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(54) **Door locking device for household appliances and bistable mechanism**

(57) The invention relates to a door actuation and/or locking device (1,11) for household appliances, wherein a hook (5,50) movable into at least one condition of engagement with the door is locked into said condition by a cursor (60) associated with bistable latching means.

In particular, the cursor (60) has a body (62) with a central seat (67) that houses rotation and/or engagement

guides (68,69): the bistable latching means (65) comprise a rotatable pin (66) that cooperates with said guides (68, 69) to ensure that the cursor takes distinct positions of stable equilibrium (60).

The invention also comprises a bistable mechanism, in particular associated with the door locking device and/or to actuation means.

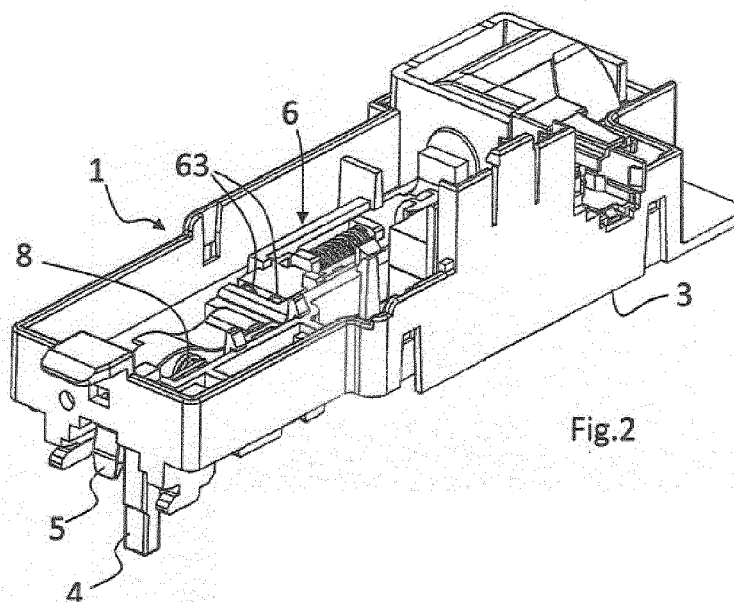


Fig.2

Description

[0001] The present invention relates to a door locking device for household appliances or the like.

[0002] Certain household appliances have doors that allow access to an inner cavity in which the appliance's typical functions are normally carried out.

[0003] Some examples of such household appliances are washing machines, dishwashers and the like.

[0004] When the appliance is in operation, it is often necessary to prevent access to the cavity in order to avoid that a user might be offended by the functions carried out by the appliance itself; this is preferably achieved by locking the door in the closed position.

[0005] To this end, devices have been conceived which are commonly called "door locks" and which are adapted to perform at least that function.

[0006] Many types of door locking devices exist, each having a different principle of operation. One of these types includes those devices wherein, as the door of the appliance approaches its closed position, a hook is moved to the locking position through a lever actuated by the door itself.

[0007] One example of this type of device is shown in patent EP2175200 to ELETTRONICA ROLD.

[0008] In this example the actuation lever, when moved by the door, actuates an electric motor, which in turn moves the hook into the closed condition.

[0009] The presence of an electric motor and of the associated kinematic systems, however, makes this solution rather complex and inadvisable from a cost viewpoint and in the light of the possible malfunctions that might jeopardize the appliance's functionality; these malfunctions are more likely to occur in such a complex solution.

[0010] In order to overcome this drawback, other solutions have been conceived wherein the hook is moved into the closed condition directly by the actuation lever, which is moved by the door as the latter is about to close the mouth of the cavity.

[0011] In one of these solutions, both the door-driven actuation lever and the hook are associated with inclined planes arranged on the hook end opposite to the one that must engage the door and on a slide connected to the actuation lever.

[0012] In short, as the door is approaching, the lever is moved and the slide connected thereto acts upon the hook, thereby rotating it into the door locking condition.

[0013] The locking of the door is obtained through a pin that engages into a hole obtained in the slide, thereby preventing it to slide; in this manner the slide, once locked in position, will not allow the hook to rotate and will therefore lock it into the door locking condition. Although functional, this solution still has some drawbacks.

[0014] A first problem relates to the fact that it cannot compensate for any extra door travels and/or door position tolerances, with the risk that the door might be locked improperly or not at all.

[0015] It should be taken into account that the doors of household appliances are typically made of moulded plastic, with rather large processing or dimensional tolerances; in addition to these, there are also assembly tolerances and tolerances caused by improper use (e.g. application of excessive force or accidental shocks during the life of the appliance).

[0016] In this case it is often observed that, as the door is being closed, it often does not reach or goes past the stop point predetermined in the design specifications.

[0017] This situation has a minimal impact when there is no actuation lever or when the latter acts as a switch push-button to control an electric motor.

[0018] However, if the lever actuates the hook directly, then this situation gives rise to several problems.

[0019] In fact, it is apparent that a door having a shorter or longer travel, i.e. stopping before or past a preset stop point, will cause an anomalous movement of the slide and consequently a misalignment of the hole in the latter with respect to the locking pin, with the dangerous consequence of preventing the locking of the hook.

[0020] Another drawback of this solution relates to the very accurate machining required by the inclined surfaces to ensure the correct hook movement, which affects production costs. A further drawback relates to wear; in fact, after a certain number of operating cycles the inclined surfaces may wear out, resulting in substantially worse operating conditions and exposing the device to the risk of seizure.

[0021] Another problem comes from the fact that these devices are typically housed in closed shells which cannot be opened for maintenance by a user; it follows that any dirt accumulated on the inclined planes contact interface cannot be easily removed and may cause the device to operate incorrectly.

[0022] Yet another problem comes from the fact that in other door locking devices an excessive travel past a predetermined stop point, e.g. due to dimensional or assembly tolerances, may even cause parts of the door locking devices to break.

[0023] The object of the present invention is to provide a door locking device for household appliances which can overcome these and other drawbacks.

[0024] This object is achieved through a device according to the appended claim 1.

[0025] The principle underlying the present invention is to provide a door locking device for a household appliance, which is suitable to engage into the closed position a door of an operational cavity of said household appliance, and which comprises a hook movable to at least one condition of engagement with said door and locking means cooperating with the hook to hold it in said engaged condition, wherein the locking means comprise at least one cursor and bistable latching means adapted to allow the cursor to take at least two distinct positions of stable equilibrium, as a result of the repetition of the same force of actuation of said cursor.

[0026] For this purpose, advantageously, the cursor

comprises at least one body provided with a seat that houses rotation and/or engagement guides; said bistable latching means comprise an engagement pin with a profiled head, preferably at least partly housed or delimited by said seat and rotatable relative to said cursor, which cooperates with said rotation and/or engagement guides to ensure that said cursor takes said at least two distinct positions of stable equilibrium, preferably as a result of a linear movement thereof.

[0027] In a preferred embodiment, which will be described below, the hook can be locked into a condition in which it engages the door through a slide which is separate from said lever, so that a movement of the latter deriving from an extra travel of the door will not impair the proper locking of the hook.

[0028] The invention further comprises a bistable mechanism which can be used in the door locking device and/or in actuation means or in other applications.

[0029] Further advantageous features of the present invention will be set out in the appended claims.

[0030] These features as well as further advantages of the present invention will become more apparent from the following description of an embodiment thereof shown in the annexed drawings, provided by way of non-limiting example and wherein:

Fig. 1 is a perspective view of a device according to the present invention;

Fig. 2 is a perspective view of the device of Fig. 1 without a portion of the housing shell;

Fig. 3 is a front perspective view of the device of Fig. 2;

Figs. 4 and 5 are perspective views of functional parts of the device of the preceding figures, respectively in a first and a second operating conditions;

Figs. 6 and 7 show the functional parts of the device of Figs. 4 and 5, from a different perspective in the same two operating conditions;

Figs. 8 and 9 show a detail of the device of the preceding figures, respectively in a first and a second operating conditions;

Figs. 10 and 11 show the detail of Figs. 8 and 9 together with another detail, respectively in a first and a second operating conditions;

Fig. 12 is an exploded view of the device of the preceding figures;

Figs. 13 to 15 are top views of the device of the preceding figures in three different operating conditions;

Figs. 16 to 18 are perspective views of the device of Figs. 13 to 15 in the same three different operating conditions;

Figs. 19 and 20 show a variant of the device of Figs. 4 and 5 from two different perspectives;

Fig. 21 is an exploded view of the variant of Figs. 19 and 20;

Fig. 22 shows a detail of a sliding locking element which is common to both variants of the preceding figures;

Fig. 23 shows the sliding locking element of the preceding figure;

Figs. 24 to 28 show the sliding locking element of Fig. 22 in different operating positions;

Fig. 29 shows an enlarged detail of Fig. 23.

[0031] With reference to the example shown in the annexed drawings, reference numeral 1 designates a door locking device according to a first embodiment of the present invention, as a whole.

[0032] In general, the device of the present invention can be used as a door lock for a household appliance, since it is adapted to lock into the closed position a door of an operational cavity of the appliance.

[0033] For this purpose, in the example shown in Figs. 1 and 2 the device comprises:

- hook actuation means 4, which are movable from the door of the household appliance,
- hook 5, movable to at least one condition of engagement, preferably lockable, with the door,
- locking means 6, which at least lock the hook 5 into the engaged condition.

[0034] The hook actuation means 4 are adapted to control the movement of the hook 5 into the door engaging condition; to this end, they can be moved by the door between at least a first position, in which the hook 5 is not in a condition of engagement with the door, and a second position, in which the hook 5 is in a condition of engagement with the door.

[0035] In this second position the hook 5 is lockable into the engaged condition, meaning that in this position the locking means 6 can be actuated in order to lock the hook engaged with the door.

[0036] Advantageously, the device 1 comprises a compensation means 8 adapted to compensate for a movement of the actuation means 4, in order to prevent or compensate for the actuation of said hook 5 in the presence of an additional movement of said hook actuation means 4, said "additional" movement being different from the movement between the first position and the second position.

[0037] In this way, any anomalous movements of the door or extra travels of the hook actuation means 4 can be compensated for, in the sense that they will not cause a movement or displacement of the hook which might compromise its engagement with the door or adversely affect the locking thereof, which takes place in said second position through the effect of the locking means, and/or cause damage.

[0038] More in particular, it can be observed that the movement of the hook actuation means 4 between said first and second positions substantially follows a single direction of movement, which is substantially straight.

[0039] In this case, any extra travels of the actuation means 4 substantially coincide with additional movements of said hook actuation means 4 past the second

position, in the direction of movement from the first position to the second position.

[0040] In the example shown herein, the hook actuation means comprise at least one lever 4 which is linearly movable between said two positions and which is coupled to the hook 5 through said compensation means 8, so that the hook 5 is indirectly actuated by the lever through the interposition of said compensation means 8, preferably mechanically, thus advantageously simplifying the design of the device 1 and making it more effective.

[0041] In this solution, the compensation means 8 is interposed between the lever 4 and the hook 5, and is coupled to both of them.

[0042] In order to compensate for any additional movements of the lever 4, the compensation means 8 is an elastic means, and preferably comprises a coil spring 8 interposed between the hook 5 and the lever 4 to rotatably drag the hook 5 as a result of a linear movement of the lever 4 between said two (first and second) positions.

[0043] In fact, the coil spring compresses or extends in the presence of a movement of said lever other than that between said first position and said second position, thereby preventing said movements from improperly actuating the hook 5.

[0044] Said movements of the lever other than that between said first position and said second position may be generated, for example, by small tolerances of the door or by an extra travel of the lever.

[0045] Of course, it must be pointed out right away that, as an alternative to or in combination with the coil spring, the compensation means 8 may also comprise toothed wheels and/or cam profiles and/or a plastic elastomer or the like.

[0046] Still generally speaking, the device 1 further comprises locking means 6 adapted to lock the hook in the engaged condition.

[0047] Advantageously, said locking means 6 are separated from the actuation means 4 of the hook 5 for reasons that will be described later on.

[0048] As a whole, the locking means 6 are adapted to lock the hook into the engaged position, taking a position in which they interfere with the hook itself, thus preventing it from moving.

[0049] Preferably, said locking means 6 comprise additional recovery means 63; in particular, these are used to prevent anomalous operation and/or actuation conditions.

[0050] Said recovery means 63 are preferably elastic, e.g. springs, elastomers or the like.

[0051] In the example shown, the locking means 6 comprise a cursor 60 which is movable into a condition wherein it interferes with the hook 5, so as to lock it into a condition of engagement with said door.

[0052] In this condition, in fact, the head 61 of the cursor 60 prevents the hook 5 from disengaging from the door, as will be described more in detail below.

[0053] It is interesting to note that the locking means

6 can be moved into a condition wherein they interfere with said hook 5 in a manner substantially independent of the position of the lever 4, in particular even in the presence of an additional movement of the latter other than the movement between said first position and said second position.

[0054] More in detail, in the example shown herein the device 1 comprises two half-shells 2 and 3 which can be coupled together to house the functional components of the device 1.

[0055] In Fig. 2 and in the following figures, the device 1 is shown without the upper half-shell 2 to illustrate more clearly its components and operation.

[0056] The two half-shells 2 and 3 are preferably made of plastic, e.g. by moulding, and are fitted with coupling and/or hooking means, such as elastic tabs and/or hooks, so that they can be coupled by snapping them together.

[0057] This description will first illustrate the components of the device 1 with reference to their function of engaging with a door of a household appliance, and then it will describe those components which are adapted to perform the locking operation in the engaged condition and the subsequent unlocking operation.

[0058] Referring in particular to Figs. 2, 3 and 12, 13, in this example the device 1 comprises: the actuation lever 4, the hook 5, the locking means 6 and an actuator 7 for said locking means 6.

[0059] The latter may be of various types, but preferably it is of the type that comprises an electromagnet; it may however comprise a wax-type thermoactuator or a motor.

[0060] In the example shown, the actuator 7 is an electromagnet of a per se known type, fitted with a coil, a magnetic yoke 72 and a mobile core 73; the operation and any variants of this type of electromagnet are well known to those skilled in the art: in short, when power is supplied to it, the mobile core or piston is extracted, thus pushing the locking means 6 towards the hook 5.

[0061] Preferably, in the door locking device 1 the actuator 7 comprises an electromagnetic winding 75 associated with the respective magnetic yoke 72, through which the mobile stem or core 73 can pass and act upon the locking means 6; the magnetic yoke 72 substantially has a "C" shape, and from its open side an electric connector 74 protrudes which is in particular intended for electrically connecting the actuator 7 to the control system of the household appliance in which the door locking device 1 has been incorporated or installed.

[0062] Preferably, said yoke 72 also determines fixing or positioning means in a respective seat of the door locking device 1.

[0063] The connector 74 is preferably of the RAST type, such as Rast 2.5, and comprises coupling means for an external electric connector and/or coding means (not shown) adapted to define a connection with one external connector only, thus avoiding the risk of a wrong connection and/or positioning of the connector, e.g. reversed.

[0064] As mentioned above, the actuator may be of a type other than electromagnetic, e.g. thermal or thermoelectric; in particular, said thermal or thermoelectric actuator is of a type that comprises at least one thermal actuator element, i.e. an element adapted to deform or expand or shrink depending on its temperature, and preferably also comprising an electric heating element, such as a resistor.

[0065] In such a variant, the body of the actuator may still have a control connector, whether of the RAST type or of a different kind.

[0066] Said thermal actuator (or thermoactuator or thermoelectric actuator) preferably comprises an expandable material, such as wax or the like, which expands when heated, thus promoting the displacement of a control element, e.g. the axial movement of a stem or piston, which can take at least two positions: an extracted position and a retracted position with respect to the actuator.

[0067] The heating of the expandable material is controlled electrically; for this reason, the thermoactuator is fitted with electric connectors that, as aforementioned, may be of the RAST type or of a different kind.

[0068] One example of a thermoactuator that may be used in this case is described in European patent applications EP 781 920 and EP 953 198 by the present Applicant.

[0069] A further typology of thermoactuator might comprise a form memory element, in particular of the type adapted to expand or shrink as temperature increases, such as a metal alloy or a thermoplastic or polymeric material.

[0070] Between the lever 4 and the hook 5 there is the compensation means 8 adapted to compensate for any extra travel of the lever 4, which in this example comprises at least the coil spring 8, coupled to the hook 5 and to the lever 4.

[0071] The lever 4 is made in one piece with (or is likewise coupled to) a slide 9 which can slide within the device 1.

[0072] The hook 5 is rotatable about a fulcrum 10 arranged substantially perpendicular to the sliding direction of the slide 9, and shown in detail in Figs. 6 to 11.

[0073] In this example, the device 1 is mounted on the frame or chassis of the household appliance, in a manner such that the lever 4 comes in contact with a door of the appliance when the door is rotated or moved to close an operational cavity of the appliance itself. The door of the household appliance is provided with a seat into which the hook 5 can be engaged.

[0074] The operation of the device as it engages with the door, so far illustrated only in general terms, will now be described more in detail.

[0075] When a user moves or rotates the door to close the cavity of the household appliance, the door approaches the lever 4 until it comes in contact with the latter.

[0076] As it continues to move, the door actuates the lever 4, which slides within the device thanks to the slide

9, and in its turn actuates the spring 8, which then rotates the hook 5, which thus engages into the seat provided on the door.

[0077] Therefore, the rotary actuation of the hook 5 occurs through the spring 8, the two opposed ends of which grip the hook 5 and the lever 4, respectively.

[0078] Alternatively, one end of the spring 8 may grip the slide 9 instead of the lever 4, without however altering the operation and the principle of operation described.

[0079] The spring 8 acts as a means for compensating any anomalous movements of the lever 4, e.g. an extra travel thereof: in fact, if the travel of the door is such as to displace the lever 4 past the point where the hook 5 is engaged with the door, this additional movement (extra travel) will cause no further movements of or damage to the hook because the spring 8 will compress and will allow the lever 4 to move beyond said position without the hook being rotated any further.

[0080] Advantageously, this overcomes the drawbacks of prior-art solutions, since the presence of the compensation means 8, in this case the spring, ensures the correct positioning of the device even in a condition of improper installation or excessive operation or production tolerances.

[0081] In substance, with this measure the hook is properly moved into a condition of lockable engagement with the door, in a position where said engagement can be locked, even in the presence of a movement of the door (and hence of the lever 4) past the design specifications (corresponding to the achievement of the condition of engagement of the hook).

[0082] It should also be considered that with this measure the hook 5 can be locked correctly regardless of said anomalous movements or extra travel of the lever 4.

[0083] The two conditions of non-engagement and of lockable engagement of the hook are shown in the pairs of Figs. 4,5 and 6,7 and 8,9 and 10,11, respectively.

[0084] In particular, in Figs. 4,6,8,10 the hook is in a condition of non-engagement with the door: in fact, it is rotated in such a way that its front end 5a is raised.

[0085] When the door moves the lever 4 linearly backwards (towards the fulcrum 10 of the hook 5), the spring 8 acts upon the hook 5 at an eccentric point relative to the fulcrum 10, thus causing it to rotate, until the front end 5a descends into the condition of engagement with the door, as shown in Figs. 5,7,9,11.

[0086] It should be reminded that, in other alternative embodiments, the compensation means equivalently comprise, as a replacement for the spring 8, a different elastic means, e.g. capable of operating in a different way or at different points between the lever 4 and the hook 5, or capable of absorbing said extra travels of the actuation means 4, such as a rubber rod or the like, so long as it is adapted to deform elastically to compensate for said extra travels.

[0087] The slide 9 is associated with an additional spring 14 gripping the slide 9 and the lower shell 3, so that the slide 9 (and hence the lever 4) are subject to an

elastic reaction and are therefore pushed in the direction opposite to the sliding direction of the slide 9 during the engagement manoeuvre (when the door abuts on the lever 4).

[0088] The spring 14 thus performs the task of allowing the lever 4 to be moved or reset to the disengaged position of the hook 5 when the door is opened.

[0089] The slide 9 also comprises a longitudinal extension 15, which in this example is the free end of the slide 9 opposite to the end coupled to the lever 4.

[0090] In this example, the longitudinal extension 15 is useful to control signalling and/or control means 16, such as an electric switch 16, which is also housed in the shell 3, e.g. a push-button switch, so that when the door is closed the push-button activates an electric or electronic signalling and/or control circuit, e.g. to turn on a warning light on the front panel of the household appliance and/or to enable the operation of the latter and/or to enable the power supply to the actuator 7 in order to lock the condition of engagement, as will be described more in detail later on.

[0091] This implies an additional advantage: in fact, the combination of the lever 4, the slide 15 and the switch 16 allows to attain a plurality of actions during the same door closing operation: the engagement of the door through the rotation of the hook 5, the indication that the door has been properly closed, and/or other actions useful for the safe operation of the household appliance.

[0092] As far as locking the hook into the condition of engagement with the door is concerned, the device 1 includes for this purpose locking means 6 which in this example comprise the cursor 60 fitted with at least the head 61, which is movable by the actuator 7 into a condition where it interferes with the hook 5 when the latter is in a condition of engagement with the door.

[0093] For this purpose, the hook 5 has a free rear end 5b on the side of the fulcrum 10 opposite to the front end 5a, so that when the latter rises relative to the lower shell 3 the former will descend, and vice versa.

[0094] In this manner, when the hook 5 is in the condition of engagement with the door, the end 5b is raised with respect to the underlying lower shell 3, thus freeing up a space into which the head 61 of the cursor 60 can install itself like a latch, as shown in Figs. 13 to 15 and more in detail in Figs. 24 to 28.

[0095] It can therefore be stated that in this position the hook 5 is in a position of engagement (with the door) that can be defined as "lockable", meaning by this that in this position the hook 5 can be stably secured in engagement with the door.

[0096] In Fig. 13 the door has not yet come in contact with the lever 4, which stays in the position shown in the drawing because of the spring 14, as previously described.

[0097] The head 61 of the cursor 60 has approached the rear end 5b of the hook without however interfering therewith, and in this position the hook 5 is raised.

[0098] In Fig. 14 the door of the household appliance

has actuated the lever 4, which, thanks to the spring 8, has moved the hook 5 into the condition of engagement with the door, as previously described.

[0099] In this situation, the front end 5a of the hook 5 is turned downwards, and therefore the rear end 5b has risen, thus freeing up the underlying space between it and the shell 3, i.e. freeing up the seat into which the head 61 of the cursor 60 of the locking means 6 can install itself.

[0100] Starting from the condition of Fig. 14, the device arrives at the condition shown in Fig. 15, wherein the actuator 7 has moved the cursor 60 due to the presence of bistable latching means 65, which will be described later on.

[0101] The insertion of the head 61 of the cursor 60 underneath the rear end 5b of the hook 5 locks the latter in engagement with the door, thereby preventing the hook 5 from rotating in the direction of disengagement from the door, with the consequence that the engagement between the hook 5 and the door will stay locked as long as the front end 61 remains in that position.

[0102] The locking into the engaged position obtained with this solution is independent of the position of the lever 4 or of the slide 9, so that any movement of the latter following an anomalous movement of the door or an extra travel generated by the lever due to dimensional tolerance problems will not adversely affect the locking operation.

[0103] In substance, the provision of means for locking the hook into the engaged condition which are separate and distinct from the means for actuating the hook into the engaged position allow to absorb any anomalous movements of the door and to lock the latter into the closed position.

[0104] As for said bistable latching means 65, they are shown in different operating positions in the detail illustrated in Figs. 22 and 23 and in Figs. 24 to 28.

[0105] With reference to Fig. 22, the cursor 60 comprises, in addition to the above-described head 61, also a body 62 elastically connected to the head 61 through the interposition of the springs 63 for reasons that will be discussed hereafter.

[0106] The end of the body 62 opposite to that connected to the head 61 has an abutment profile 64 for the piston of the actuator 7.

[0107] The cursor 60 also comprises bistable latching means 65 adapted to allow said cursor 60 to take at least two distinct positions of stable equilibrium as a result of the repetition of the same force of actuation deriving from the action of the actuator 7.

[0108] Said bistable latching means 65 comprise an engagement pin 66 with a suitably profiled head, e.g. a substantially butterfly-like head 66A associated with a cylindrical body 66B, as shown also in the exploded view of Fig. 12.

[0109] The free end of the body 66B of the engagement pin 66 is engaged into a respective circular seat of the housing 3; said profiled head 66A is free to rotate by

moving within a seat 67 of the body 62.

[0110] According to this preferred embodiment of the invention, the seat 67 is internal to the body 62 and is closed at the sides, as shown in Fig. 29, as well as at its top and bottom faces by the half-shells 2 and 3; this configuration allows protecting the components of the bistable mechanism 65 housed therein. The seat 67 may however be open, at least partially along at least one side, while still remaining substantially internal to the body 62. The seat 67 accommodates, at least partly, rotation and/or engagement guides 68,69 cooperating with said butterfly-head pin 66.

[0111] Preferably, the head 66A of the engagement pin 66 is made in one piece with the body 66B, which is free to rotate about its axis.

[0112] The head 66A of the engagement pin 66 is housed in the seat 67; when in operation, it comes in contact with the rotation and/or engagement guides 68,69 with which it cooperates: in fact, during the sliding action of the cursor 6, generated by the actuator 7, the seat 67 moves integrally with the body 62 with respect to the pin 66.

[0113] More in detail, the preferred version of the head 66A of the pin 66 comprises two opposed ends projecting out of the area of engagement with the pin body 66B and provided with two notches or seats, e.g. two V-shaped notches.

[0114] The rotation guides 68,69 comprise coupling portions to be coupled to said notches of the pin 66, which are adapted to allow for mutual engagement between the parts in order to cause a rotation or stop the rotation of the pin 66, as will be described more in detail hereafter.

[0115] In this configuration, at least one of the engagement means 66 and the rotation and/or engagement guides 68,69 is at least partly located in a position substantially internal to the seat 67.

[0116] The body 62 also comprises a seat 70 adapted to house the return spring 71 acting between the body 62 itself and the underlying shell 3; the return spring 71 is so fitted as to keep the body 62 pushed in the direction of the profile 64, i.e. towards the actuator 7. In this manner, the body 62 can be subject to two distinct forces: the force of the return spring 71 and the force of the actuator 7, which act in opposite directions; in particular, the actuator 7 counters the force of the return spring 71.

[0117] Figs. 24 to 28 provide a better view and understanding of the operation of the bistable latching means 65.

[0118] Every time it is necessary to lock or unlock the engagement between the hook and the door of the household appliance, power is supplied to the actuator 7; this causes its piston to come out, which, being coupled to the abutment profile 64, pushes the cursor 60 in the direction of the hook 5, thereby countering the force exerted by the return spring 71.

[0119] In the initial position of Fig. 24 the head 61 of the cursor 60 is set back; it does not interfere with the rear end 5b of the hook 5, which can therefore move

freely.

[0120] The position of Fig. 24 is considered to be stable because the cursor 60 is subject to the opposed forces of the actuator 7 and of the return spring 71.

[0121] Should the actuator piston re-enter, due to a malfunction and/or if no power is supplied to the actuator, the head of the pin 66 would abut against the front wall (the upper one in the drawing) of the seat 67, thus advantageously remaining stably in this condition even when the actuator 7 is off.

[0122] When the door is closed, the rear end 5b of the hook 5 goes up.

[0123] At a preset time instant (e.g. when the household appliance is about to start operating), power is supplied to the actuator 7, so that the cursor 60 is pushed forwards (i.e. upwards in Fig. 24) in the direction of the hook 5, overcoming the opposed force of the return spring 71.

[0124] The cursor 60 then goes through the position of Fig. 25, which is not stable (i.e. it cannot be held without keeping the actuator piston extracted, and therefore without keeping the actuator on).

[0125] In this position the cursor 60, under the action of the actuator 7, has moved forwards up to the point where its head 61 lies underneath the rear end 5b of the hook 5, resulting in a displacement of the seat 67 (which moves integral with the body 62) with respect to the pin 66 (which is fixed relative to the body 62).

[0126] When the forward movement is complete, the head of the pin 66 comes in contact with the rotation guide 69, which engages into the pin 66 and causes it to rotate by a certain predetermined number of degrees.

[0127] When the power to the actuator 7 is turned off, the actuator piston goes back and the return spring 71 pushes the body 62 towards the actuator 7 itself (downwards in Figs. 25,26).

[0128] The backward movement of the cursor 60 is stopped in the stable position of Fig. 26 through the effect of the interference between the head of the pin 66 and the other rotation and engagement guide 68.

[0129] The detail of Fig. 29 may be useful to better understand this operation: the head 66A of the pin 66 has two opposite ends 66C and 66D arranged substantially at 180° and each having a concave seat or notch, e.g. a V-shaped notch, 66E and 66F.

[0130] Each rotation and engagement guide 68, 69 comprises an engagement relief or angle 68A,69A to be engaged with the concave notch 66E and 66F, and a guide portion 68B,69B so oriented as to generate or induce a rotation of the pin 66 when the concave notch 66E,66F engages with the engagement angle 68A,69A, thus causing a rotation of the pin 66 itself.

[0131] Referring back to Fig. 26, in this position the head 61 is advanced towards the hook 5; in particular, it is positioned under the rear end 5b of the hook 5, thereby locking the engagement between the latter and the door, even when the actuator 7 is off: in fact, the hook cannot rotate into the condition of disengagement of the door.

[0132] When the household appliance has completed its cycle and the user wants to unlock the door, power is supplied to the actuator 7 again.

[0133] Its piston moves forwards again and overcomes the force of the return spring 71, thereby moving the cursor 60, which advances to the position of Fig. 27, which is to be considered as non-stable (as previously discussed).

[0134] In this position the movement of the seat 67 has caused the head of the pin 66 to rotate upon engagement with the guide 69, thus eliminating the condition of interference between the head of the pin 66 and the rotation guide 68 and letting the cursor 60 move back into the stable position of Fig. 28, coinciding with that of Fig. 24, wherein the head 61 does not interfere with the rotation of the hook 5.

[0135] In fact, when the power to the actuator 7 is turned off, its piston goes back and the return spring 71 pushes the cursor 60 in the direction opposite to the hook 5, as shown in Fig. 28.

[0136] In this stable position, the cursor 60 moves back until the head of the pin 66 comes in contact with the wall of the seat 67.

[0137] This backward movement removes the head 61 of the cursor 60 from under the rear end 5b of the hook 5, thereby unlocking the engagement between the latter and the door.

[0138] In summary, the device 1 can thus advantageously lock the engagement between the hook 5 and the door of the household appliance without keeping the actuator 7 on.

[0139] This provides a twofold advantage: in the first place it saves energy, because the actuator 7 needs to be powered only when changing state (between locked and unlocked); in the second place, if the actuator is an electric one, the door will stay locked and cannot be opened by a user also in the event of a power failure (e.g. due to a breakdown or the like).

[0140] This proves to be extremely advantageous when the household appliance is an oven, wherein cleaning steps can typically be carried out through high-temperature pyrolysis, in that it will be in any case impossible to open the door to gain access to the hot cavity in the event of a power failure.

[0141] Referring again to the cursor 60, it should be remembered that the head 61 is connected to the body 62 through the interposition of the springs 63.

[0142] Advantageously, the latter can prevent problems from arising when the device 1 is in operation.

[0143] In fact, the spring 63 are so arranged as to allow a relative elastic movement between the head 61 and the body 62: let us assume that, in operation, the hook 5 is engaged and seized (for whatever reason) with its end 5b pressing against the head 61 of the cursor 60; in this condition, if the head 61 were rigidly connected to the body 62, an activation of the actuator might easily break one or more of the various parts or anyway it might not allow unlocking because the cursor 60 would not be

able to move.

[0144] Thanks to the fact that the head 61 of the cursor 60 is elastically connected to the body 62, in the event of such a seizure the body 62 will be able to move, thus allowing the pin 66 to rotate.

[0145] As soon as the reasons that caused the rear end of the hook to press against the head 61 disappear, the springs 63 will draw the latter back towards the body 62, thus restoring the proper operation of the device and preventing damage to the various parts or additional malfunctions.

[0146] In the light of these features, at least the step described with reference to Fig. 27 can also take place with the end 61 blocked by the hook 5, e.g. in the event of an intervention of the actuator 7 while the user is pulling the door, in which case the hook 5 would be stressed in a manner such that its portion 5B would push excessively against the portion 61 of the locking means 6; in such a case, the locking means 6 can nevertheless disengage from the pin 66, to move then backwards as soon as said anomalous force against the door, and hence against the hook, ceases.

[0147] The presence of the elastic connection between the head 61 of the cursor 60 and its body 62 also provides a further advantage: in fact, in the event of an anomalous seizure of the head 61 under the hook 5, as previously described, the head 61 can be moved manually from under the hook 5 without having to move the body 62 as well, thus avoiding any damage to the device 1.

[0148] This can be useful should the actuator fail, if the device 1 is equipped with a suitable aperture for inserting a suitable unlocking tool from the outside, such as a tool directly operating, by pushing and/or pulling them, the locking means 6 and/or the head 61 of the cursor 60.

[0149] Of course, the device described so far may be subject to many variations.

[0150] For example, the springs 63, 71, 8 may be replaced with alternative elastic means, e.g. elastic means made of elastomer or thermoplastic material, provided that they can perform the above-described functions.

[0151] An alternative embodiment of the compensation means 8 for a device 11 similar to the device 1 is shown in Figs. 19 to 21.

[0152] In this variant, the same reference numerals designate the same parts of the previous example, which will not be discussed any further.

[0153] This variant 11 differs in that the compensation means does not comprise the spring 8 of the previous example; in its place, the lever 40 is fitted with a side extension 41 having at least one face 40A which is inclined with respect to the sliding direction of the slide 90, which is integral with the lever 40 itself as shown in Fig. 20.

[0154] In this variant, the hook 50 comprises an outer surface with segments 50A, 50B, 50C, 50D progressively inclined or curved with respect to the side extension 41, thus generating a series of contiguous inclined planes or a single curved plane; the hook 50 further comprises a

flat top portion 50E, visible in Fig. 20, which is straight and parallel to the sliding direction of the lever 40.

[0155] Said segments 50A, 50B, 50C, 50D cooperate with the inclined face 40A to rotate the hook 50 when the lever 40 goes back as a result of the door closing movement.

[0156] The movement of the lever 40 upon closing the door, in fact, brings the inclined face 40A thereof in contact with the inclined segments 50A, 50B, 50C, 50D of the hook 50, so that preferably the lever 40 progressively rotates the hook 50 to bring it into the condition of engagement with the door of the household appliance.

[0157] The effect of recovering any extra travels of the lever 40 is immediately apparent: after having brought the hook into the condition of engagement with the door, the lever 40 can be further moved in the direction opposite to that of the door (e.g. because of an anomalous movement of the latter) without such movement causing a wrong displacement of the hook or generating excessive forces or malfunctions when locking the hook 50 into the engaged condition: it should be noted, in fact, that the hook 50 is moved through the effect of the cooperation between said segments 50A, 50B, 50C, 50D and the inclined face 40A of the lever, and that the latter is free to slide over the flat top portion 50E of the hook 50, thus not moving or stressing the latter any further.

[0158] As far as the step of locking the hook 50 into the engaged condition is concerned, it is carried out in the same way as previously described, i.e. by using the cursor 60 to engage and rotate the hook 50 like a latch, and therefore it will not be discussed any further. Other variants are also possible, all of which are within the grasp of those skilled in the art in the light of the teachings provided so far.

[0159] One of such variants, for example, uses a combination of the advantageous features of the two variants described above: in this case, for example, the side extension 41 is at least partly made of an elastic material (e.g. elastomer or rubber), thus summing together the above-mentioned advantages.

[0160] In this respect, the side extension, or at least a portion of the lever, is fitted with a tolerance compensation device which, in addition to acting upon cooperating inclined planes of the hook and of the lever, also comprises an elastic insert which absorbs any tolerances or extra travels.

[0161] It is worth mentioning a further variant wherein at least a portion of the cursor 60 can be directly connected to or associated with the hook 5, preferably in order to move it into the lockable condition of engagement with the door upon activation of the actuator that cooperates with the cursor.

[0162] In this case the actuator 7 is turned on when one wants to close or lock the door, so that the cursor 60 moves and interferes with the hook 5 to move it into the condition in which it closes and/or locks the door.

[0163] The bistable latching means 65 may be subject to variations as well; for example, the rotation guides 68

and/or the engagement means 69, which in the embodiment shown in the drawings are associated with the body 62 of the cursor 60, may instead be at least partly associated with the lower half-shell 3 of the device.

[0164] Likewise, it must be pointed out that the trajectory of the cursor may also be curvilinear; for example, the body 62 may be guided by a cam profile arranged on the side of the lower half-shell 3.

[0165] The device according to the invention may also include an actuator 7 exerting a pulling force onto the cursor 60, instead of pushing it as in the previous example.

[0166] Such a solution may be implemented by appropriately modifying the actuation and/or locking means 6 of the hook 5, e.g. by changing the configuration of the cursor 60 in a manner such that, when it is retracted towards the actuator 7, the spring 71 therewithin is compressed; for example, the cursor 60 may be similar to the one shown in the various examples described above, but substantially rotated by 180° relative to the axis of the engagement pin 66. Of course, in this case the head 61 of the cursor will still be placed on the end of the cursor 60 facing the hook 5; for this reason, the shape of the cursor will be slightly different from the one shown in the drawings.

[0167] In such a variant, the actuator 7 moves and holds at least temporarily the cursor 60 while countering the force of the spring 71, which operates in the way opposite to the previous example; the cursor 60 is then held by the bistable latching means 65.

[0168] In practice, the latter allow locking the cursor 60 in a position away from the hook 5, following a first operating step of the actuator 7 in which it pulls the cursor towards itself by overcoming the elastic countering force of the spring 71.

[0169] Subsequently, e.g. when the hook 5 engages the door of the household appliance in the closed condition, during a second operating step the actuator 7 pulls the cursor 60 towards itself again to disengage the bistable latching means 65 and allow it to move under the thrust of the spring 71.

[0170] In this way, the cursor 60 can be disengaged by the actuator and can snap forwards, with the aid of the spring 71, to lock it, just as in the example taken into account in the drawings.

[0171] It is worth pointing out that in this variant the mobile core 73 of the actuator is connected to the cursor 60 (e.g. by means of a hook-hole solution or the like), so that it can exert onto it the force required to retract it towards the actuator 7, in contrast with the force of the spring 71.

[0172] Finally, according to an inventive feature of the present invention, the bistable catching mechanism comprising at least the cursor 60, with the pin 66, the head 66A, the guides 68 and the engagement means 69, can also be used in other devices where bistable mechanisms are required.

[0173] Such devices are not necessarily door locking

devices like the one taken into account herein; for example, they may be devices for stopping mobile components of household appliances such as washing machines, dishwashers or the like.

[0174] According to a further inventive feature, said bistable mechanism, comprising at least two components selected among the cursor 60 and the pin 66 and the head 66a and the guides 68 and the engagement means 69, may also be associated with an actuator, e.g. of the previously described electromagnetic or thermoelectric type, in order to obtain a bistable actuator, such as an electric actuator adapted to take two stable working positions.

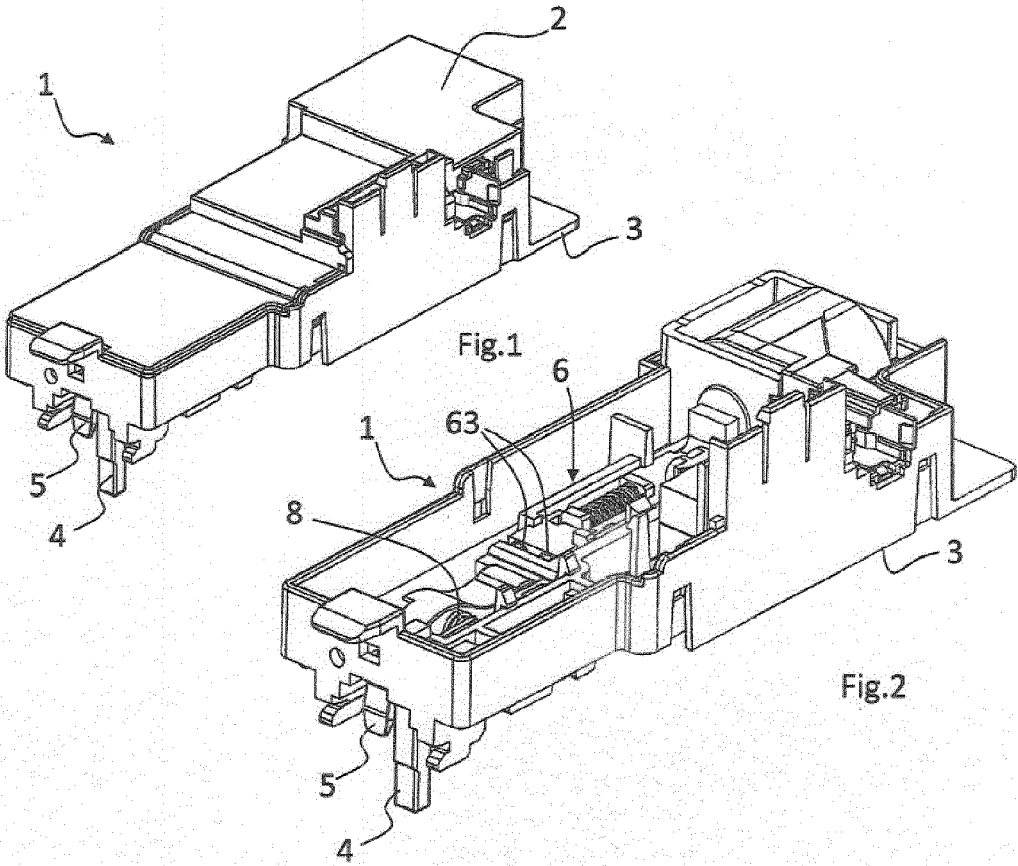
[0175] All of these variants will still fall within the scope of the following claims.

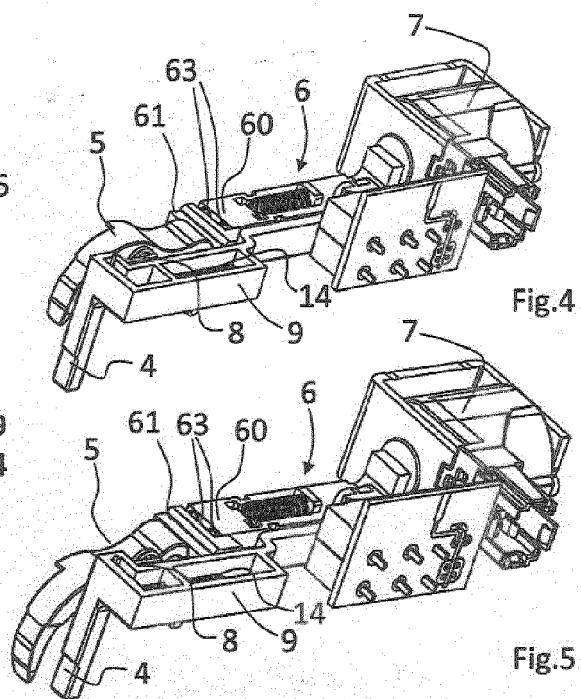
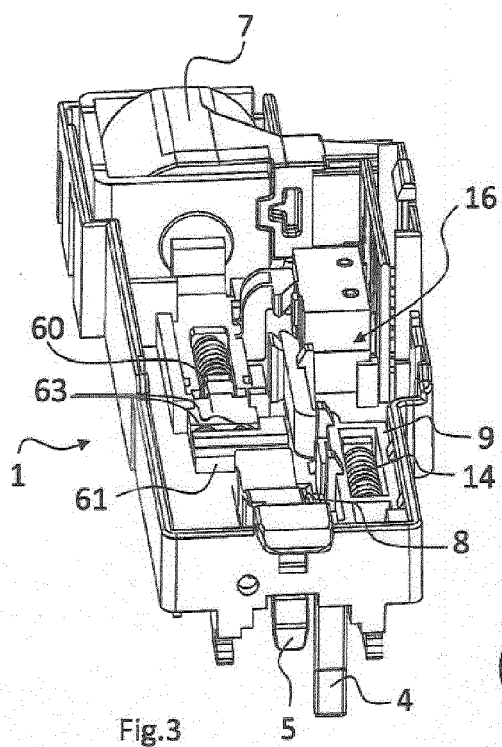
Claims

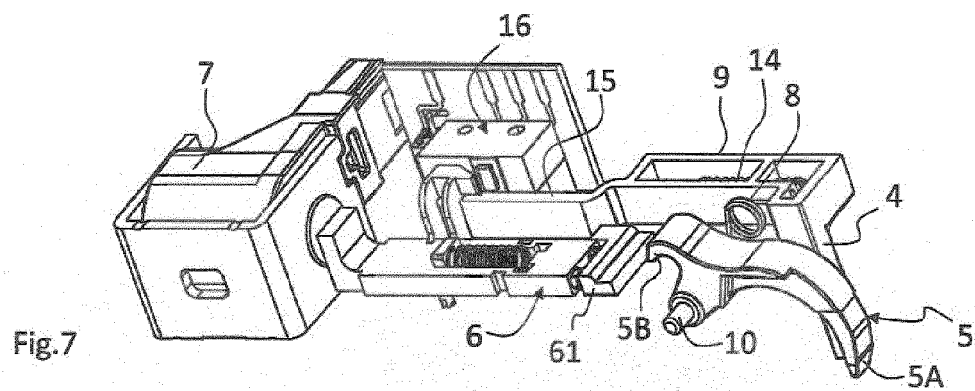
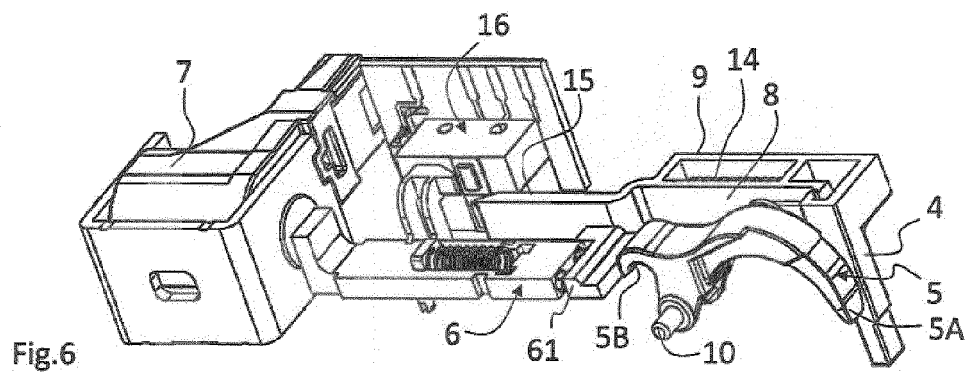
1. A door locking device (1,11) for a household appliance, adapted to engage into the closed position a door of an operational cavity of said household appliance, comprising:
 - a hook (5,50) movable to at least one condition of engagement with said door,
 - locking means (6) cooperating with the hook in order to hold it in said engaged condition, said locking means (6) comprising at least one cursor (60) and bistable latching means (65) adapted to allow said cursor (60) to take at least two distinct positions of stable equilibrium as a result of the repetition of an actuation force of said cursor (60), wherein said cursor (60) comprises at least one body (62) cooperating with the bistable latching means (65) to ensure that said cursor (60) takes said at least two distinct positions of stable equilibrium as a result of a movement thereof (60),
 - characterized in that**
 - said cursor (60) comprises at least one head (61) distinct from said body (62) and coupled thereto through recovery means (63).
2. A device according to claim 1, wherein said bistable latching means (65) comprise an engagement pin (66) having a profiled head (66A) and rotatable relative to said cursor (60), which cursor (60) comprises at least one body (62) provided with a substantially internal seat (67) which at least partly houses the profiled head (66A) and rotation and/or engagement guides (68,69), said cursor (60) and guides (68, 69) cooperating to ensure the engagement of said at least two distinct positions of stable equilibrium.
3. A device according to claim 1 or 2, wherein the cursor (60) moves relative to the engagement pin (66) during the movements between said positions of stable equilibrium.
4. A device (1,11) according to any one of the preceding claims, wherein said profiled head (66A) of said pin (66) comprises two opposed ends (66C,66D) provided with concave seats or notches (66E,66F), in particular cooperating with corresponding coupling portions (68A,68B,69A,69B) of said rotation guides (68) and engagement guides (69) for mutually engaging the parts and causing a rotation or stopping the rotation of said pin (66).
5. A device according to claim 4, wherein the coupling portions (68A, 68B; 69A, 69B) of the rotation guides (68) comprise an engagement projection (68A, 69A) intended for engaging with the concave notch (66E, 66F) of the head (66A) of the pin (66), and a guide portion (68B, 69B) so oriented as to induce a rotation of the head (66A) of the pin (66) when the concave notch (66E, 66F) engages with the engagement projection (68A, 69A).
6. A device (1,11) according to any one of the preceding claims, wherein said recovery means (63) are elastic and preferably comprise springs, in particular coupled to said head (61) and said body (62).
7. A device (1,11) according to any one of the preceding claims, wherein said head (61) of said cursor (60) is movable to a condition where it interferes with said hook (5,50) for locking it into a condition of engagement with said door.
8. A device (1,11) according to any one of the preceding claims, wherein said hook (5,50) is rotatable about a fulcrum (10) to be put into said condition of engagement with said door through its front end (5A), said hook (5,50) being also provided with at least one free rear end (5B) on the opposite side of said fulcrum (10) relative to said front end (5A), said head (61) of said cursor (60) being adapted to interfere with said rear end (5B) of said hook (5) to lock it into a condition of engagement with said door.
9. A device (1,11) according to any one of the preceding claims, further comprising actuation means (4,40) for actuating the hook (5,50), which can be controlled by said household appliance's door for moving said hook (5,50) to said condition of engagement with the door, said actuation means (4,40) being movable by said door between at least a first position, in which said hook (5,50) is not engaged with said door, and a second position, in which said hook (5,50) is in a lockable condition of engagement with said door.
10. A device (1,11) according to claim 8 or 9, wherein said locking means (6) are movable to a condition wherein they lock said hook (5,50) in a manner sub-

stantially independent of the position of said hook actuation means (4,40) in the presence of an additional movement of the latter (4,40) other than said movement between said first position and said second position, said movement of said hook actuation means (4,40) between the first and second positions being preferably accomplished in a first direction of movement, and said additional movement substantially corresponding to a movement of said hook actuation means (4,40) past said second position in the first direction of movement from the first position to the second position.

11. A device (1,11) according to one or more of claims 8 to 10, comprising a compensation means (8) for compensating for a movement of hook actuation means (4,40) in order to prevent the actuation of said hook (5,50) in the presence of an additional movement of said hook actuation means (4,40) other than said movement between said first position and said second position.
12. A bistable mechanism (65) for latching a cursor (60), adapted to allow the cursor to take at least two distinct positions of stable equilibrium as a result of the repetition of an actuation force, comprising bistable latching means (65), wherein said cursor (60) comprises at least one body (62) cooperating with the bistable latching means (65) to ensure that said cursor (60) takes said at least two distinct positions of stable equilibrium as a result of a movement thereof (60),
characterized in that
said cursor (60) comprises at least one head (61) distinct from said body (62) and coupled thereto through recovery means (63).
13. A bistable mechanism according to claim 12, further comprising an actuator (7), preferably an electromagnetic or thermal or electrothermal one, adapted to apply a force to the cursor (60) in order to make it take said at least two positions of stable equilibrium.
14. A mechanism according to claims 12 or 13, wherein the body (62) of said cursor (60) comprises a seat (67) which at least partly houses rotation and/or engagement guides (68,69), and wherein the bistable latching means (65) comprise an engagement pin (66) with a profiled head (66A) at least partly housed in said seat (67) and rotatable relative to said cursor (60), cooperating with said rotation and/or engagement guides (68,69) to ensure that said cursor (60) takes said at least two distinct positions of stable equilibrium as a result of a movement thereof (60).







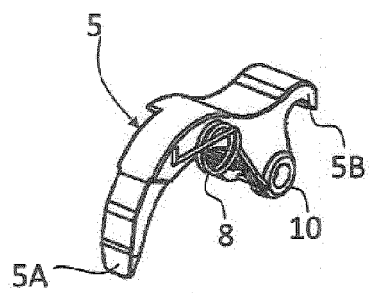


Fig. 8

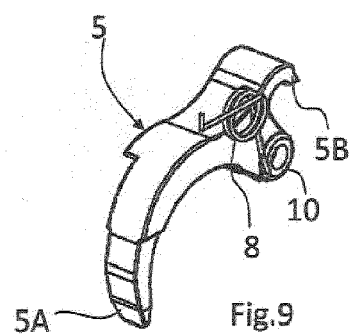


Fig. 9

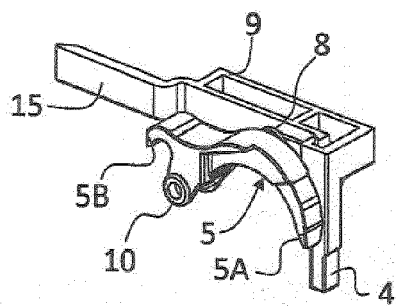


Fig. 10

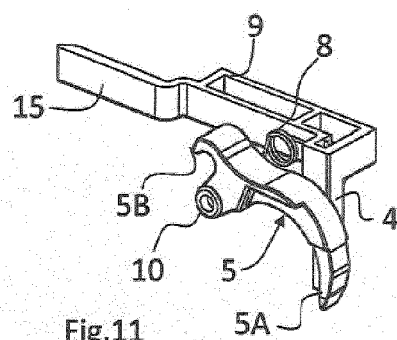


Fig. 11

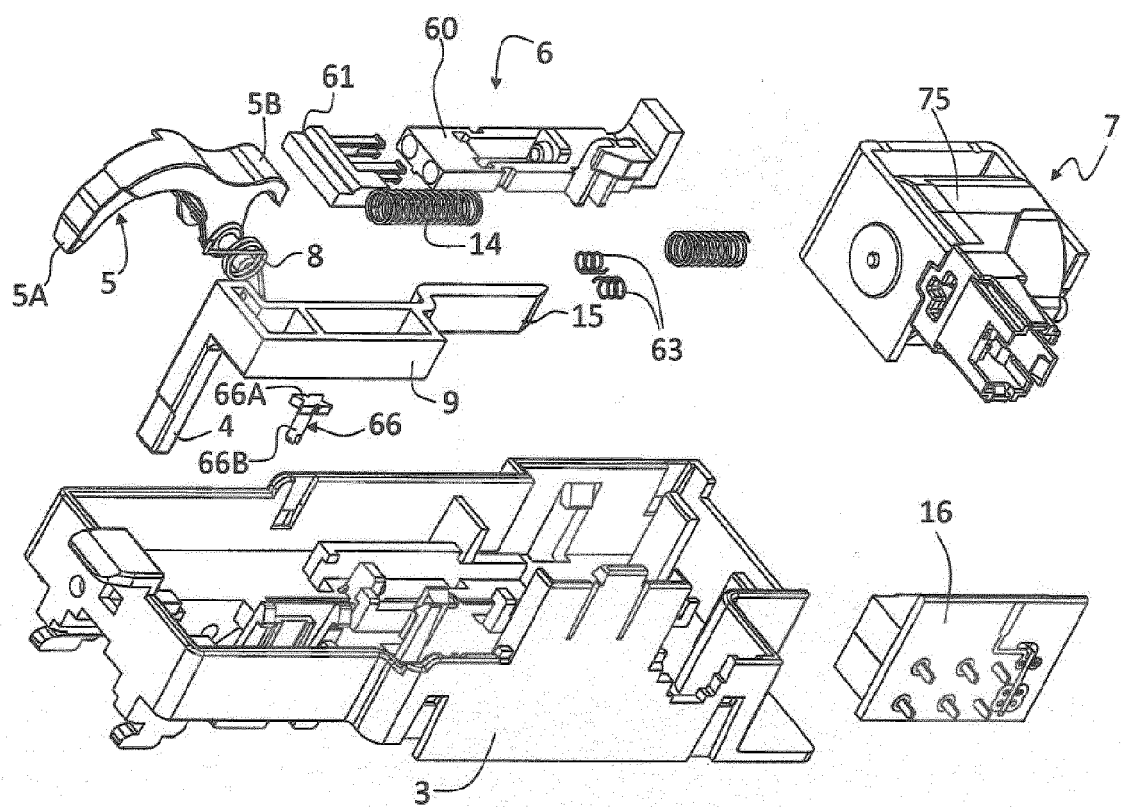


Fig.12

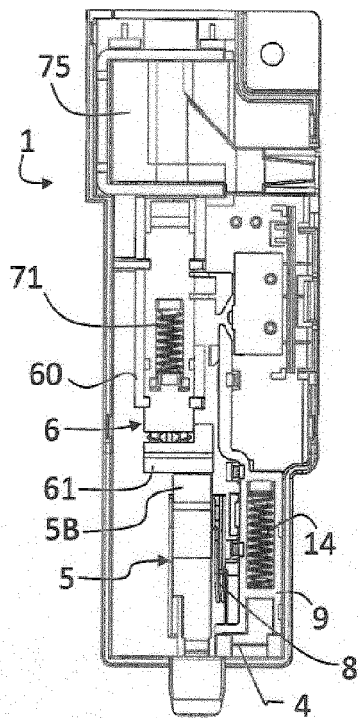


Fig.13

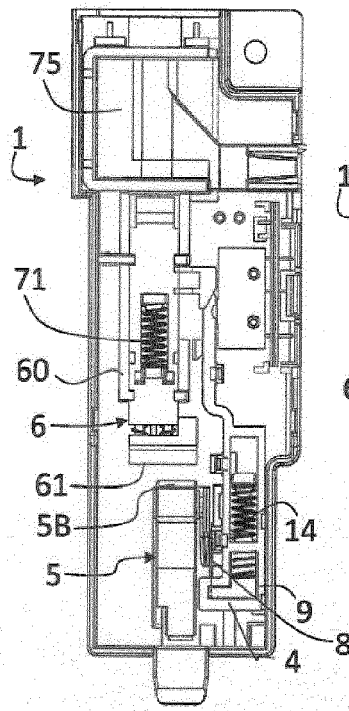


Fig.14

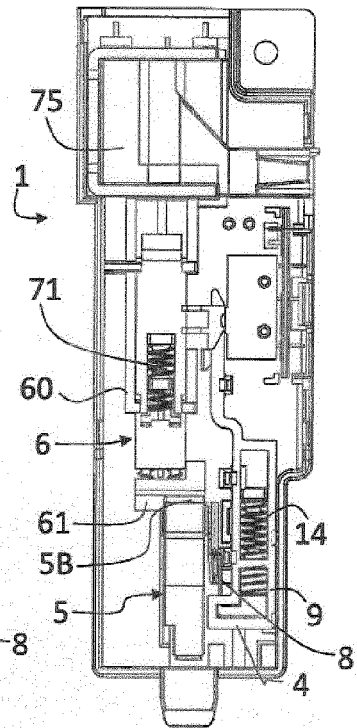
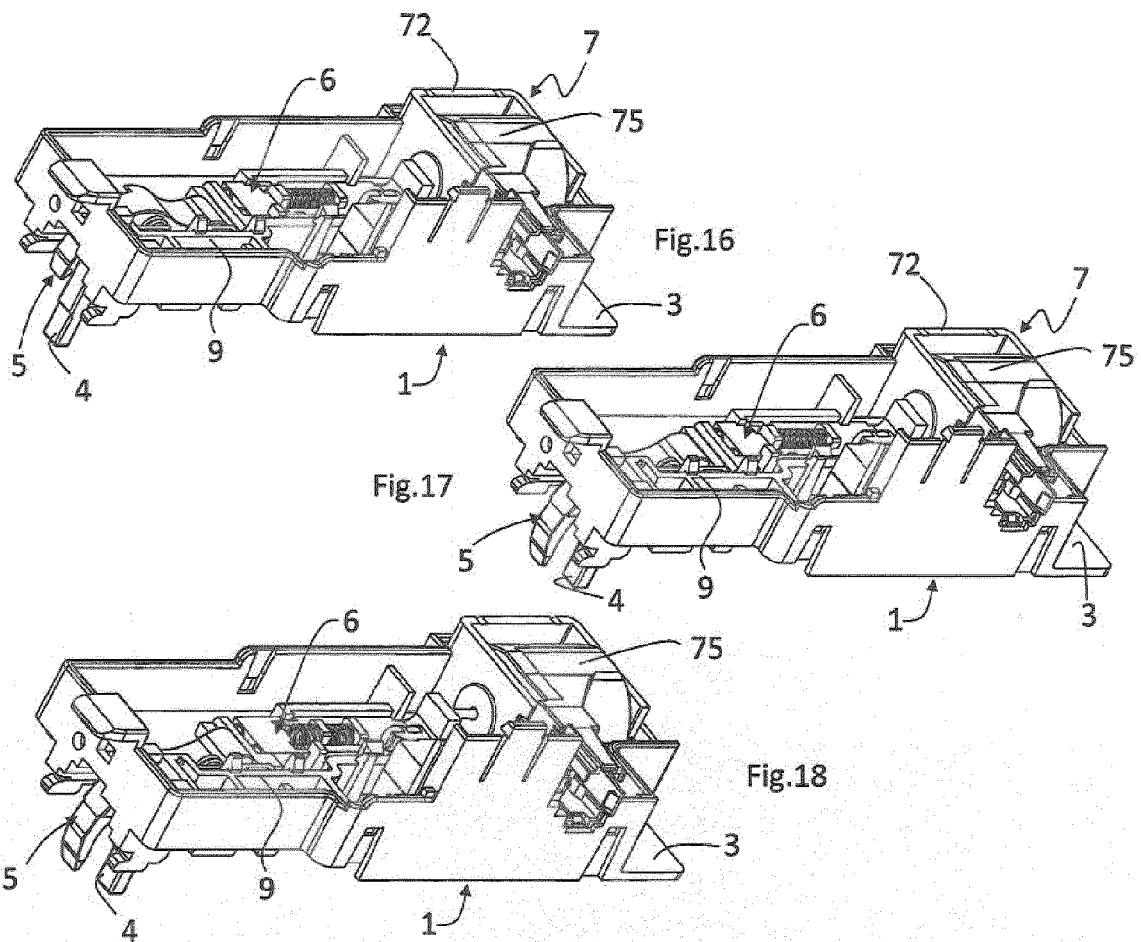
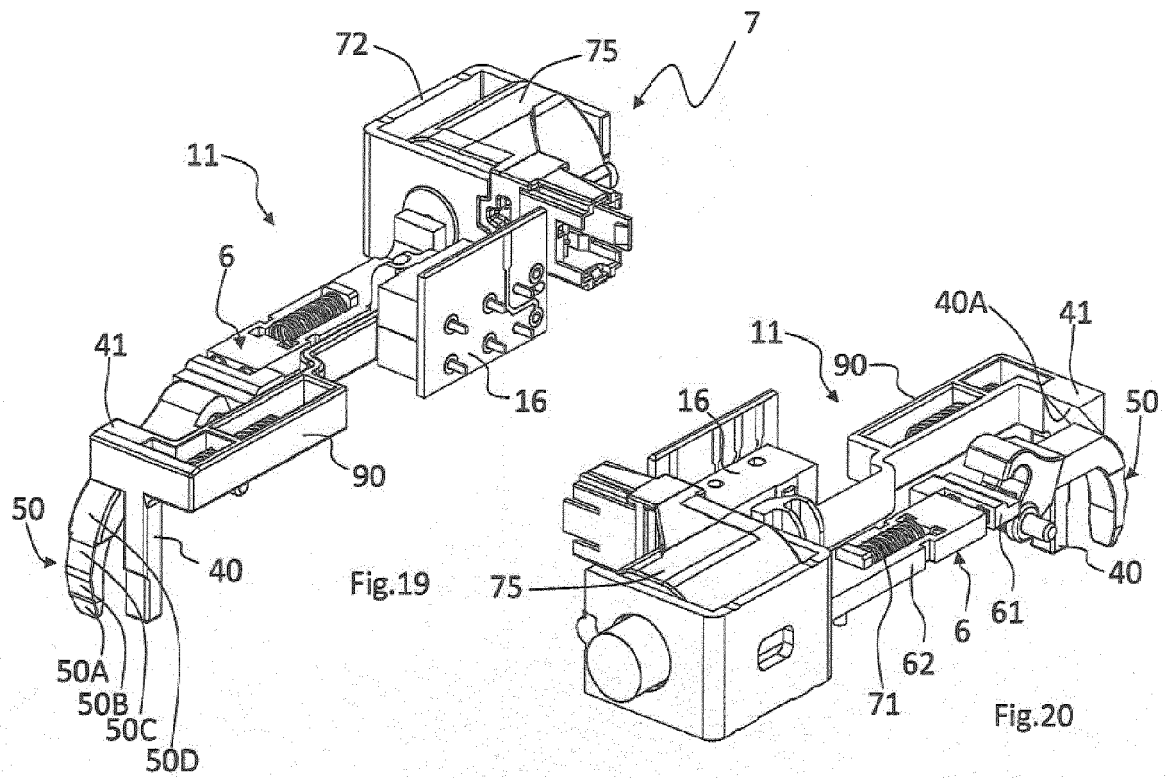


Fig.15





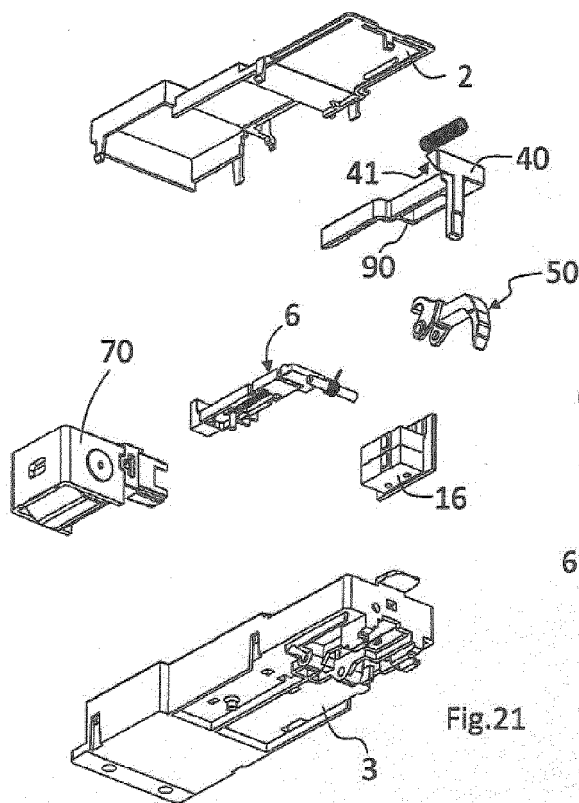


Fig. 21

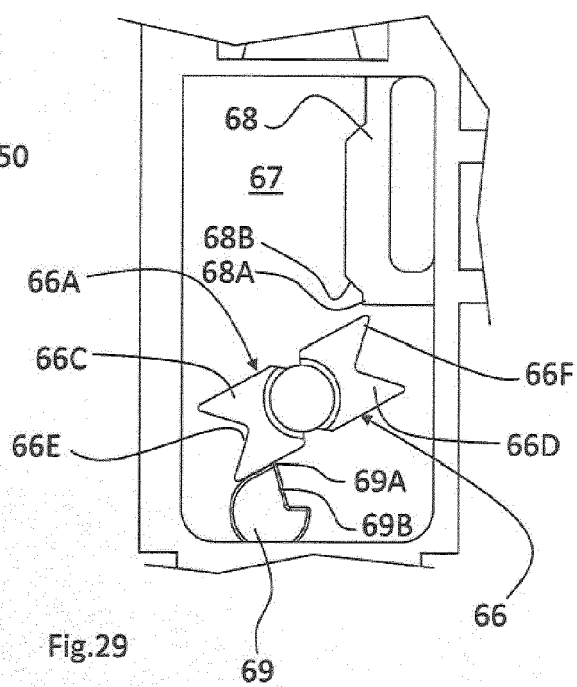


Fig. 29

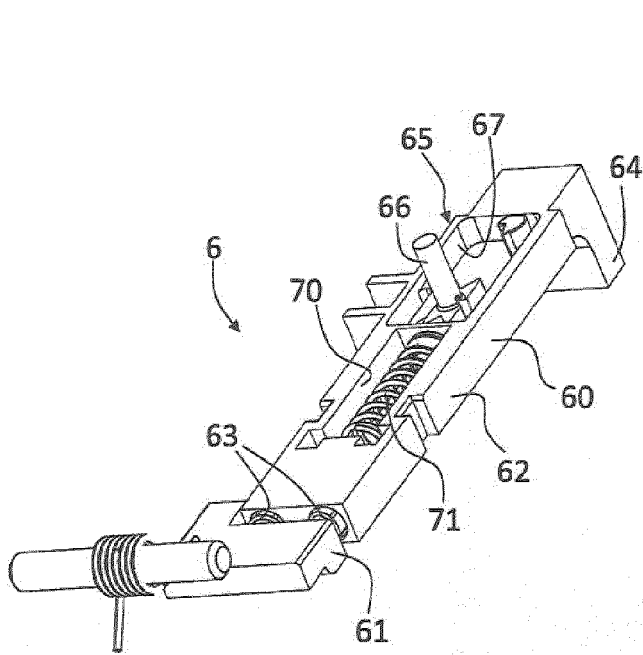


Fig.22

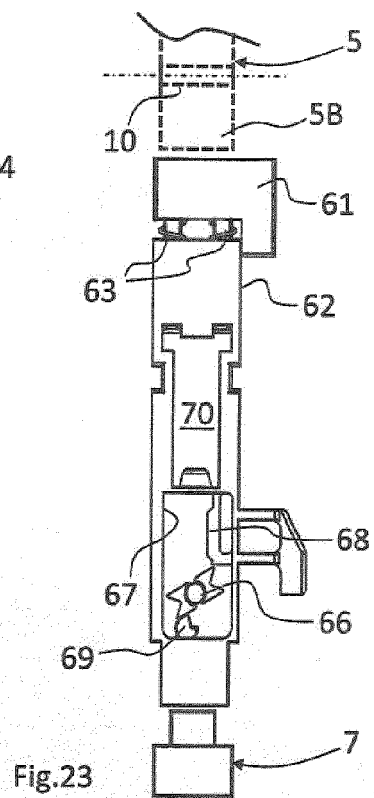


Fig.23

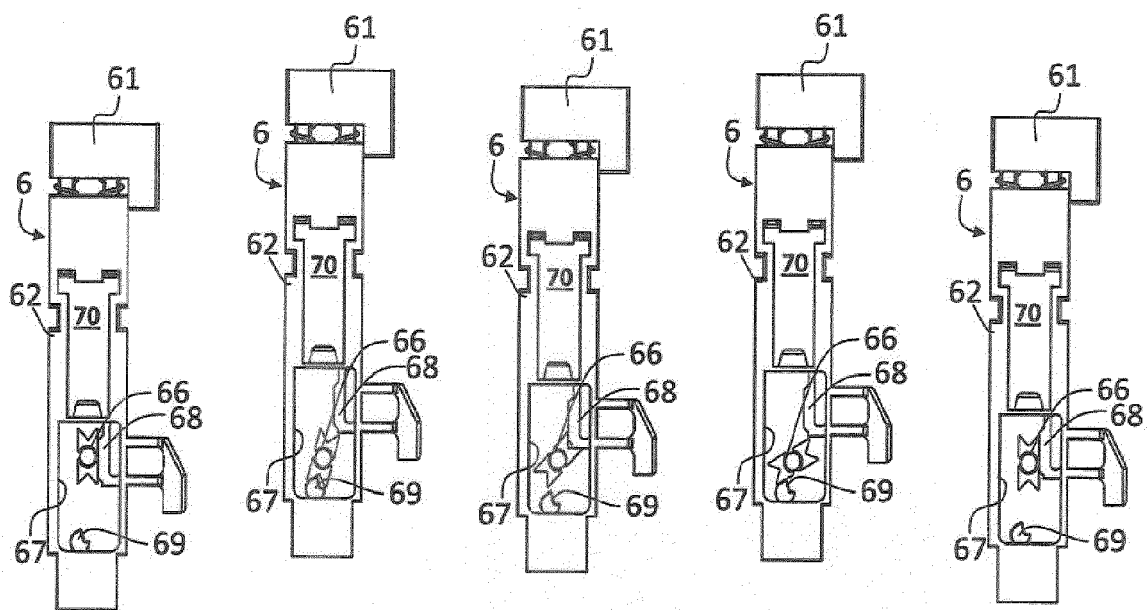


Fig.24

Fig.25

Fig.26

Fig.27

Fig.28

REFERENCES CITED IN THE DESCRIPTION

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