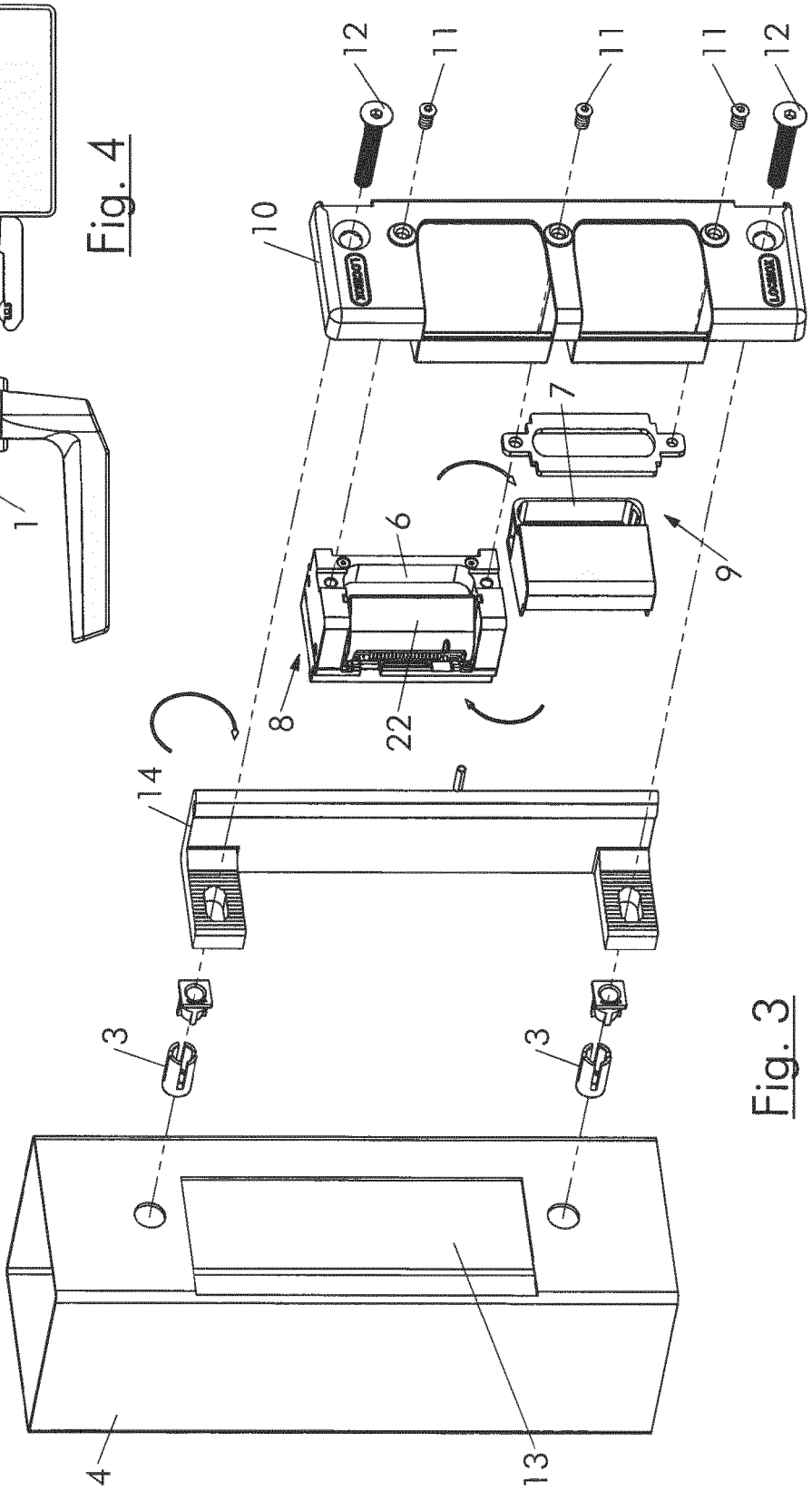

Fig. 3

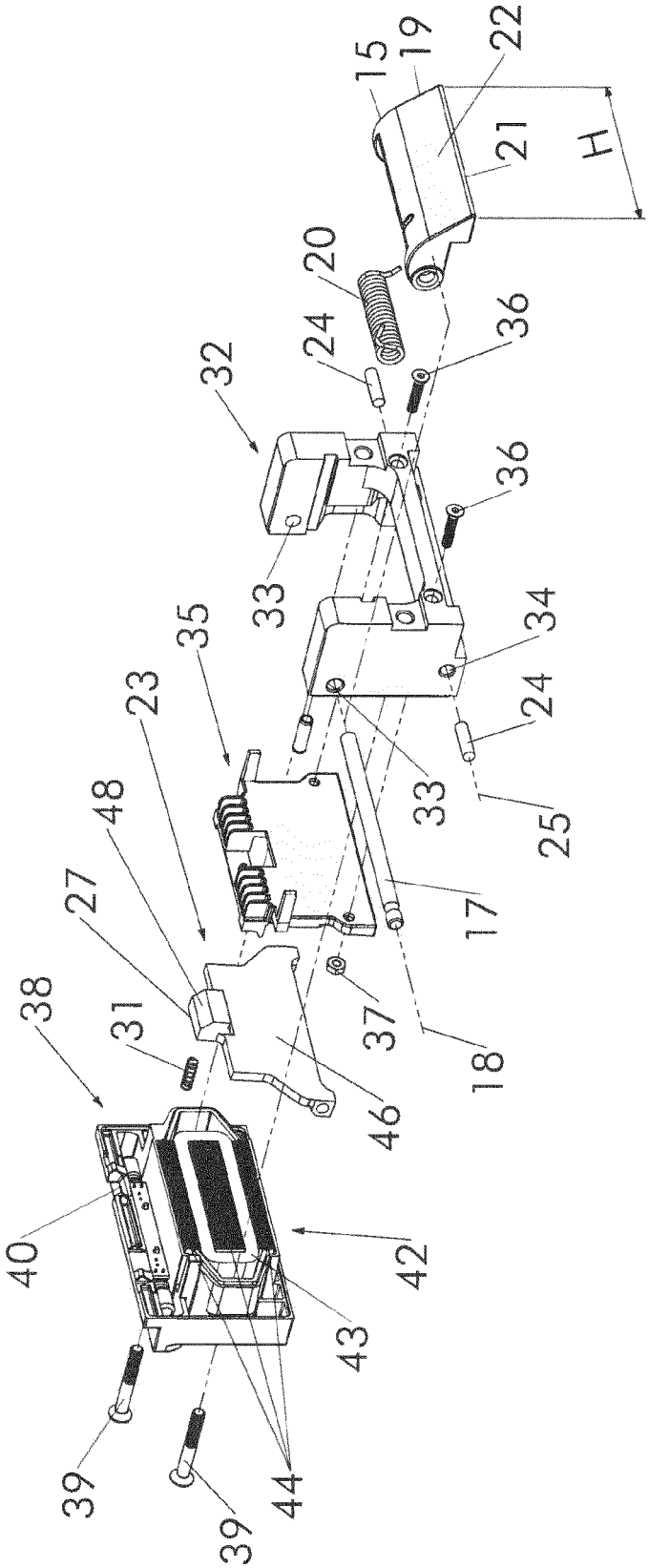
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Fig. 5

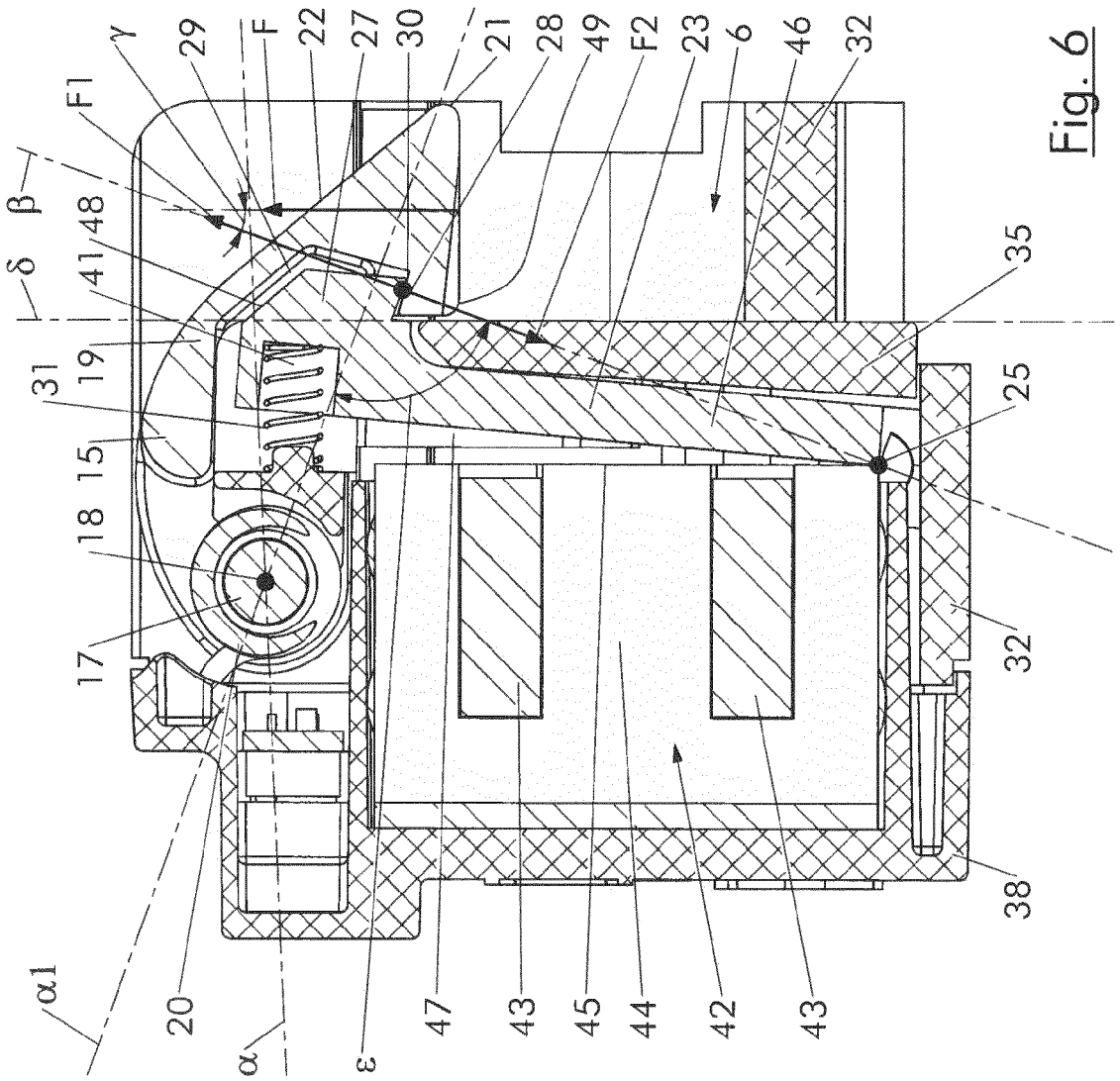
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Fig. 6

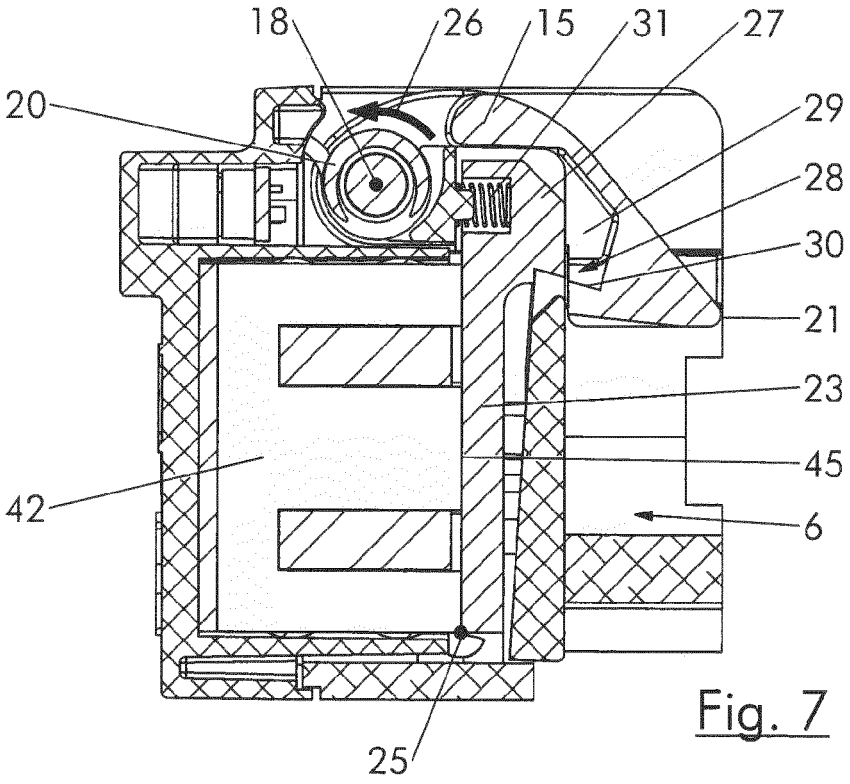

Fig. 7

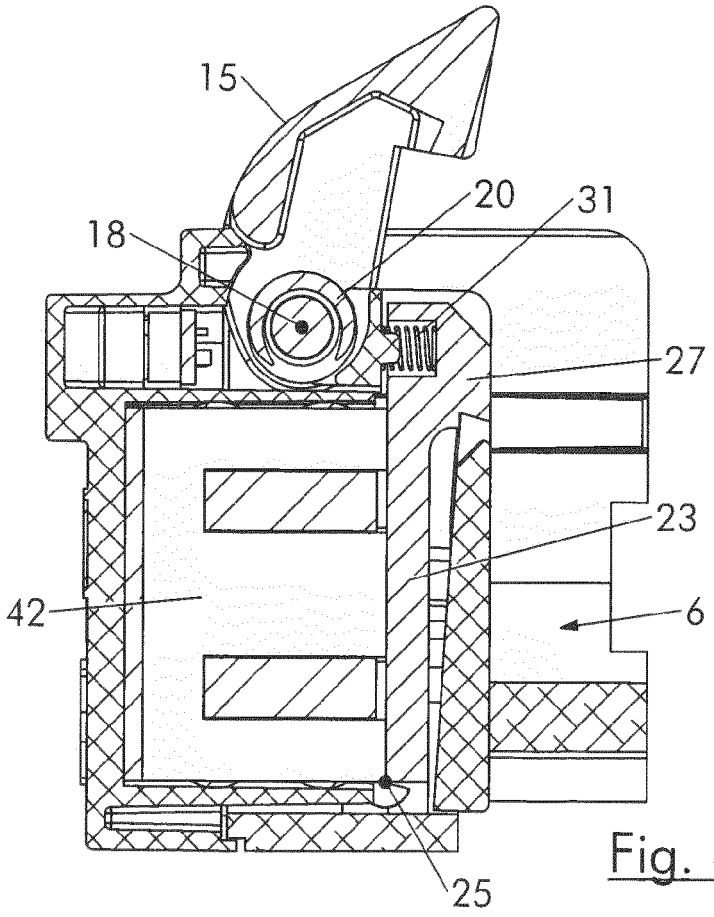

Fig. 8

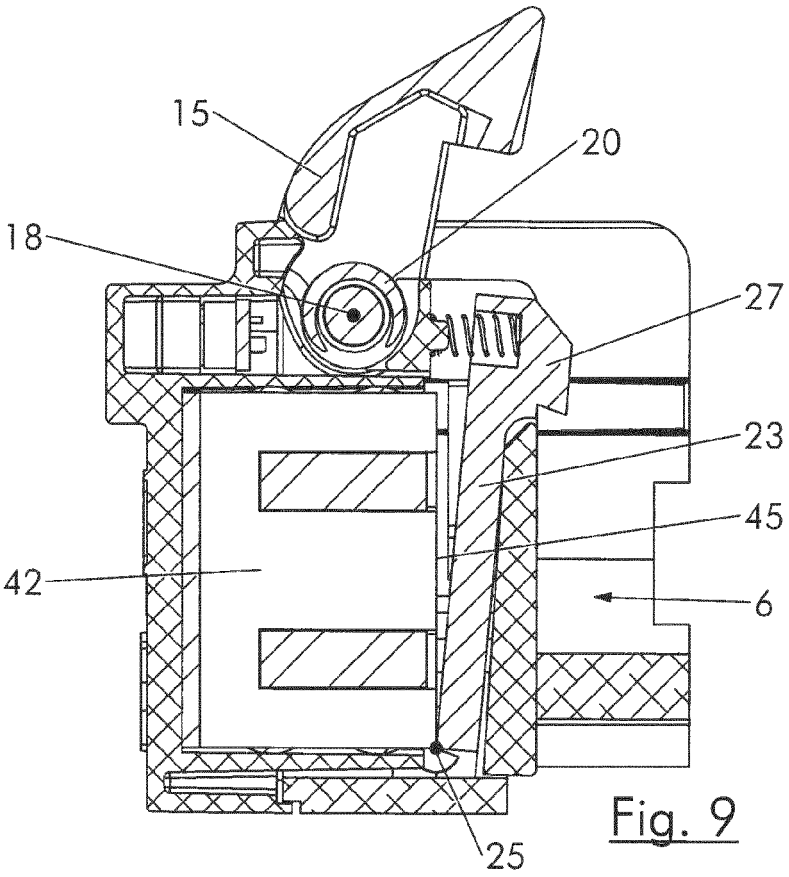

Fig. 9

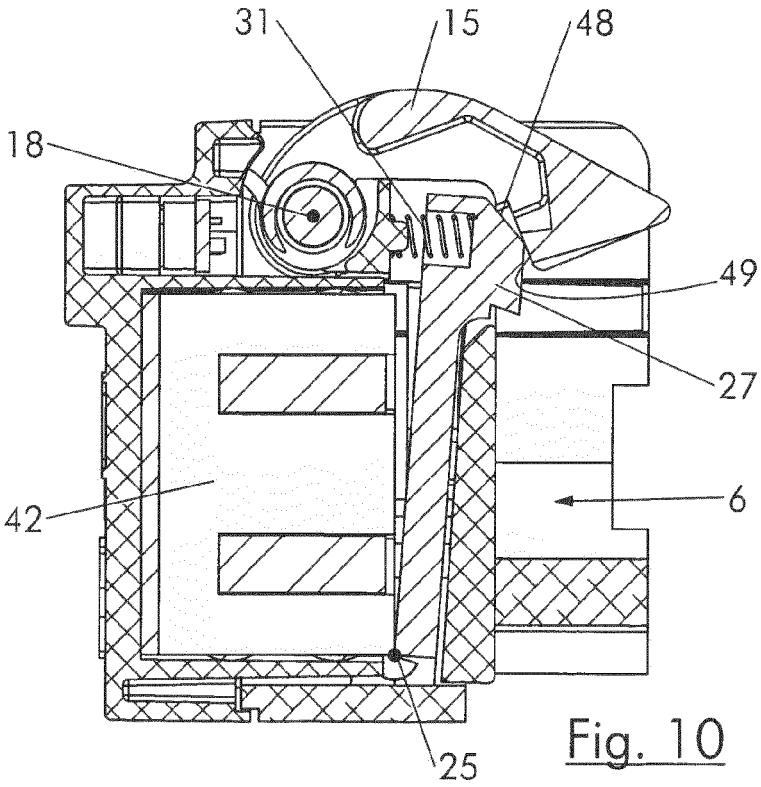

Fig. 10

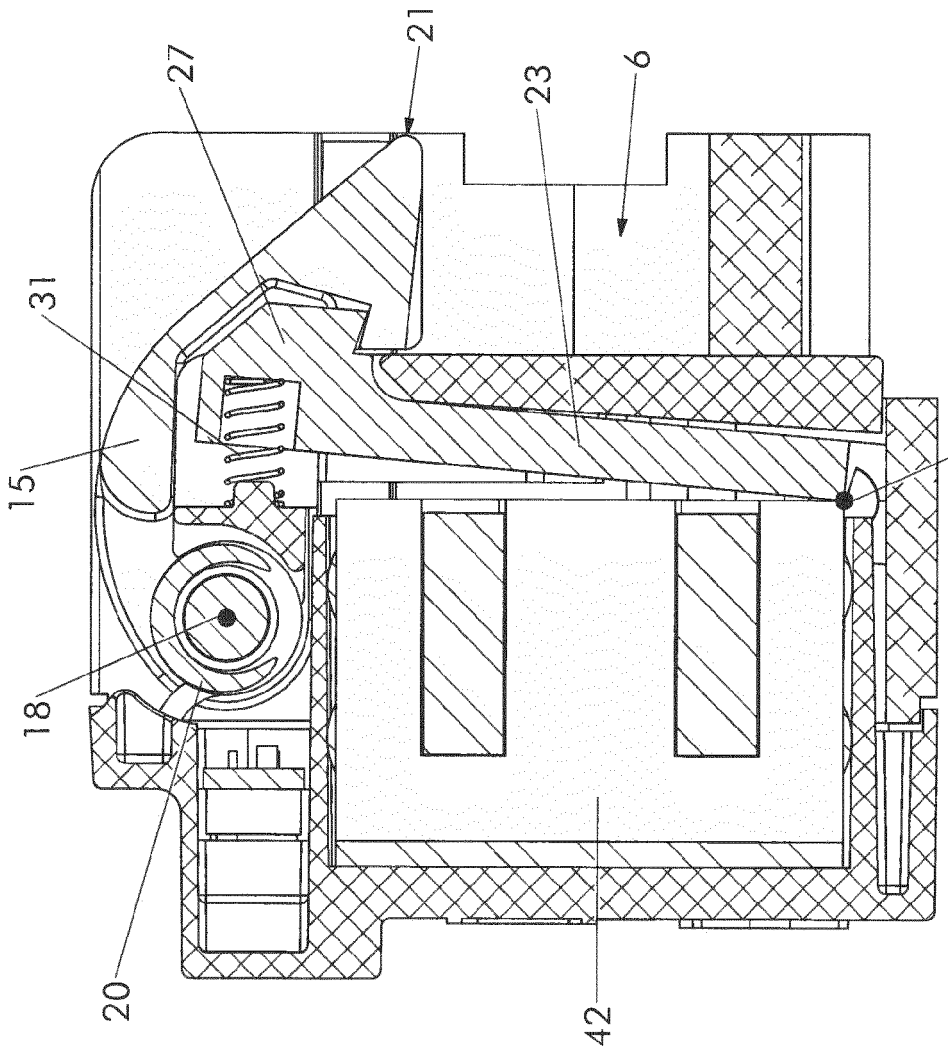

Fig. 11

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EUROPEAN SEARCH REPORT

Application Number
EP 15 17 4182

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 2 312 094 A2 (DORMA GMBH & CO KG [DE]) 20 April 2011 (2011-04-20) * the whole document *	1	INV. E05B47/06 E05B47/00
A	US 1 880 850 A (DAUTRICK OWEN L) 4 October 1932 (1932-10-04) * figure 2 *	1	
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E05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	4 January 2016	Ansel, Yannick

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04-01-2016

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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