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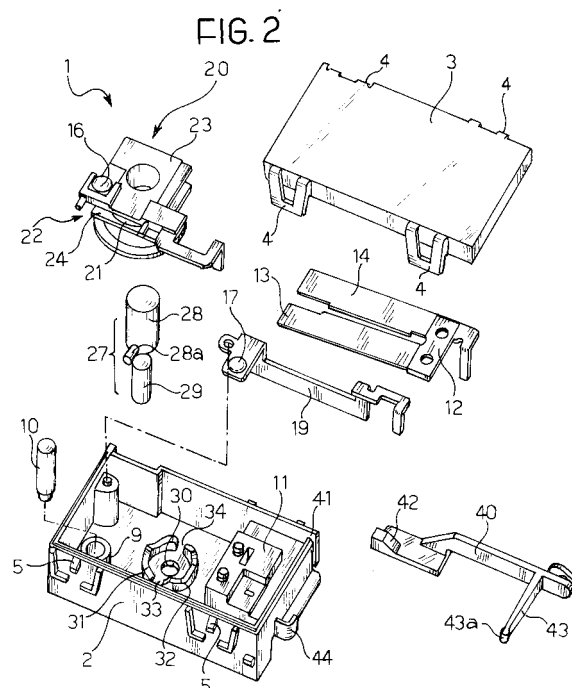
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(54) **A door locking device, in particular for a domestic appliance**

(57) The device (1) includes
a support structure (2, 3);
a retaining slider (6) operable to remain in a rest position while the door is open but to move into a working position in which it retains the door in its closed position; and
an electro-mechanical control device (20) including a stationary solenoid (21) for controlling the axial position of an associated core (29) which is movable along a path intersecting the trajectory of the slider (6);
a resilient member (14) associated with the core (29) and cam members (31-35) associated with the core (29) and cooperating with it in such a way that each time the solenoid (21) is excited, the core (29) is returned to its axially retracted position and rotated about its axis by a predetermined amount, and each time the solenoid (21) is de-excited, the core (29) is urged back into its axially extended position by the associated resilient member (14).

The cam members (31-35) are shaped so as to define at least first and second stable angular positions for the core (29), in which they respectively allow the core (29) to move or prevent it from moving into its axially extended position.



Description

[0001] The present invention relates to a door locking device, in particular for a domestic appliance, such as a washing machine.

[0002] The object of the present invention is to provide an improved door locking device, of an extremely simple construction, including a minimum number of components, and proving extremely safe and reliable in operation.

[0003] This and other objects are achieved according to the invention by providing a door locking device comprising

a support structure for connection to a domestic appliance;

a retaining slider, which is movable relative to the said structure and operable to assume an inactive position when the door is open and which, by interacting with the door as this is closed, is able to move to a working position in which it holds the door in this closed position; and an electromechanical control device, comprising a stationary solenoid, carried by the said structure and operable to control the axial position of an associated core, movable in a direction which intersects the path of the slider;

resilient means associated with the said core and tending to urge it from a retracted axial position into an extended axial position, in which it either allows or prevents the slider from returning to its resting position from the working position; and

cam means associated with the said core, extending around it and cooperating with it in such a way that each time the solenoid is excited, the core is returned axially to its retracted position while rotating about its axis by a predetermined amount, and that each time the solenoid is deactivated it is urged back into the extended position by the associated resilient means;

the said cam means being shaped in such a way that they define at least first and second stable angular positions of the said core, in which, respectively, they prevent the core from moving and allow it to move into its axially extended position.

[0004] Further characteristics and advantages of the invention will become apparent from the following detailed description, provided purely by way of non-limitative example, with reference to the appended drawings, in which:

Figure 1 is a perspective view of a door locking device according to the present invention;

Figure 2 is a partial, exploded, perspective view of the door locking device of Figure 1;

Figure 3 is a partly sectioned partial, perspective view of the door locking device of the preceding drawings;

Figure 3a is a section taken on the line IIIa-IIIa of Figure 3;

Figures 4 and 4a are sections taken on the lines IV-IV

and IVa-IVa of Figure 1;

Figure 5 is a section taken on the line V-V of Figure 4; Figure 6 is a partly sectioned partial perspective view, similar to Figure 3 and showing the door locking device in the position it assumes when the associated door of the domestic appliance is closed but not locked;

Figure 6a is similar to Figure 4a but shows the door locking device in a different operating condition;

Figures 7 and 8 are two partial perspective views showing part of the electro-mechanical control device of the door locking device of the invention, in the conditions in which it respectively allows or prevents the door of the appliance from being opened; Figure 9 is a partly sectioned view similar to that of Figure 4, showing the door locking device in the condition in which it keeps the associated door of the appliance closed and locked;

Figure 10 is a section taken on the line X-X of Figure 9; and

Figure 11 is a partial perspective view of the device of the invention, showing means enabling the door of the domestic appliance to be opened by hand, should the electric power supply fail.

[0005] With reference to the drawings, and in particular to Figures 1 and 2, a door locking device 1 according to the invention includes a support structure which in the embodiment illustrated by way of example essentially includes a box-shape body 2 and an associated lid 3, both made of a moulded plastics material for example.

[0006] In the embodiment illustrated, the lid 3 has a plurality of fixing holes 4 with corresponding retaining projections 5, formed in the external surfaces of the main side walls of the box-shape body 2, engaged therein (see Figures 1 to 3 in particular).

[0007] The door locking device 1 also includes a retaining slider 6, made of metal for example. This slider, which can be seen in only some of the appended drawings, is mounted in a manner which is known per se so as to be movable relative to the support structure 2, 3 along a path indicated by the double arrow F of Figure 1.

[0008] In a known manner once again, the retaining slider 6 can assume a rest position as shown in Figures 3 to 5, corresponding to the condition in which the associated door of a domestic appliance is open.

[0009] Again in a known manner, the retaining slider 6 is able to interact with the door (generally provided with a hook) as this is closed and to move into a working position, shown in Figures 6, 9 and 10, in which it acts to keep the door of the domestic appliance in its closed condition.

[0010] The retaining slider 6 has a first aperture 7, essentially in the form of a slot, extending along the path F of the said slider (see Figures 3, 4 and 6).

[0011] As can be seen from Figure 3a in particular, the edges of the aperture 7 in the slider 6 form downwardly-converging inclined surfaces 7a, 7b, at least along the

opposite end portions of the aperture, for reasons which will become clearer later.

[0012] The slider 6 has another aperture, indicated 8 in Figures 5, 9 and 10, the function of which will be explained later.

[0013] With reference in particular to Figures 2, 4a and 6a, a tubular formation 9 extends upwardly within the box-like body 2 from the bottom 2a thereof, with a rod or pin 10 mounted for axial translation therein, with an advantageously rounded end towards the slider 6.

[0014] With reference to Figures 2, 3 and 6, a shaped support base 11 is formed in the box-like body 2, on the right hand in said drawings, with an electrical terminal 12 fixed thereon with two extensions or spring metal blades 13, 14, substantially coplanar and parallel to one another.

[0015] The distal end of the metal blade 13 bears on the end of the rod or pin 10 opposite the slider 6 (see Figure 3, for example) and tends to urge this pin 10 against said slider 6.

[0016] As can be seen better in Figures 3, 4a and 6a, a contact 15 is fixed to the lower surface of the metal blade 13, for cooperation with an associated fixed contact 16 which is stationary relative to the support structure 2, 3 of the door locking device.

[0017] This arrangement is such that when the door of the domestic appliance to which the device is connected is open, the slider 6 is positioned as shown in Figures 3, 4 and 4a. In this position, the thrust of the associated metal blade 13 urges the rounded end of the pin 10 against the slider 6, but not through the aperture 7 through this latter. In this condition, as can be seen in Figure 4a in particular, the movable contact 15 carried by the blade 13 is separated and spaced from its associated fixed contact 16. Together, these contacts form an electrical switch, which can be connected to a control unit of the domestic appliance so as to signal whether the door is open (switch open) or closed (switch closed).

[0018] When a user closes the door of the domestic appliance, interaction between a hook member on the door and a corresponding aperture (not shown) in the cursor 6, causes the latter (against the biasing action of resilient means which are not shown) to move from the position of Figures 3, 4 and 4a into the position shown in Figures 6 and 6a in which the pin 10 is in register with the slot 7 and, urged by the metal blade 13, extends through it. This axial movement of the pin 10 causes the contact 15 carried by the metal blade 13 to bear against the fixed contact 16, whereby the switch formed by these contacts is operable to send a signal indicating that the door is closed.

[0019] Once the door is closed, but before it is locked, or after it has been unlocked, the door can be opened manually by a user: the movement of opening the door causes the slider 6 to move, in the opposite direction to that indicated by the arrow F1 of Figure 6. The lower, rounded end of the pin 10 therefore moves back up along the inclined edge 7a of the slot 7, returning to bear against the slider 6. This causes the switch formed by the con-

tacts 15 and 16 to open, signaling that the door is open.

[0020] As can be seen in Figures 4 and 9, for example, the lower surface of the metal blade 13 is also connected to a respective movable contact, indicated 17, for cooperation with an associated fixed contact 18 carried by a shaped metal element 19 secured inside the box-like body 2.

[0021] As will become more clear later, the contacts 17 and 18 together form a further electric switch able to signal to a control unit of the domestic appliance that the door is locked into its closed position. The door of the electric appliance is locked into its closed position by locking the retaining slider 6 into the working position described earlier. In the embodiment illustrated by way of example, this is achieved by means of an electro-mechanical control device generally indicated 20. This device includes a solenoid 21 carried by a cylindrical former 22 which in the embodiment illustrated has upper and lower square end flanges 23 and 24 respectively.

[0022] Extensions 25, their ends 26 folded like feet, extend downwards from the lower flange 24 so as to rest on the bottom of the box-like body 2.

[0023] An assembly generally indicated 27 is mounted for axial translation inside the former 22 bearing the solenoid 21 and includes a cylindrical body 28, made of a plastics material for example, with a cylindrical core 29 of a ferromagnetic material fixed inside it. In the embodiment illustrated, the lower end of the core 29 projects from the corresponding bottom end of the cylindrical body 28.

[0024] The lower end of the cylindrical body 28 has two diametrically opposite projections indicated 28a (see Figures 2, 5 and 10 for example).

[0025] As can be seen in Figure 2, a substantially circular aperture 30 is formed through the bottom portion of the box-like body 2, with the lower end of the core 29 of the solenoid 21 extending through it, as can be seen in Figures 4, 5, 9 and 10.

[0026] Two almost semi-circular formations 31, 32 extend upwardly from the upper surface of the bottom of the box-like body 2, coaxially of the aperture 30, and are shaped at the top so as to form respective cam sections for cooperating in operation with the projections 28a on the body 28 of the movable assembly 27. In particular, two diametrically opposite interruptions or gaps 33 and 34 are formed between the formations 31 and 32, for engagement by the projections 28a on the movable body 28 of the solenoid 21, as can be seen for example in Figure 8.

[0027] In the embodiment illustrated by way of example, the upper edge of each of the formations 31 and 32 is serrated and, starting from a window, 33 or 34 respectively and proceeding in an anti-clockwise direction when observing Figure 2, has three upwardly facing crests, separated by two valleys which form downwardly facing crests.

[0028] A circular formation extends from the lower surface of the flange 24 of the former of the solenoid 21,

having a toothed profile which substantially corresponds, or is virtually complementary with that of the arrangement of formations 31 and 32 projecting from the bottom surface of the box-like body. With reference to Figures 7 and 8, a circumferentially extending row of saw teeth 35 extend from the lower flange 24 of the former of the solenoid, the pitch thereof substantially corresponding to that of the crests and valleys of the formations 31 and 32. The teeth 35 of the lower flange of the solenoid former are also slightly offset angularly with respect to the crests and valleys of the formations 31 and 32, in an anti-clockwise direction when observing Figures 7 and 8.

[0029] The vertical distance between the edges of the teeth 35 and the edges of the serrated formations 31 and 32 is greater than or equal to the transverse dimension of the projecting formations 28a on the body 28 of the movable assembly 27.

[0030] The arrangement described above is such that, when the door of the appliance is not locked (that is when the door is either open or closed but not locked), the movable assembly 27 associated with the solenoid 21 is positioned as shown in Figures 4, 5 and 7: the core 29 does not extend beyond the bottom of the box-like body 2 and the radial projections 28a on the associated body 28 are engaged in respective valleys in the formations 31 and 32 described above, as a result of the downwards thrust exerted by the blade 14 on the said body 28.

[0031] As explained earlier, the act of closing the door causes the pin 10 to engage the slot-shape aperture 7 in the slider 6 and the switch formed by the contacts 15 and 16 to close. It is convenient if, in addition to signaling that the door is closed, this switch also closes a power circuit operable to excite the solenoid 21.

[0032] Once the domestic appliance has been started, the electro-mechanical or electronic control unit thereof can then excite the solenoid 21. The magnetic field thus formed recalls the movable assembly 27 upwards, against the action of the metal spring blade 14. The radial projections 28a on the body 28 each slide up a crest of the formations 31 and 32 until they engage a corresponding groove facing this crest and formed between two adjacent teeth 35 on the lower flange 24 of the former bearing the solenoid. The excitation of the solenoid causes the movable assembly 27 not only to move upwards axially but also to rotate, clockwise as viewed when looking at Figure 2.

[0033] As soon as the solenoid 21 is de-excited, the movable assembly 27 moves back down under the thrust of the metal spring blade 14. The radially projecting formations 28a on the body 28 then engage the descending ramps of the corresponding crests up which the formations 31 and 32 moved earlier, until they drop into the grooves 33 and 34 formed between the said formations. The lower end of the core 29 therefore projects from the bottom of the aperture 30 in the bottom of the box-like body 2, engaging the corresponding aperture 8 in the slider 6 (see Figures 8 and 10). In this condition, the slider 6 is prevented from returning to its rest position (see Fig-

ures 3 to 5). The door is thus locked. In this condition, closure of the switch formed by the two contacts 17 and 18 signals to the control unit of the domestic appliance that the door is closed and locked. In order to release the door of the domestic appliance, the control unit thereof can excite the solenoid 21 once again. This initially causes the movable assembly 27 to translate upwards axially until the radial projections 28a on the body 28 disengage the grooves 33 and 34 formed between the formations 31 and 32.

[0034] Subsequently, while the solenoid 21 remains excited, the projections 28a move up the rising face of the next crest in the formations 32 and 31 until they engage a corresponding groove defined between two adjacent teeth 35 of the flange 24 of the former bearing the solenoid. As soon as the solenoid 21 is de-excited, the action of the metal spring blade 14 causes the movable assembly 27 to move back down, rotating further in the same sense as before, until each projection 28a on the body 28 engages the next valley in the formations 32 and 31. The height of these valleys from the bottom surface of the box-like body 2 is such that the core 29 disengages from the aperture 8 in the slider 6, thereby releasing the door of the domestic appliance, ready for it to be opened again.

[0035] Alternatively, the height of these valleys 31 and 32 from the bottom surface of the body 2 can be such that the core 29 still projects far enough through the bottom of the body to lock the slider 6 in its door closed position. In this case, in order to unlock the door the solenoid 21 must be excited and subsequently de-excited once again, causing the subsequent rise up a rising face of a crest of the formations 31 and 32, followed by a descent into the next valley of these formations, this last valley being at a height sufficient to disengage the core 29 from the corresponding aperture 8 in the slider.

[0036] In the variant embodiment of the invention just described, while the solenoid needs only one excitation/de-excitation pulse in order to move the door locking device into its locked condition, two subsequent pulses are required in order to release the door.

[0037] Other variants can be envisaged, in which by suitably adapting the profiles of the formations 31 and 32 it is possible to ensure that the solenoid requires n excitation/de-excitation pulses in order to lock the door, and m excitation/de-excitation pulses to release it.

[0038] If electrical power should fail while the appliance is working and the door is closed and locked, the user can release the door and open it manually by acting on a traction member, for example a cable (not shown), connected to a member 40 (see Figures 1, 2 and 11) mounted for translation in a slot 41 through the box-like body 2. The portion of this member extending inside the box-like body has a projection 42 with an inclined face for engagement with a radial projection 28a on the body 28, which would cause it to disengage from the corresponding valley 33 and 34 defined between the formations 31 and 32, thereby causing the entire movable assembly 27

to move upwards, thereby disengaging the core 29 from the slider 6. This manoeuvre releases the slider 6, enabling the user to open the door manually.

[0039] It is convenient if the member 40 described above has a transverse spring extension 43 able to act as a resilient biasing element. In the embodiment illustrated, the distal end 43a of this spring extension 43 is engaged in a retaining housing 44 formed in the box-like body 2 (Figure 2).

[0040] The device of the invention consists of a very limited number of components, thanks in part to the use of the core 29 as the member which locks the slider. An additional structural simplification and reduction of the number of parts can be achieved by using the metal blades 13 and 14 as biasing springs as well as contact-bearing conductors.

[0041] Naturally, the object of the invention remaining unchanged, embodiments and manufacturing details can be varied widely from those described and illustrated purely by way of example, without departing thereby from the scope of the invention, as claimed in the appended Claims.

Claims

1. A door-locking device (1), in particular for a domestic appliance, comprising
 - a support structure (2, 3) for connection to the domestic appliance;
 - a retaining slider (6), movable relative to the said structure (2, 3) and intended to assume a rest position when the door is closed but, interacting with the door as this is closed, to move into a working position in which it retains the door in its closed position; and
 - an electromechanical control device (20) including a stationary solenoid (21) carried by the said structure (2, 3) and operable to control the axial position of an associated core (29) which is movable along a direction intersecting the path of the cursor (6);
 - resilient means (14) associated with the said core (29) and tending to urge it from an axially retracted position into an axially extended position, in which it respectively allows or prevents a return of the cursor (6) to its rest position from its working position; and
 - cam means (31-35) associated with the said core (29), extending around it and cooperating with it in operation so that each time the solenoid (21) is excited, the core (29) is moved into its axially retracted position and each time the solenoid (21) is de-excited, the core (29) is urged back once again into its axially extended position by the associated resilient means (14);
 - the said cam means (31-35) being shaped in such a way that they define at least first and second stable angular positions for the said core (29), in which they prevent the core (29) from moving or respectively allow it to move into its axially extended position.

2. A door locking device according to Claim 1, in which the said cam means (31-35) are shaped in such a way that each time the solenoid (21) is excited, the core (29) rotates about its axis by a predetermined amount.
3. A door locking device according to Claim 2, in which the said cam means (31-35) are shaped in such a way that each time the solenoid (21) is de-excited, the core (29) rotates further about its axis by a predetermined amount, in the same sense as that of the previous rotation.
4. A door locking device (1) according to any of the preceding Claims, also including a (first) electric switch (13; 15, 16) comprising a movable contact (15) carried by a (first) resilient metal blade (13) mounted on the said support structure (2, 3), an associated fixed contact (16) and a movable member (10) urged resiliently towards the slider (6) by the said blade and cooperating with the said slider (6) in such a way that the said (first) switch commutes when the slider (6) passes from its rest position to its working position and vice versa; the said blade (13) acting at the same time as the electrical terminal for the said (first) switch and as a resilient member associated with the said movable member (10).
5. A door locking device according to Claim 4, also including a second electric switch (14; 17, 18) comprising a movable contact (17) carried by a further resilient blade (14) mounted on the said support structure (2, 3) and connected electrically to the said first blade (13), and an associated fixed contact (18); the said additional blade (14) being associated in operation with the said movable core (29) in such a way that the said second switch (14; 17, 18) is able to change state when the said core moves from its extended to its retracted position and vice versa; the said additional blade (14) serving at the same time as an electrical terminal for the said second switch (14; 17, 18) and as a resilient member associated with the said core (29).
6. A door locking device according to Claim 5, in which the said first electric switch (13, 15, 16; 14, 17, 18) is connected electrically to the said solenoid (21) whereby the said solenoid (21) can be excited only when the slider (6) is in its said working position.
7. A door locking device according to Claims 5 or 6, in which the said metal blades (13, 14) extend from a single electrical terminal (12) with which they are formed in one piece.
8. A door locking device according to any of the preceding Claims, in which the said cam means (31-35) include a plurality of shaped formations (31,32; 35)

extending around the said core (29) and with which at least one laterally projecting formation (28a) of the said core (28, 29) is able to cooperate.

9. A door locking device according to Claim 8, in which the said cam means include a lower ring (31, 32) with a serrated upper profile and an upper ring (35) with a serrated lower profile, with the same pitch but angularly offset with respect to the upper profile of the lower ring (31, 32); the said profiles being coaxial and spaced vertically. 5
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10. A door locking device according to Claim 9, in which the lower ring (31, 32) has at least one gap or window (33, 34) in a predetermined angular portion. 15

11. A door locking device according to Claims 9 or 10, in which the upper ring (35) is formed in one piece with an end portion (24) of a former (23) on which a solenoid (21) is wound. 20

12. A door locking device according to Claim 11, in which the lower ring (31, 32) is formed in a wall of the said support structure (2, 3). 25

13. A door locking device according to any preceding Claim, also including a movable release member (40) for cooperating with the said core (28, 29) and forcing it to move from its extended into its retracted position. 30

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FIG. 1

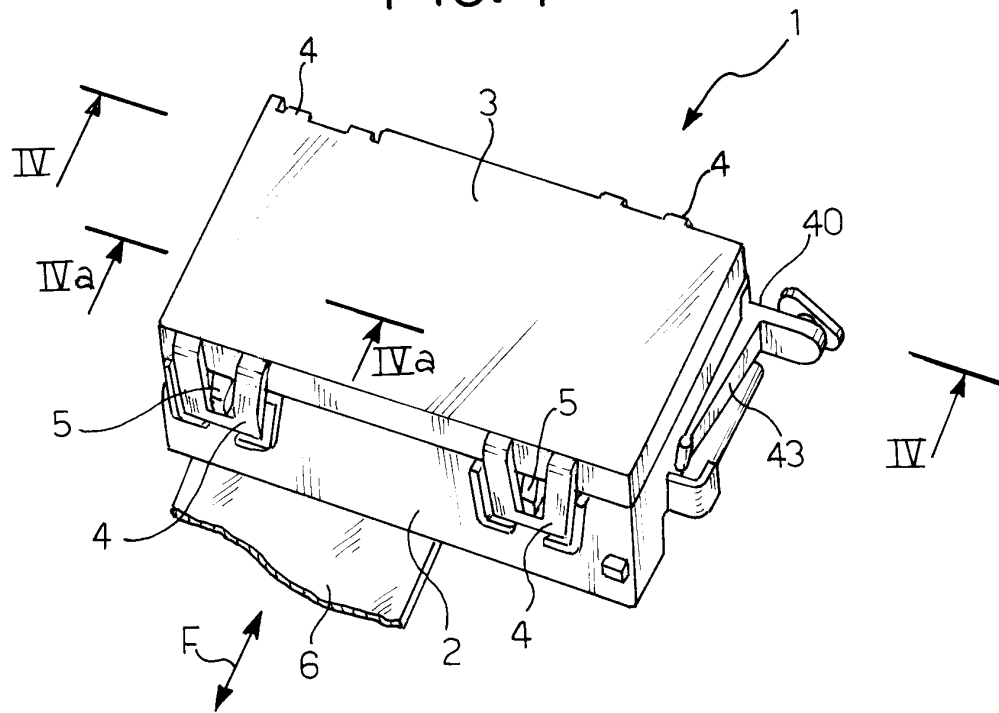


FIG. 3

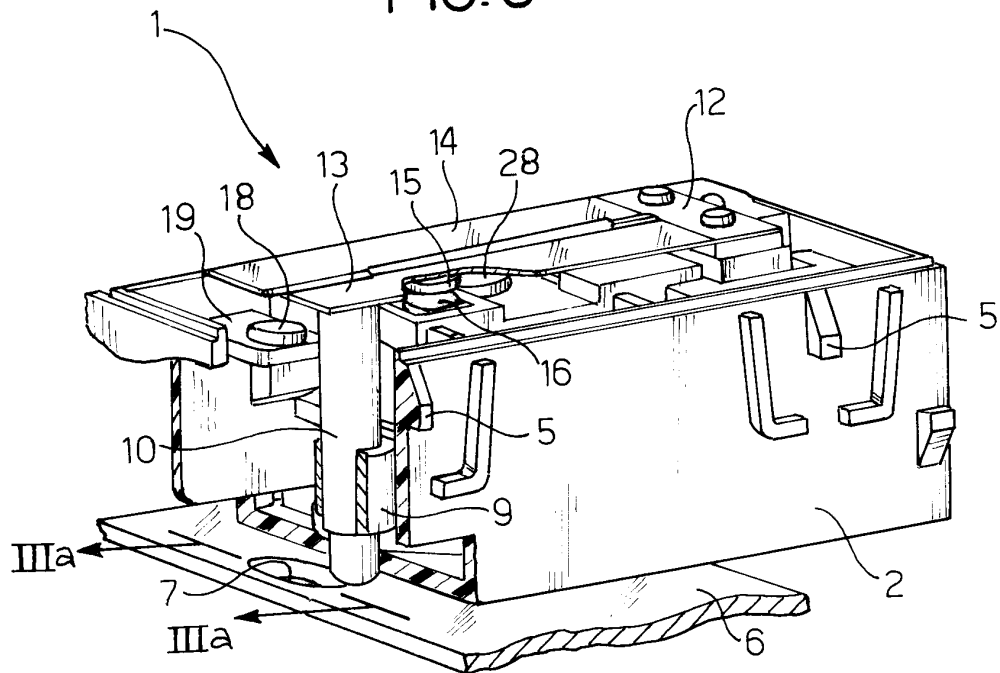


FIG. 2'

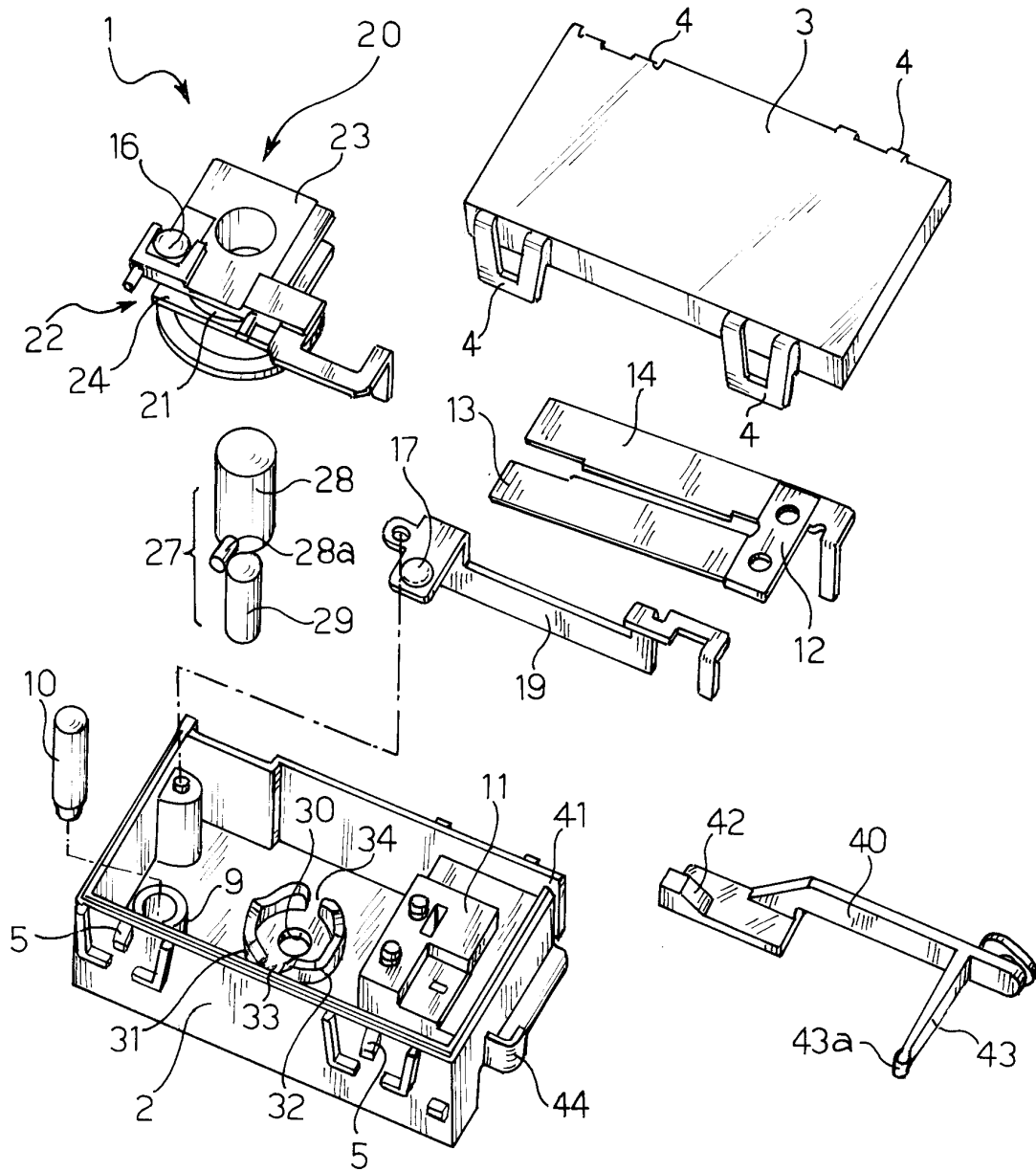


FIG. 3a

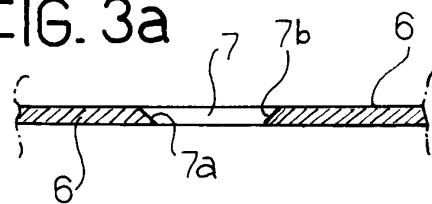


FIG. 4

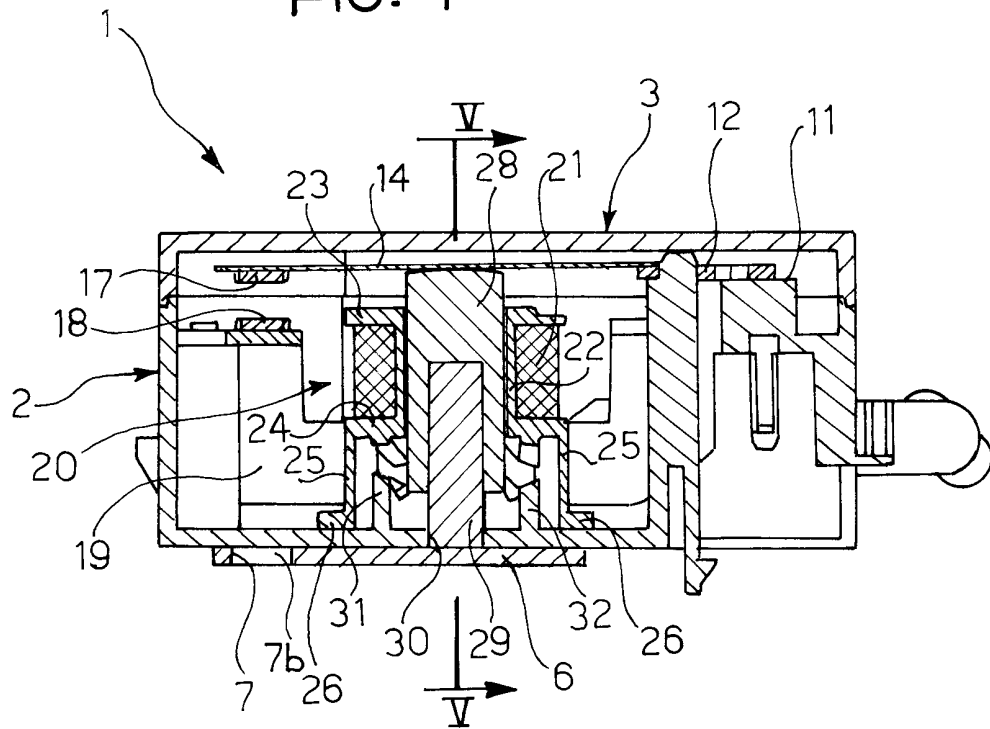


FIG. 5

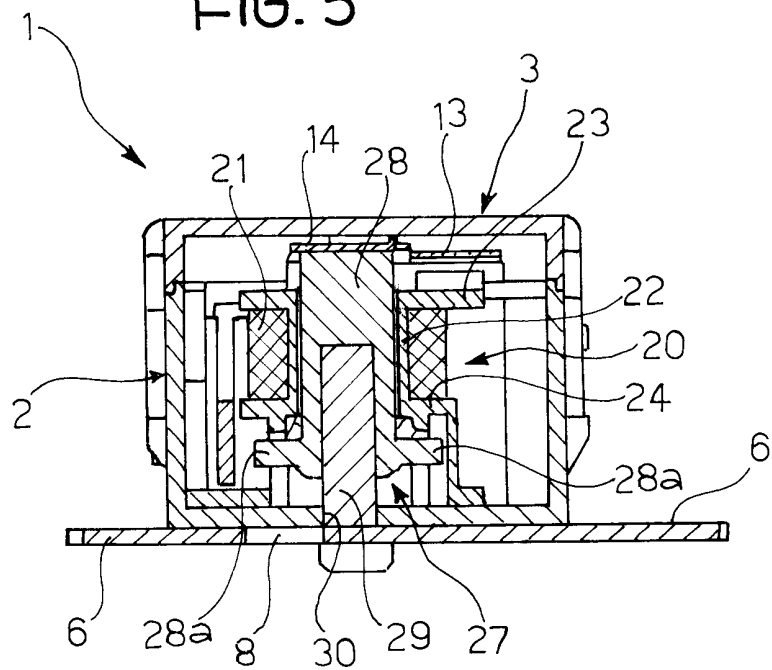


FIG. 4a

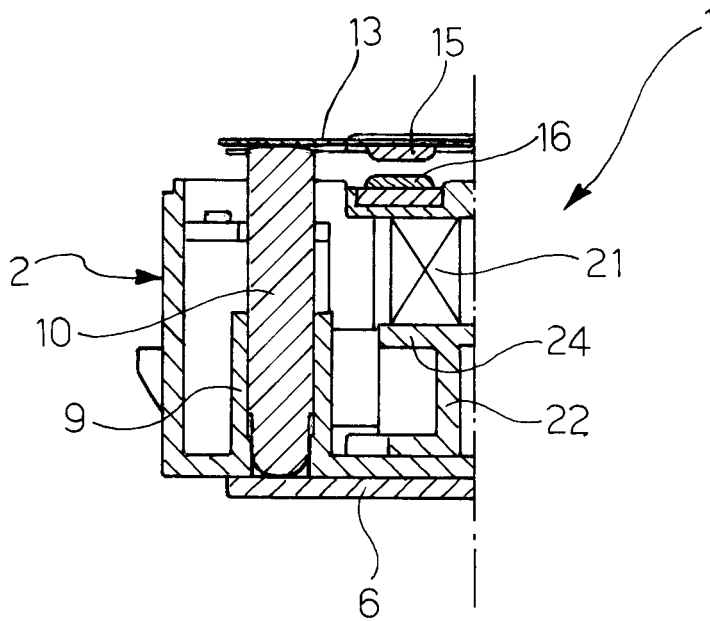


FIG. 6a

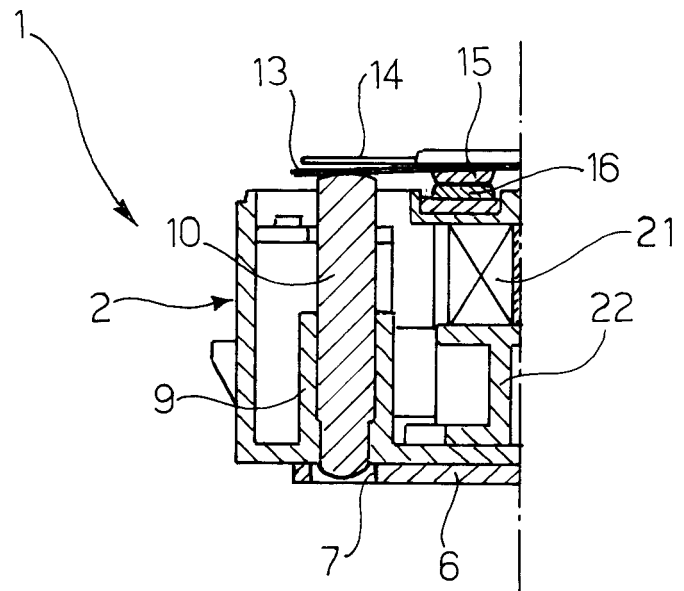


FIG. 6

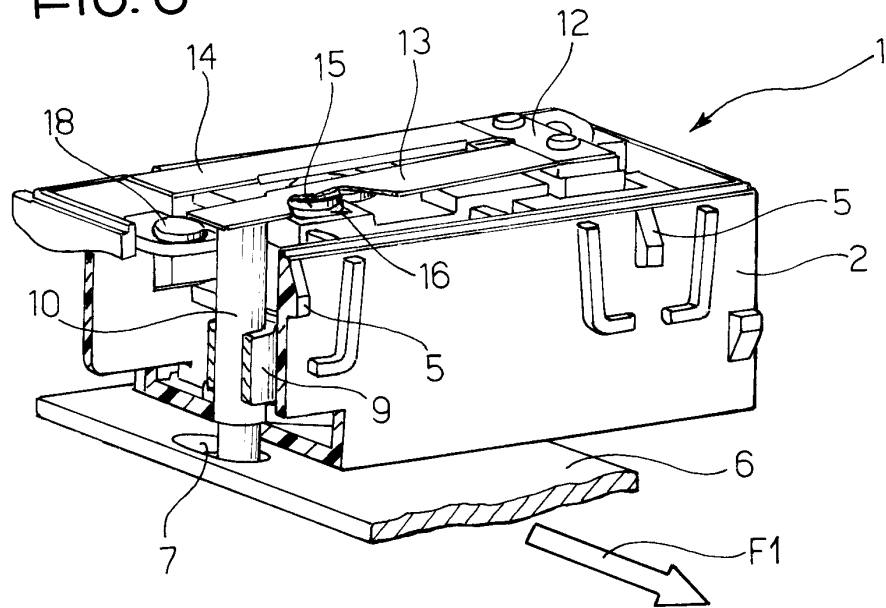


FIG. 8

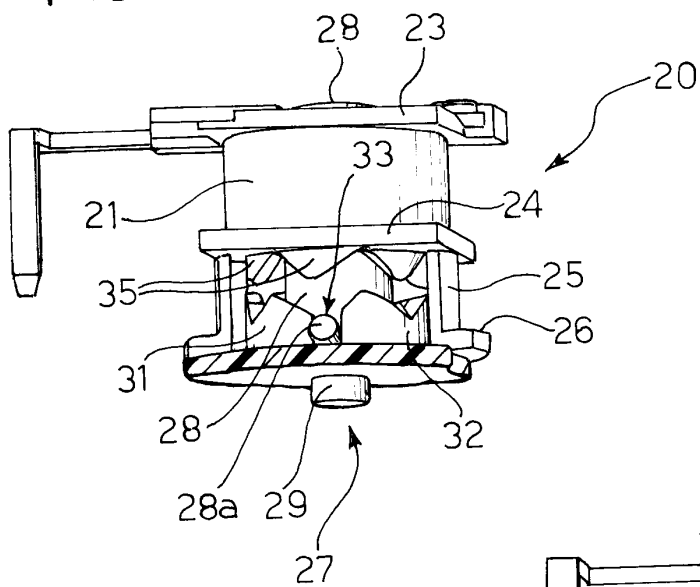


FIG. 7

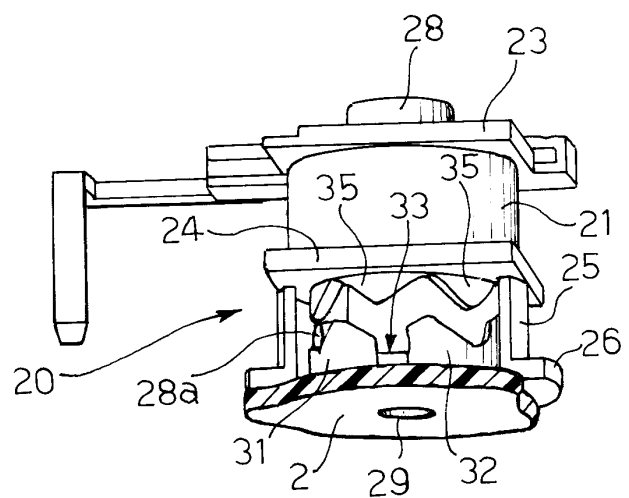


FIG. 9

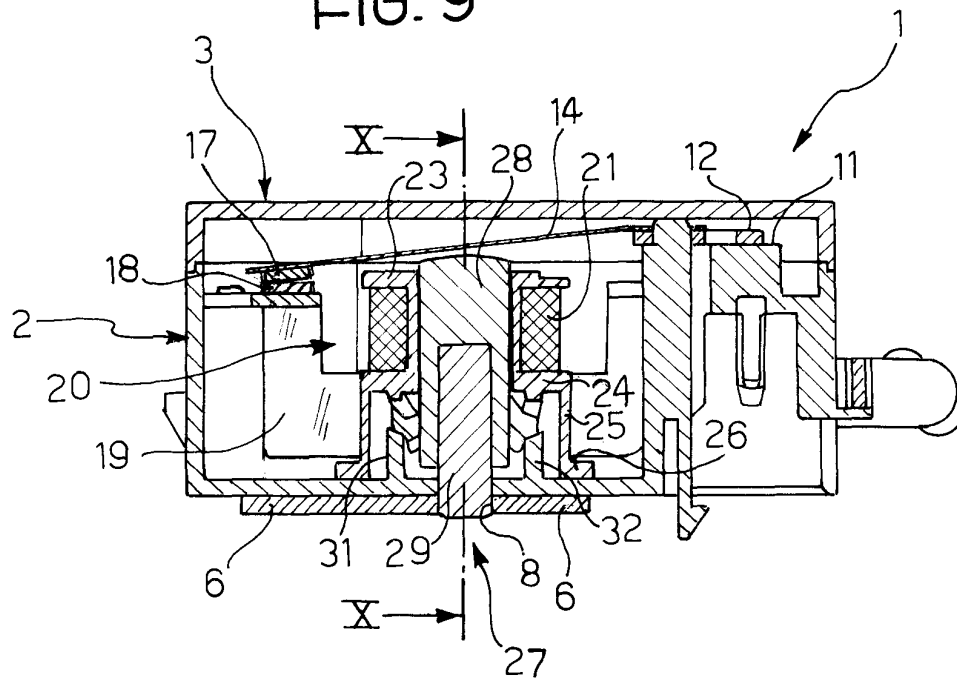


FIG. 10

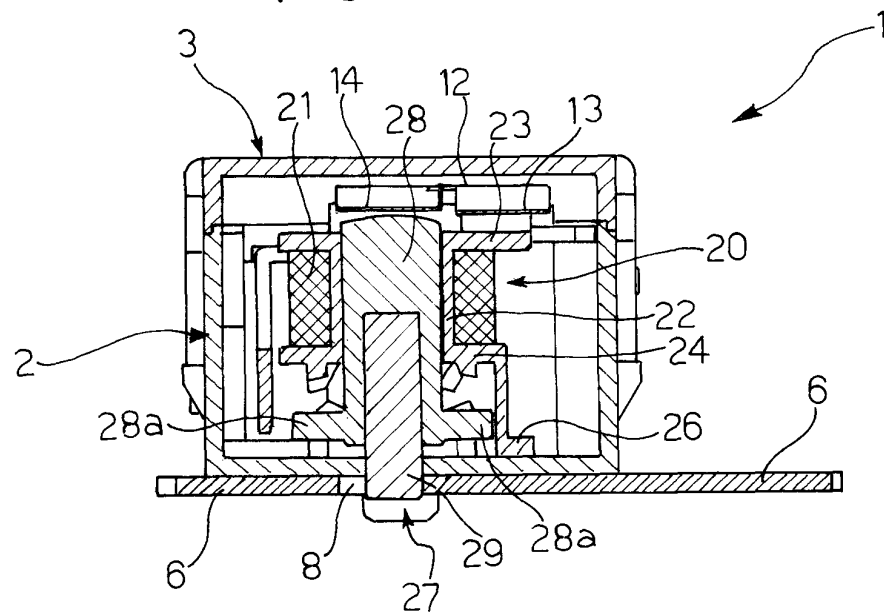


FIG 11

