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(54) **Device for locking and unlocking a door of an electric household appliance**

(57) The device (1) comprises:
a support casing (2) with an opening (5) for the introduction of a hook member (A) connected to the door (P),
a retaining member (6) movable between a rest position in which it allows the introduction of the hook member (A) into the opening (5) and a working position in which it is adapted to retain the hook member (A) introduced into this opening (5);
a locking device including a locking member (9) movable between a disengaged position and an engaged position, in which it is adapted to allow and prevent, respectively, the passage of the retaining member (6) from the working position to the rest position, and control means (20 to 34) which are electrically activatable and are adapted to control the position of the locking member (9); and
an electric switch (10) with an opposing contact (11) and a movable contact (13), the latter being carried by a first flexible conductive blade (14), mounted in the casing (2), the blade (14) being coupled to the locking member (9) in such a way that the blade causes the switch (10) to be closed when the movable locking member (9) is in the engaged position, in which it prevents the door (P) from being opened.

The opposing contact (11) is movable between a position close to and a position remote from the movable contact (13), and the control devices (20 to 34) are also coupled to the opposing contact (11) and are adapted to control the position thereof in such a way that, when they cause the locking member (9) to pass from the engaged position to the disengaged position, they also cause the opposing contact (11) to pass from the position close to the movable contact (13) to the position remote from the latter, thus contributing to the opening of the switch (10).

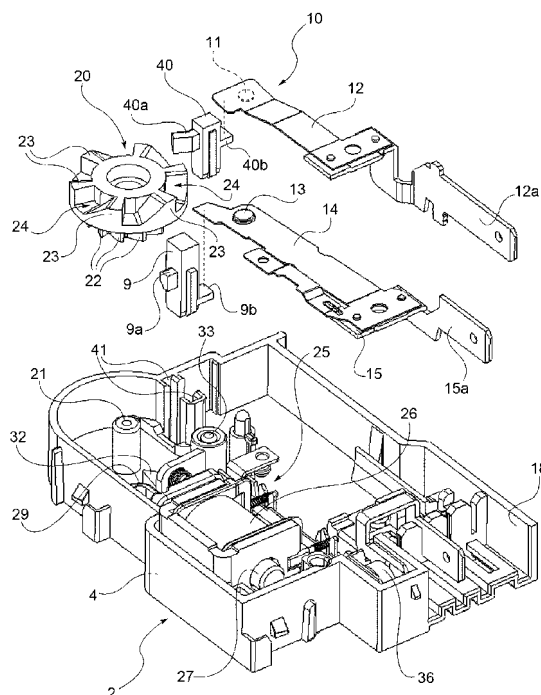


FIG. 5

Description

[0001] The present invention relates to a device for locking and unlocking a door of a household appliance such as a washing machine or a washer-drier.

[0002] United States Patent US 6 334 637 B1 held by the present applicant discloses a device of this type, comprising a support casing with an opening for the introduction of a hook member connected to the door, and with a retaining member or slider which is movable with respect to the casing between a rest position in which it allows the introduction of the hook member into the opening and a working position in which it can retain the hook member introduced into the opening. The device disclosed in this United States Patent further comprises a locking member which is movable between a disengaged position and an engaged position, in which it can allow and prevent, respectively, the passage of the retaining member or slider from the working position to the rest position, and an electrically activatable control device for controlling the position of this locking member.

[0003] This locking and unlocking device further comprises an electric switch including a fixed contact and a movable contact. The latter is carried by a flexible metal blade which is coupled to the locking member in such a way that it can cause the switch to close when the locking member is in the engaged position in which it prevents the door from opening.

[0004] In a prior art locking and unlocking device of this type, a situation may arise in which the pressure of the movable member or slider on the movable locking member causes this member to be retained in its extended position, in which the door is locked. If this situation arises in the prior art device, not only does the door remain locked in the closed position, but the aforesaid switch also remains closed. Since this switch controls the supply of power to various devices in the household appliance, this situation may lead to a risk of overheating, and in exceptional circumstances may cause a fire to start.

[0005] One object of the present invention is to provide a device for locking and unlocking the door of a household appliance which enables the aforementioned drawback of the prior art devices to be overcome.

[0006] This object is achieved according to the invention by means of a locking and unlocking device whose salient features are defined in the attached Claim 1.

[0007] Further characteristics and advantages of the invention will be made clear by the following detailed description, provided purely by way of non-limiting example, with reference to the appended drawings, in which:

Figure 1 is a front view of a locking and unlocking device according to the invention,
 Figure 2 is a side view of the device of Figure 1;
 Figure 3 is a cross section, on an enlarged scale, taken along the line III-III of Figure 2;
 Figure 4 is a perspective view of the part of the locking device shown in Figure 3;

Figure 5 is a further perspective view, in partially exploded form, of the part of the device shown in Figure 3;

Figure 6 is a further perspective view of the part of the device shown in Figures 3 to 5; and

Figures 7 to 9 are partial views showing part of the device according to the invention in three different operating conditions.

[0008] In Figures 1 and 2, the number 1 indicates the whole of a locking and unlocking device according to the invention.

[0009] This device comprises a support casing 2, made of electrically insulating material, intended to be fastened to the structure of a household appliance, in the proximity of a loading or access opening which has an associated door P (Figure 2) provided in a known way with a hook member A. In the embodiment shown by way of example, the support casing 2 is formed by two half shells 3 and 4, joined together (Figure 2).

[0010] As shown in Figure 1, the casing 2 of the device 1 has an opening 5 for the introduction of the hook member A carried by the door.

[0011] A retaining member or slider 6, provided with a window-like opening 7 through which the hook member A can pass, is mounted slidably in the support casing 2 of the device 1.

[0012] When the door P is open (Figure 2), the retaining member 6 is held (by an associated spring which is not shown) in a rest position (Figure 1) in which its window 7 faces the opening 5 of the casing 2. In this condition, the hook member A of the door can be introduced into the opening 5 and into the window 7 when the door is closed, and, conversely, can be disengaged from this window and from this opening when the door is opened.

[0013] As shown in Figure 1, when the retaining member or slider 6 is in the rest position it covers an opening 8 formed in the upper half shell 3 of the supporting casing 2, in which a locking member 9 extends in a translatable way.

[0014] In a known way, the arrangement is such that, when the door is closed, the hook member A engages in the opening or window 7 of the retaining member or slider 6, and causes the latter to be translated (towards the right as seen in Figure 1) in such a way as to uncover the opening 8.

[0015] With reference to Figure 3, a switch indicated in a general way by 10 is positioned in the lower half shell 4 of the casing 2. This switch comprises an opposing contact 11 carried by a shaped flexible metal blade 12, of which one end 12a is shaped in the form of a flat pin which acts as a connecting terminal and extends into a recessed seat 18 of the support casing (Figures 3 to 6).

[0016] The switch 10 further comprises a movable contact 13 (Figures 3 and 6 to 9) carried by the upper face of an end of a metal blade 14, the other end of which is positioned above a shaped metal member 15 (Figures 3 and 5), together with which it is permanently fastened to

the support casing, by means of a rivet 16 for example (Figure 3).

[0017] The end of the blade 14 which carries the movable contact 13 extends under the opposing contact 11.

[0018] The blades 12 and 14 are made and mounted in such a way that they tend to urge the respective contacts 11 and 13 towards the bottom wall of the half shell 4 of the support casing.

[0019] The end of the blade 14 which carries the movable contact 13 engages and bears on a lateral fin 9b of the locking member 9, as shown for example in Figures 3, 5 and 7 to 9. Consequently, the blade 14 tends to urge the locking member 9 into the lowered position shown in Figure 7, in which this locking member 9 is in the disengaged position and does not protrude beyond the opening 8 of the casing, and therefore allows the door P to be opened.

[0020] The metal connecting member 15 forms an appendage or end 15a (Figure 3 and 5) shaped in the form of a flat pin, which extends into the seat 18 of the support casing and acts as a connecting terminal.

[0021] As shown for example in Figure 5, the locking member 9 has a transverse appendage 9a on the side opposite the blade 14. This appendage interacts, as detailed below, with a cam or toothed profile 23 of a toothed wheel 20 mounted rotatably in the support casing 2 about a pivot 21, adjacently to the locking member 9.

[0022] The toothed wheel 20 is conveniently made of plastic material. It can be made in one piece or, for simplicity of moulding, can be made in two parts which are bonded or otherwise fixed together.

[0023] The lower portion of the wheel 20 has toothing in the form of sawteeth 22, while the upper portion of this wheel has a plurality of cams or frontal teeth 23 which are spaced apart angularly with intervals 24 between them (Figure 5).

[0024] In a preferred embodiment, the teeth 23 have a profile in the form of a rectangular trapezium, with one side or flank inclined and the other side or flank at a right angle.

[0025] In the embodiment illustrated by way of example, the wheel 20 has twelve sawteeth 22 and six upper teeth 23. The pitch of the teeth 23 is equal to two adjacent sawteeth 22.

[0026] The arrangement is such that, when the radial appendage 9a of the locking member 9 extends on to the top of a cam or tooth 23 of the wheel 20, the locking member 9 is urged into the raised engaged position and held there against the action of the blade 14, as shown in Figure 7.

[0027] However, when the wheel 20 presents an interval 24 between two consecutive teeth or cams 23 to the radial appendage 9a of the locking member 9 as a result of an angular movement, the locking member 9 can pass into the retracted disengaged position, under the action of the blade 14, as shown in Figure 7.

[0028] In Figure 3, the number 25 indicates the whole of an electrically operated actuator. In the embodiment

illustrated by way of example, this actuator comprises a coil or solenoid 26 in which a core 27 is mounted in an axially translatable way, one end of the core being connected to a rod 28. The end of the rod 28 opposite the core 27 bears on a shaped member indicated as a whole by 29. This member has in its median part a slotted opening 30 in which there extends a fixed stud or pin 31 integral with the support casing of the device.

[0029] The end 29a of the member 29 which is opposite the actuator 25 is shaped in the form of a catch and engages between a pair of consecutive sawteeth 22 of the toothed wheel 20.

[0030] The number 32 indicates a pawl which is mounted so that it can oscillate about a fixed pivot 33 and is also engaged between a pair of consecutive sawteeth of the toothed wheel 20, by the force of a coil spring 34 which is interposed between this pawl and the end of the shaped member 29 adjacent to the actuator 25.

[0031] The arrangement described above is such that, whenever the actuator 25 is energized, the core 27 is translated (upwards as shown in Figure 3) and, by means of the rod 28, causes a movement of the shaped member 29, which in turn causes the toothed wheel 20 to rotate through one step, in other words through an angular distance corresponding to one sawtooth 22. Having completed this angular movement, the pawl 32 again stabilizes the angular position of the wheel 20.

[0032] In a known way, a positive temperature coefficient (PTC) resistor, indicated by 36 in Figures 3 and 4, is connected in series with the winding or coil 26 of the actuator 25. This resistor advantageously enables the current supplied by the coil 26 of the electromagnetic actuator 25 to be limited automatically whenever the duration of the supply of this current exceeds a predetermined period. By using the PTC resistor 36, therefore, it is possible to use an electromagnetic actuator 25 having a small and relatively economical coil 26.

[0033] With particular reference to Figure 5, the blade 12 which carries the opposing contact 11 is coupled to an actuating member 40 mounted in a vertically translatable way in the casing 2 along two opposing guides 41 provided in the lower half shell 4 of the casing 4.

[0034] The actuating member 40 also has an essentially transverse appendage 40a, which interacts with the control profile 23, 24 of the toothed wheel 20. On its other side, the actuating member 40 has a projection 40b which engages under the distal end of the blade 12 which carries the opposing contact 11.

[0035] The arrangement is such that, when the appendage 40a of the actuating member 40 bears on the top of a tooth or cam 23 of the toothed wheel 20, as shown in Figure 7, the projection 40b of the actuating member 40 places the blade 12 and its associated opposing contact 11 in a position remote from the movable contact 13 (Figure 7). Conversely, when the appendage 40a of the actuating member 40 bears on an indentation 24 between two consecutive teeth or cams 23 of the wheel 20, it allows the blade 12 and the associated opposing con-

tact 11 to assume a position relatively closer to the movable contact 13 (Figure 8).

[0036] The locking member 9 and the actuating member 40 are preferably positioned in such a way that, when one of them is raised by the interaction of its transverse appendage 9a or 40a with the cams or teeth 23 of the wheel 20, the other is lowered, under the action of the associated blade 12 or 14, with its appendage 40a or 9a extending in a recess 24 formed between two consecutive cams 23 of the toothed wheel 20 (Figures 7 and 8).

[0037] The locking and unlocking device described above operates in the following manner.

[0038] When the door P is open, the locking and unlocking device is in the condition shown in Figures 1, 2 and 7: the locking member 9 is "covered" by the retaining member or slider 6 (Figure 1) and is held in the retracted disengaged position by the action of the associated blade 14 which bears on the transverse appendage 9a of this member (Figure 7). On the other hand, the actuating member 40 is held in the raised position by the engagement of its appendage 40a with the top of a cam or tooth 23 of the wheel 20, and therefore holds the blade 12 and the opposing contact 11 in a position remote from the movable contact 13. In this condition, the switch 10 is therefore open (the switch is of the "normally open" type).

[0039] When the door P is closed, as mentioned above, the slider 6 is translated and "uncovers" the locking member 9. In this stage, however, the locking member 9 is retained in the retracted position of disengagement from the associated blade 14, and therefore remains in the same position as in the preceding stage.

[0040] When the user of the household appliance puts the appliance into operation, a control unit of the appliance causes the actuator 25 to be energized in a known way. As a result of this energization, the member 29 causes the toothed wheel 20 to rotate through a distance equal to the angular extension of one tooth 22 of this wheel. The wheel is then in the position shown in Figure 8, in which the upper portion of the wheel presents the top of a trapezoidal tooth or cam 23 to the radial appendage 9a of the locking member 9. Consequently, the locking member 9 is in the extended engaged position (Figure 8). In this condition, the actuating member 40 assumes its lowered position in which it causes the blade 12 and the associated opposing contact 11 to be in a position relatively closer to the movable contact 13. This is because the raising of the locking member 9 causes the blade 14 and the associated movable contact 13 to be raised as well, and the contact 13 then engages with the opposing contact 11. The switch 10 is therefore closed.

[0041] With the locking member 9 in the extended position, the return of the retaining member or slider 6 to the rest position, in which it allows the door P to be opened, is prevented.

[0042] On completion of the operating cycle of the household appliance, the control unit of the appliance causes two successive energizing pulses to be sent to the coil 26 of the electromagnetic actuator 25, to allow

the door to be opened. Consequently, the toothed wheel 20 is made to rotate through a distance corresponding to the extension of two of its sawteeth 22. This rotation causes the radial appendage 9a of the locking member 9 to engage in a new recess 24 formed between two consecutive trapezoidal teeth or cams 23 of this wheel. The locking member 9 is therefore returned, under the action of the associated blade 14, to the retracted or disengaged position shown in Figure 7, in which it again allows the retaining member or slider 6 to return to the position in which it allows the door to be opened.

[0043] The actuating member 40 is simultaneously returned to the raised position, causing the blade 12 and the opposing contact 11 to pass to a position remote from the movable contact 13.

[0044] Thus, when the locking member 9 is returned in the aforesaid manner to the retracted disengaged position, the switch 10 is simultaneously opened.

[0045] Because of the two energization pulses required to allow unlocking, the operation of the device described above is particularly reliable and prevents the unlocking from being enabled as a result of any undesired energization of the actuator 25, due to the reception of electromagnetic interference for example. Furthermore, the device can easily be modified in such a way that only one energization pulse for the electromagnetic actuator 25 is required for unlocking.

[0046] With the device according to the invention described above, if the toothed wheel 20 is operated by a control pulse sent to the coil 26 so as to urge the locking member 9 towards the extended position while the door P is open (and therefore while the slider 6 obstructs the opening 8 and prevents any outward movement of the locking member 9), the member 9, being locked by the slider 6, opposes this rotation of the toothed wheel, thus locking the mechanism in its existing position. After the end of the aforesaid pulse for causing the wheel 20 to rotate, this wheel 20 remains in the position which it occupied previously, and continues to allow the locking member 9 to be retained in the retracted condition (the disengaged position) of the associated blade 14.

[0047] Therefore, when the door P is subsequently closed, a new control pulse must be applied to the solenoid 26 in order to actuate its locking.

[0048] In a locking and unlocking device according to the prior art, when the locking member is in the extended engaged position and locks the member or slider, the frictional coupling between these members may be such that, after one or more pulses have been sent to the solenoid or coil of the electromagnetic control actuator to cause unlocking, the locking member fails to depart from the extended position and remains in this position, thus locking the slider and the door in the closed position.

[0049] With a locking and unlocking device according to the invention, this drawback is substantially overcome because of the presence of the actuating member 40, which is coupled in the way described above to the blade 12 which carries the opposing contact 11.

[0050] In the situation described above, in which the locking member 9 continues to be retained in the locking position because of the pressure of the retaining slider 6 on it, a rotation of the toothed wheel 20 causes a passage from the configuration of Figure 8 (where the door is closed and locked) to the configuration of Figure 9: in the latter configuration, the actuating member 40 is raised by the engagement of its appendage 40a with a trapezoidal tooth or cam 23 of the toothed wheel 20, and causes the blade 22 and the opposing contact 11 to be placed in a position remote from the movable contact 13. This automatically causes the switch 10 to open, thus interrupting the power supply to the machine, which is therefore put into a safe condition. However, it does not cause the door P to be unlocked, although the door can be unlocked if necessary as soon as the user operates the door manually for the purpose of opening it, thereby resolving the situation in which the movable slider 6 presses on the locking member 9.

[0051] Naturally, the principle of the invention remaining the same, the forms of embodiment and the details of construction may be varied widely with respect to those described and illustrated, which have been given purely by way of non-limiting example, without thereby departing from the scope of the invention as defined by the attached claims.

Claims

1. Device for locking and unlocking a door (P) of a household appliance, comprising
 - a support casing (2) with an opening (5) for the introduction of a hook member (A) connected to the door (P),
 - a retaining member (6) mounted movably with respect to the casing (2) between a rest position in which it allows the introduction of the hook member (A) into the opening (5) and a working position in which it is adapted to retain the hook member (A) introduced into the opening (5);
 - locking means including a locking member (9) movable in the casing (2) between a disengaged position and an engaged position, in which it is adapted to allow and prevent, respectively, the passage of the retaining member (6) from the working position to the rest position, and control means (20 to 34) which are electrically activatable and are adapted to control the position of the locking member (9); and
 - an electric switch (10) including an opposing contact (11) and a movable contact (13), the latter being carried by a first flexible blade (14) of an electrically conductive material, mounted in the support casing (2), the blade (14) being coupled to the locking member (9) in such a way that the blade (14) causes the switch (10) to be closed when the movable locking member (9) is in the aforesaid engaged position, in which it prevents the door (P) from being opened;

characterized in that the opposing contact (11) is mounted movably in the casing (2) between a position close to and a position remote from the movable contact (13), and **in that** the control means (20 to 34) are also coupled to the opposing contact (11) and are adapted to control the position thereof in such a way that, when the control means (20 to 34) cause the locking member (9) to pass from the engaged position to the disengaged position, they also cause the opposing contact (11) to pass from the position close to the movable contact (13) to the position remote from the latter, thus contributing to the opening of the switch (10); the arrangement being such that, when the locking member (9) is retained in the engaged position after the control means (20 to 34) have operated to cause the door (P) to be unlocked, the opposing contact (11) is in all cases brought to the position remote from the movable contact (13), thus causing the opening of the switch (10).

2. Device according to Claim 1, wherein the aforesaid control means comprise:

an electrically controlled actuator (25, 26) adapted, each time it is energized, to cause the rotation by a predetermined amount of a toothed wheel (20) mounted rotatably in the casing (2) and having a predefined control profile with specified cams or teeth (23), coupled to the locking member (9); the arrangement being such that successive activations of the actuator (25, 26) tend to make the toothed wheel (20) assume at least one first angular position and one second angular position, respectively, in which the control profile (23) frees and urges, respectively, the locking member (9), thus allowing it to remain in the disengaged position and keeping it in the engaged position, respectively.

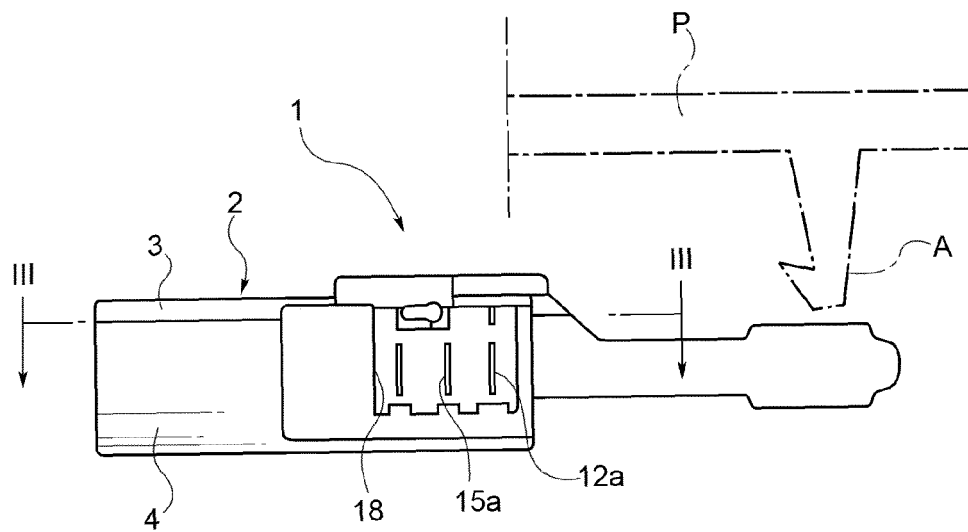
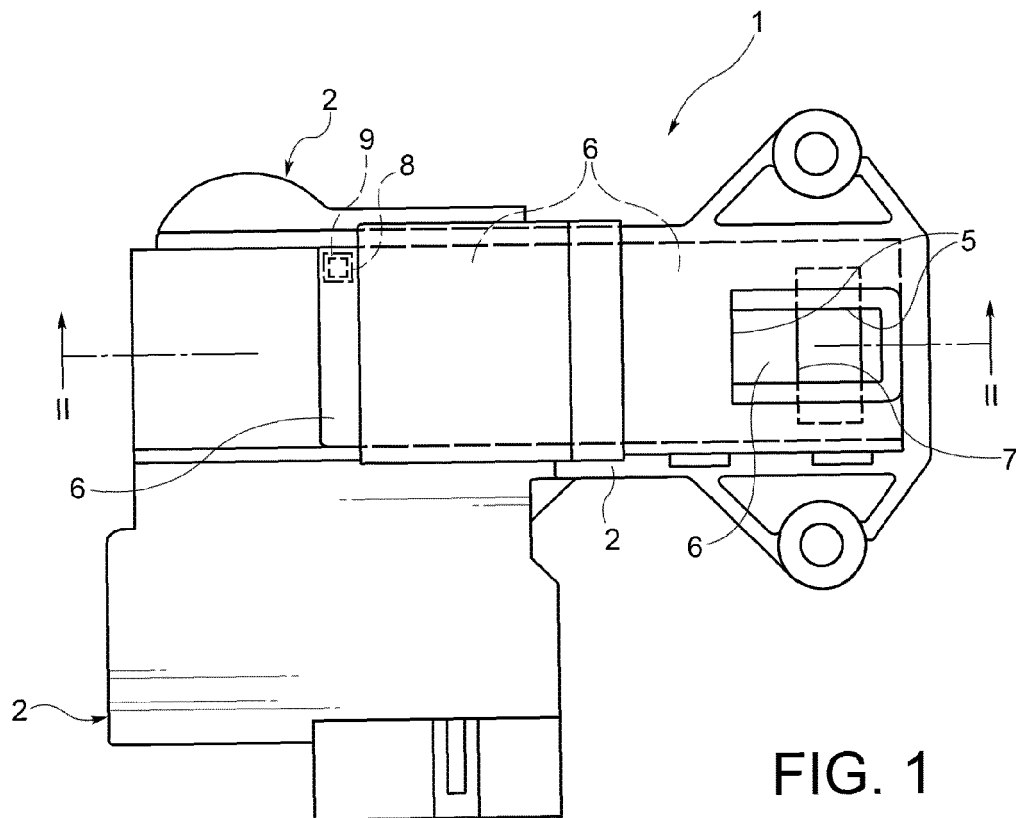
3. Device according to Claim 2, wherein the opposing contact (11) is carried by a second flexible blade (12) of an electrically conductive material, mounted in the support casing (2); the second blade (12) being coupled to a control member (40) mounted movably in the casing (2) and likewise coupled to the control profile (23) of the toothed wheel (20), such that a passage of the toothed wheel (20) from the first position to the second position, and from the second position to the first position, respectively, causes a passage of the second blade (12) and the opposing contact (11) associated therewith from a position remote from the movable contact (13) to a position close thereto, and from a position close to the movable contact (13) to a position remote therefrom, respectively.

4. Device according to Claim 2 or 3, **characterized in that** the toothed wheel (20) has a ring of angularly equi-spaced sawteeth (22), interacting with a hook-shaped end (29a) of a control member (29) mounted movably in the support casing (2) under the action of the actuator (25); the arrangement being such that each energization of the actuator (25) causes, through the control member (29), a rotation of the toothed wheel (20) through a distance corresponding to one tooth (22) of the ring of sawteeth.
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5. Device according to Claim 4, **characterized in that** the control profile (23) of the toothed wheel (20) has a number of cams or teeth (23) such that at least one energization of the actuator (20) is necessary to make the toothed wheel (20) pass from the second position to the first position.
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6. Device according to Claim 5, **characterized in that** the control profile of the toothed wheel (23) has a number of cams or teeth (23) such that at least two successive energizations of the actuator (25) are necessary to make the toothed wheel (20) pass from the second position to the first position.
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- 25
7. Device according to any of Claims 4 to 6, **characterized in that** the toothed wheel (20) has the control profile (23) on the side opposite the ring of sawteeth (22)
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8. Device according to any of Claims 4 to 7, **characterized in that** the toothed wheel (20) has an associated swinging stabilizing pawl (32) engageable between two consecutive teeth (22) of the ring, under the action of associated resilient means (34) tending to urge it towards the toothed wheel (20).
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9. Device according to any of the preceding claims, **characterized in that** the actuator (25) comprises a solenoid (26) and an associated movable core (27).
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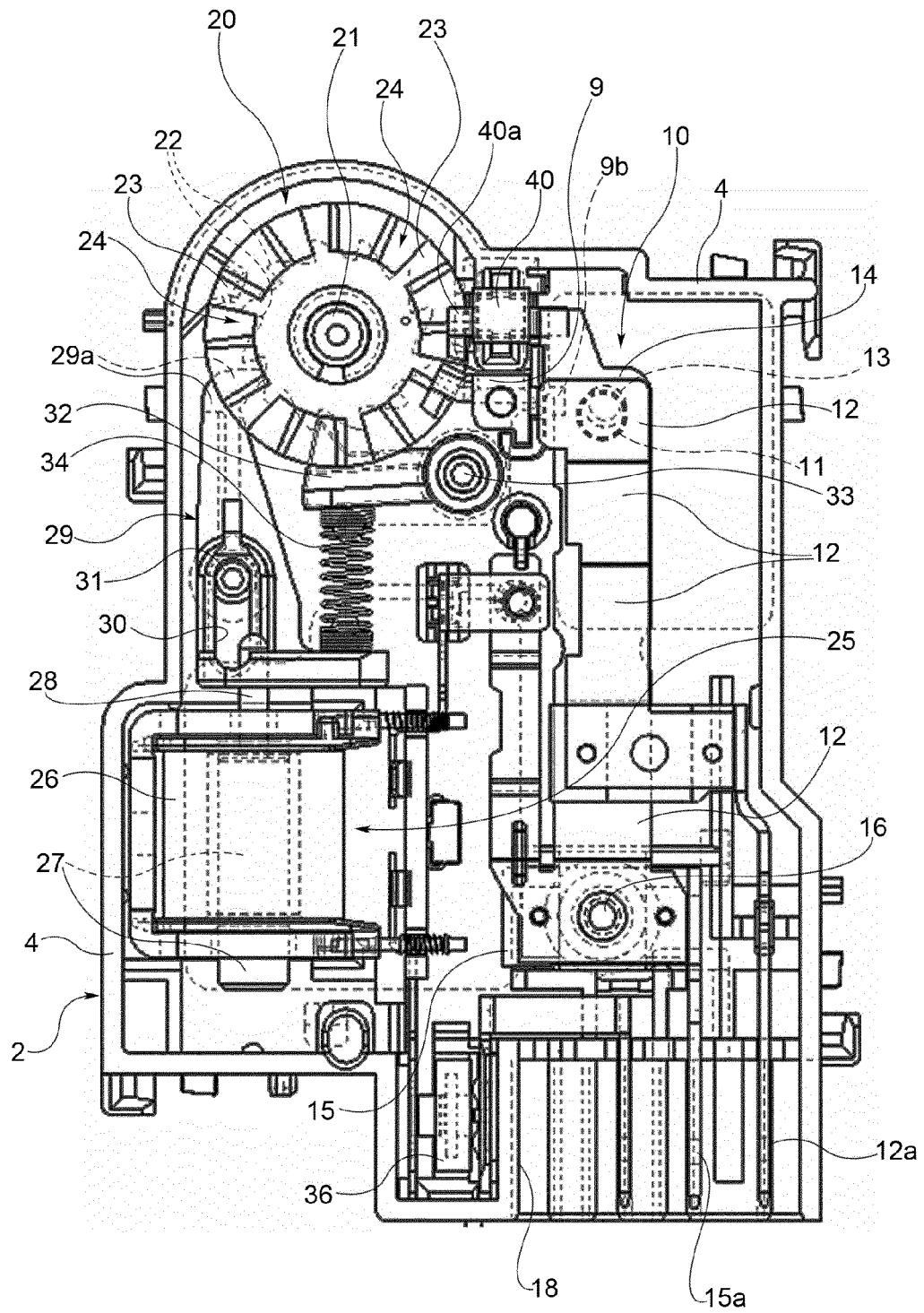


FIG. 3

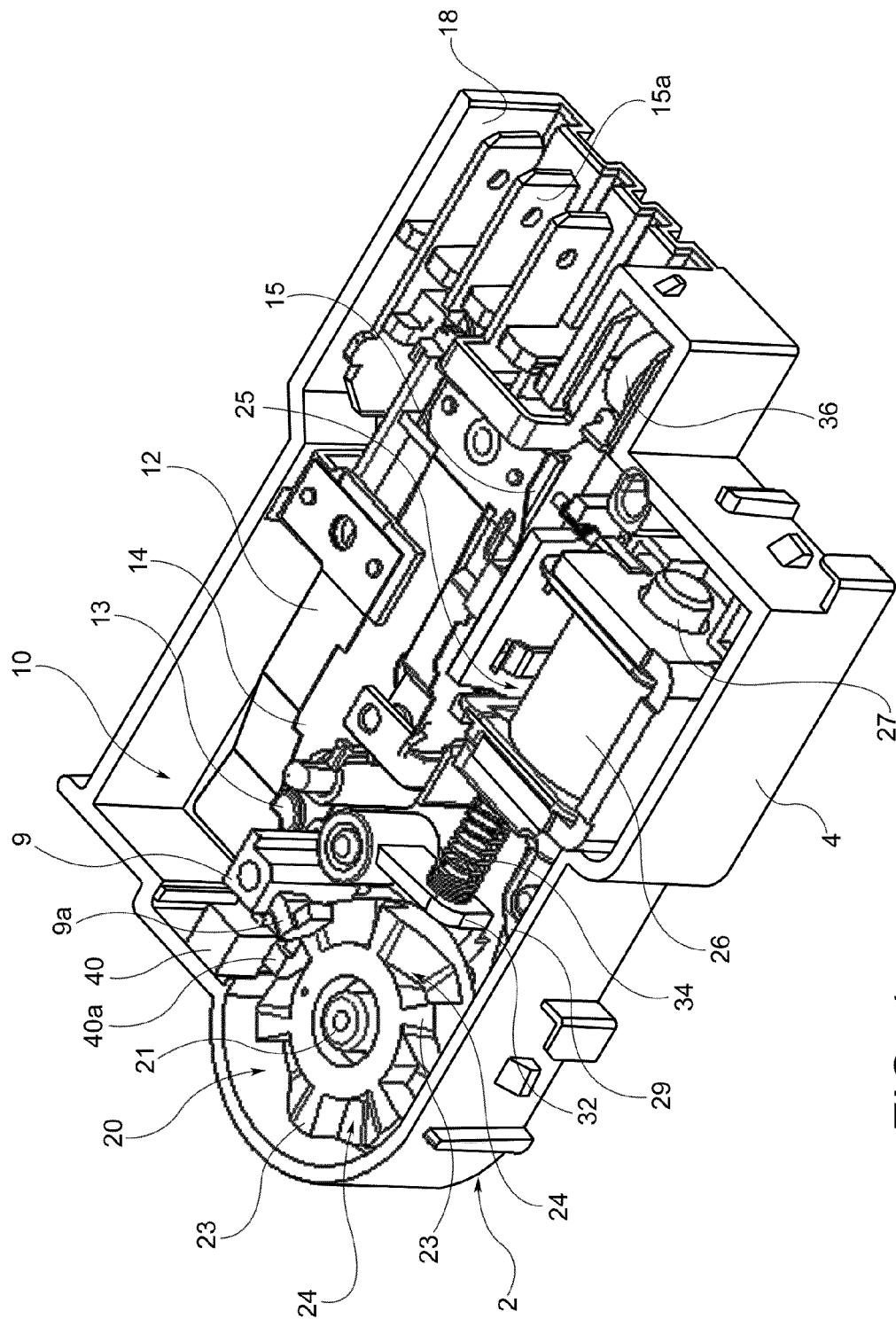


FIG. 4

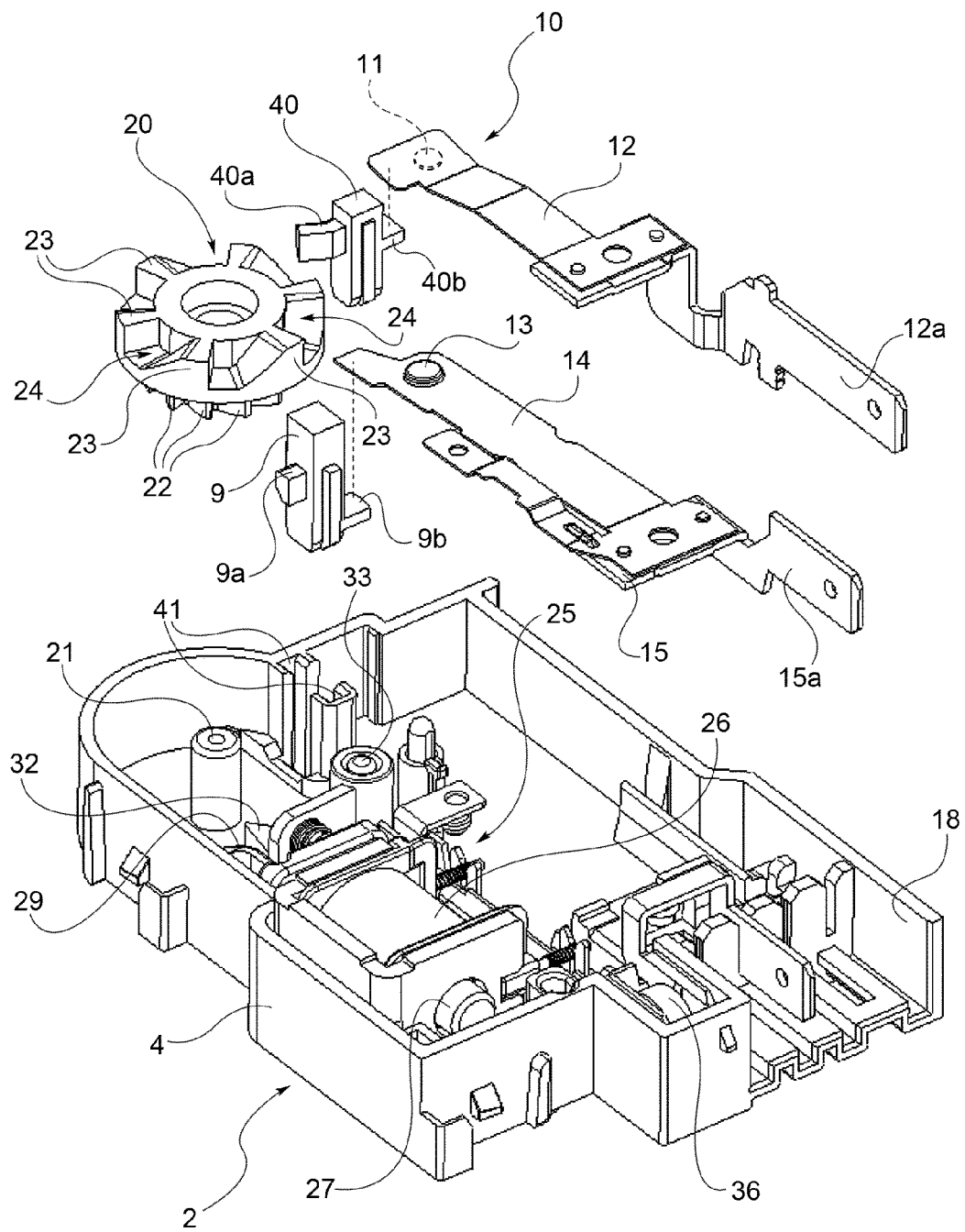


FIG. 5

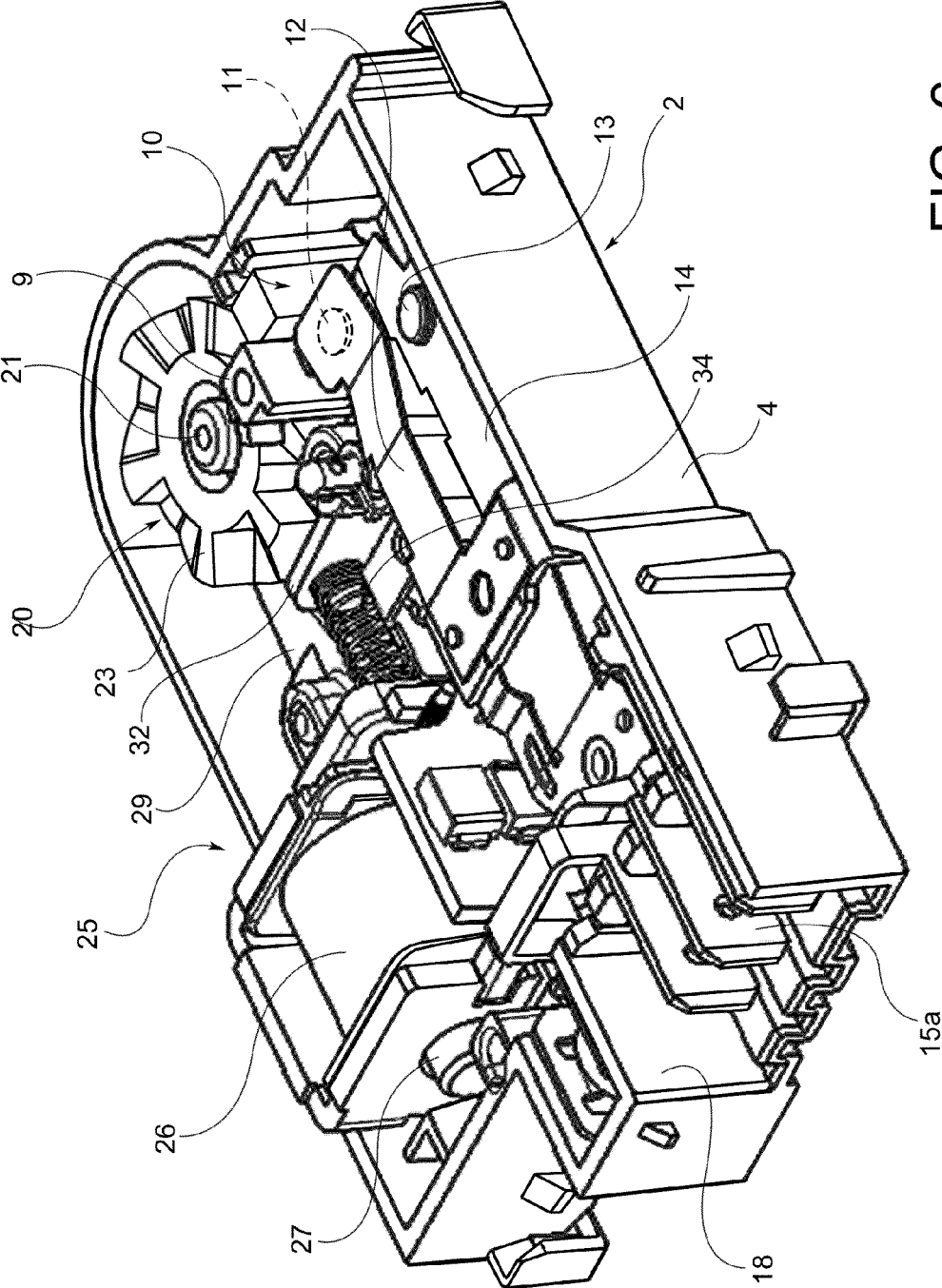
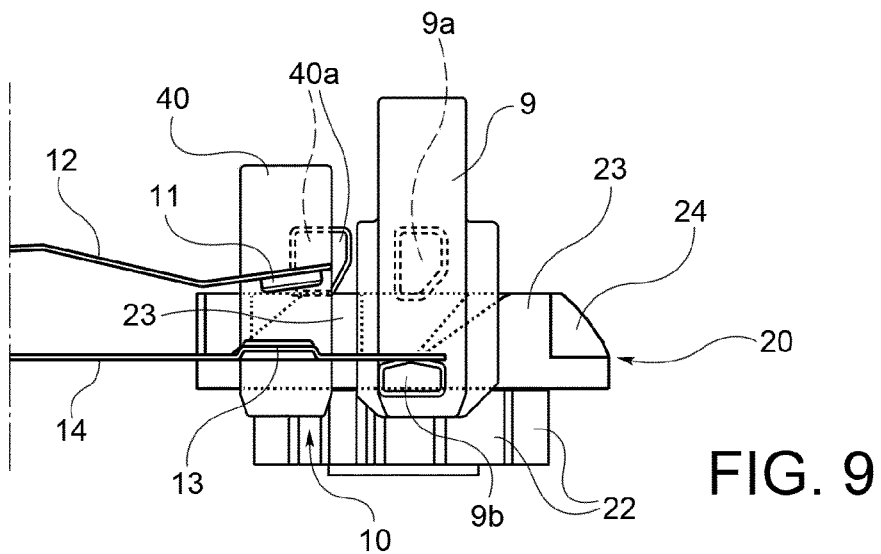
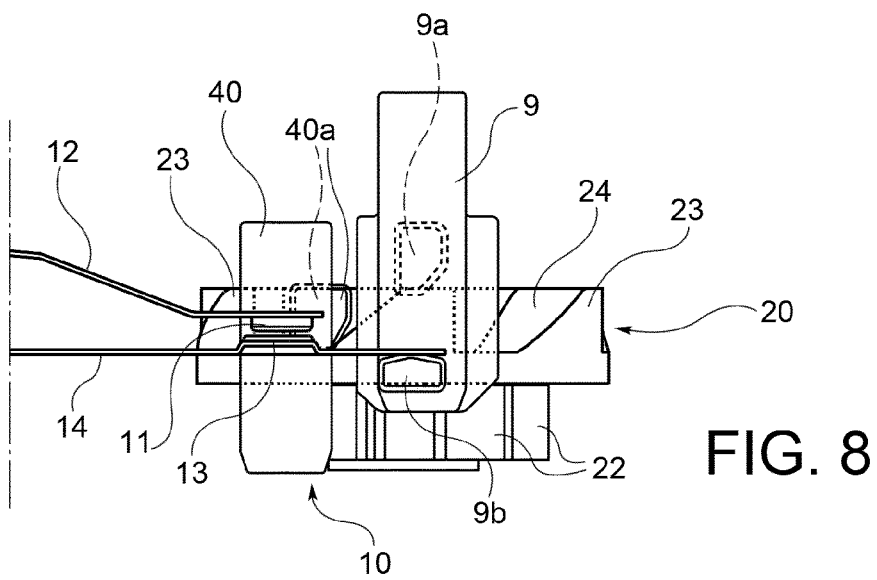
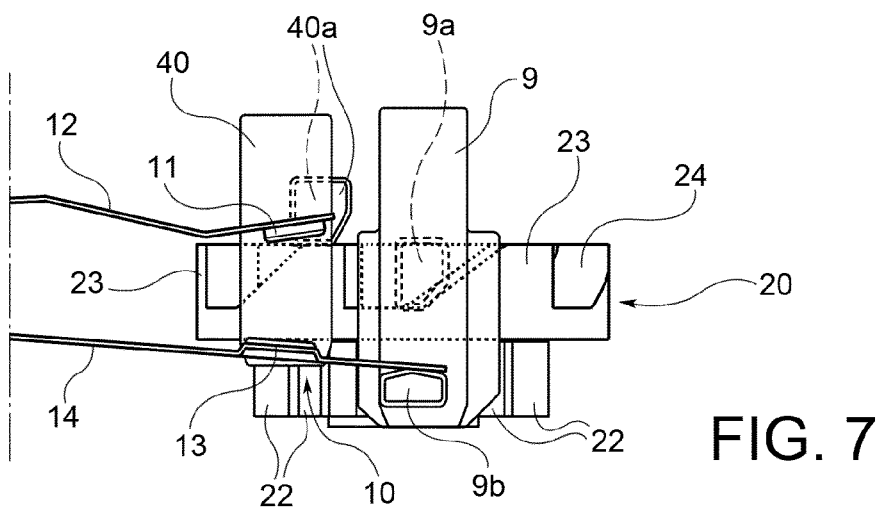


FIG. 6





EUROPEAN SEARCH REPORT

 Application Number
EP 12 17 3182

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Place of search Munich		Date of completion of the search 15 October 2012	Examiner Fachin, Fabiano
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 12 17 3182

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