(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 632 477 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **94109177.9**

(51) Int. Cl.[6]: **H01H 71/10**

(22) Date of filing: **15.06.94**

(30) Priority: **22.06.93 IT MI931332**
06.12.93 IT MI932581

(43) Date of publication of application:
04.01.95 Bulletin 95/01

(84) Designated Contracting States:
AT BE DE FR

(71) Applicant: **ABB ELETTROCONDUTTURE S.p.A.**
Via Ampère, 30
I-20131 Milano (IT)

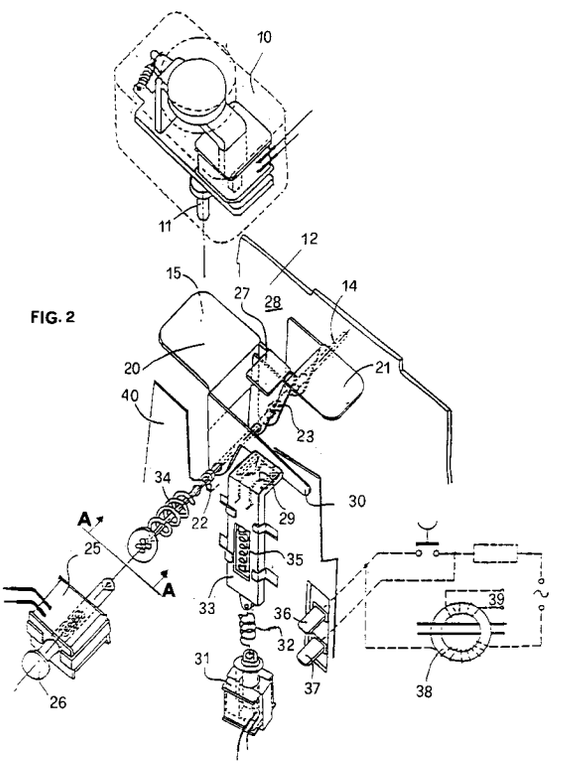
(72) Inventor: **Giardini, Giorgio**
Via F. Marinetti, 3
I-20127 Milan (IT)

(74) Representative: **Gervasi, Gemma, Dr. et al**
Studio Brevetti e Marchi
NOTARBARTOLO & GERVASI S.r.l.
33, Viale Bianca Maria
I-20122 Milano (IT)

(54) Device for automatically or manually testing of a protecting, controlling or signalling apparatus.

(57) Device to automatically or manually test the efficiency of the most sensitive and main components of an electrical apparatus for proctecting, controlling or signalling, in particular of a residual current circuit breaker, without interrupting the electrical supply, wherein the mechanical disconnecting chain which starts from the detector of the failure (relay) (10) to the hooking (17) of the mechanism is switched off for a litte while, decoupling the lever which usually transmits the motion in two half-lever (20) and (21) hinged on the same axis (14), when the interruption of the click mechanism is wished, having two possible mutual positions, the first one corresponding to the normal working order, the second one with the two half-levers (20, 21) free.

FIG. 2



EP 0 632 477 A2

PRIOR ART AND SUMMARY OF THE INVENTION

The object of the present invention is a device which automatically or manually performs a screening of a protection device after prefixed whiles and may therefore work with any electric parameter, e.g. the current, the tension, or the homopolar current or any other quantity, even not an electric one, as long as it can go back to an electric quantity.

Electro-mechanical devices suitable for protecting plants, users and workers are well known. A working failure of said devices causes damages to the plant and is also dangerous for the safety of the persons. Therefore, a continuous check, or at least after regular whiles, of the working of said devices is important, as well as an automatical intervention when the device fails, by replacing it with another one or by cutting off the checked plant and/or by signalling the failure to the operator.

The description specifically refers to a checking device for residual current circuit breakers against contact voltages in order to protect human life; however, the principle and the embodiment are suitable, with obvious modifications, to a further protecting and adjusting device and also to a further regulating or signalling device.

The device object of the present invention deviates or stops the mechanical disconnecting chain for a little while (around one second) inside the protecting apparatus. Said mechanical disconnecting chain, starting from the electro-mechanical detector of the failure quantity (i. e. the relay), releases automatically or manually the hooking of the mechanism which normally activates the contacts.

In a particular embodiment during the short while in which the disconnecting chain is intentionally cut off, a cycle programming automatism (C.P.A.) having a prefixed cycle sends an electrical impulse to the electro-mechanical detector of the checked quantity (relay), which is as strong as the one to be emitted in case of a plant failure. If the system is in good working order said impulse causes the working of the relay by giving a signal which is sent to the C.P.A. and which confirms that all is in order.

As a consequence of that, the C.P.A. sets in motion again the mechanical disconnecting chain previously cut off. Otherwise, if the relay does not work, the C.P.A. does not receive the back signal and, regarding this fact as a failure, it produces a signal.

Said first embodiment of the present invention comprises:

A) a C.P.A. performing the aforesaid cycle according to a well-known technique; said cycle could be mechanical, electrical, electronic, hydraulic or pneumatic or a suitable combination of these techniques;

B) one or more actuators produced by means of a well-known technique, carrying out the orders given by the C.P.A. and which are disclosed in the description as little electro-magnets;

C) an embodiment of the system which deviates or cuts off for a reduced while the order flow from the relay to the disconnecting chain of the device. Said system may be differently carried out, according to the energy used (i.e. electro-mechanical, magnetic, mechanical, pneumatic, oleodynamic) or by means of a combination of two or more different kinds of energy.

All the above described functions are ruled by an automatism (cycle-programming) and carried out by electro-magnets (or equivalent means) guided by the aforesaid C.P.A..

Aim of a third embodiment of the present invention is to show an accomplishment of the same function, no longer by means of a programmed automatism, but by means of a manual switching on carried out by the user.

This latter accomplishment is easier and cheaper, especially with regard to the residual current circuit breakers. According to the rules, said breakers must be provided with a manual button which, by simulating a current failure towards earth, provokes the click of the breaker and then an interruption of the electrical supply, thus disturbing the user and damaging the plant.

Hereinafter three non-limiting electro-mechanical embodiments are described which could be easily used by employing a kind of energy different from the mechanical one.

It is also possible to employ the first two electro-mechanical embodiments according to the free space available inside the protecting device:

D) with no free space inside the protecting device: it is possible to effect the cutting off of the disconnecting chain by acting on at least a lever which links the acting point of the relay pusher to the hooking point of the click mechanism of the contacts;

E) with free space inside the protecting device: it is possible to cause the shifting or the rotation of the whole body of the disconnecting device in order to reach a new position where the thrust pin does not interfere with the mechanical disconnecting chain of the protecting device.

LIST OF THE FIGURES

- Figure 1 shows an electro-magnetic disconnecting device placed in a protecting device;
- Figure 2 shows a first embodiment of the present invention automatically checked by a C.P.A., when no free space is available inside

the protecting device;

- Figure 3 is a horizontal section A-A along an axis of the first embodiment shown in figure 2;
- Figure 4 shows a flow-chart of the C.P.A., which represents a well-known technique;
- Figure 5 shows a second embodiment of the device according to the present invention, in that case a free space is available inside the apparatus;
- Figure 6 represents a third embodiment of the device according to the present invention, which manually works;
- Figure 7 represents the electical working of the embodiment shown in figure 6.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows, inside an electrical protecting device, the part where the polarised relay 10 is placed; said relay 10 fixed to stand 12 has a pusher 11. The disconnecting lever 13, being able to rotate around axis 14, rotates by means of pusher 11 when the relay 10 is energized owing to a plant failure, said pusher 11 pushing point 15 of the aforesaid lever 13. By means of tip 16 this latter disconnects hooking means 17 which switches on the whole disconnecting apparatus 18.

This working is usual in most of the mechanical protecting devices and it will be modified as follows according to the present invention.

Figure 2 shows a first embodiment of the present invention automatically checked by a C.P.A., when no free space is available inside the protecting device.

As shown in figure 2 the lever 13 of figure 1 is split into two half-levers 20, 21 hinged on the same axis 14, being said two half-levers 20, 21 integral to each other during the normal service working as only one lever 13 previously described. In figure 2, which is an exploded view, and in figure 3, which is a horizontal section A-A along the centre line of axis 14, one of said half-levers 20, 21, e.g. half-lever 20, is integrally fixed to axis 14 by means of two suitable stops 22, 23; when axis 14 shifts forward and backward it trails half-lever 20, whereas half-lever 21 stops because of bush 24 which binds said half-lever 21 to stand 12.

According to this particular feature, or an equivalent one, when the C.P.A. (not shown in figure 2) decides to verify the working of the device, it switches on the electro-magnet 25 which attracts core 26. In that case, axis 14 shifts trailing half-lever 20, whereas half-lever 21 stops.

In this way tailpiece 27 of half-lever 20, which up to this point engaged half-lever 21 making it integral to said half-lever 20 during its possible clockwise rotation, is placed in correspondence to free space 28 of half-lever 21; in this position the two half-levers 20, 21 are now free. At this moment the C.P.A. sends an impulse to the relay 10, said impulse being as strong as the one produced by a failure in the plant with a consequent coming out of pusher 11 which causes a counter-clockwise rotation of half-lever 20, whereas half-lever 21 and hooking means 17 (not represented in Figs. 2-3) stop and then stops also the main mechanism which operates the network contacts. During its rotation half-lever 20 operates a suitable contact 29 by means of its arm 30, said contact 29 being represented in figure 2 as a mechanical one, but may be reed-type or static ones. A signal is generated and sent to the C.P.A. causing the excitement of a second electro-magnet 31 which provokes, by means of spring 32, a counter-rotation of half-lever 20 with its slide 33 towards the starting position and further, in order to make sure that through the aforesaid half-lever 20 also pusher 11 of the relay 10 reaches its starting point. Afterwards, the C.P.A. provides to de-energize the electro-magnet 25 and then subsequently electro-magnet 31, so that half-lever 20 goes exactly back to the starting point by means of reaction springs 34, 35. After checking the efficiency of the differential trasformer, of the failure detector (relay) and of the first operating unit of the disconnecting apparatus, the C.P.A. resets and starts a new delay cycle, at the end of which it checks again and so on, till when, during such an automatic check, it happens that the relay 10, although energized by means of a test impulse, does not activate pusher 11. It is obvious that the protecting apparatus fails because the relay is no longer efficient or because the mechanical frictions have increased, or because oxidation or corrosion occurs, or because the anchor of the magnetic circuit of the relay 10 adheres, etc.

Because of the failed action of pusher 11, half-lever 20 does not rotate and contact 29 does not switch on. The C.P.A. takes note of this, and, as above said, stops, thus activating the means foreseen by the procedure in case of failure, said means being respectively:

- the replacement of the failed apparatus with a spare one by automatically acting suitable switches of the electrical network, besides the activation of a signal;
- the immediate remote switching off of a main circuit breaker placed before the failed apparatus, besides the activation of a suitable signal in situ or far away;
- the simple activation of a suitable signal in order to require the immediate presence of a technician.

Figure 2 shows a particular embodiment of two half-levers 20 and 21, linked by means of any

mechanical device, e.g. a pin or a lock placed in suitable bores on parallel side walls of half-levers 20 and 21. The placement of said pin corresponds to the normal working of the device, whereas the extraction of said pin by means of an electro-magnet commanded by the C.P.A. makes the two half-levers 20 and 21 free to indipendently move. The aforesaid linkage could be carried out by means of any other device, electro-magnetic (e.g. an electro-magnetical coupling), magnetic (e.g. one or more permanent magnets suitably disposed by an external operator), hydraulic or pneumatical (e.g. by means of a little pinion commanded by an electro-valve), the working of said means being always controlled by the C.P.A..

The practical application of the device suitable to the apparatus which does not provide a free space is advantageous when the apparatus is a modular one, namely:

- C.P.A. (very small if completely electronic);
- two electro-magnets 25 and 31 with relevant working levers, slide 33 and core 26;
- contact 29;
- the optical signal device in situ;
- the contact sending said signal, and
- the source for the whole device, which is fed below the protecting apparatus to be controlled,

may be contained in one module to add by a simple assembling operation to the modular protecting apparatus, if it has already programmed to this aim.

In fact, this latter must have already been provided during its construction with:

- two split half-levers 20 and 21, wherein half-lever 20 and the relevant axis 14 can freely shift;
- interfacing end elements 36 and 37 destined to energize the relay 10, which have derived, in the case of residual current circuit breakers or relays, from the electrical test button with suitably limited current, which the C.P.A. will afterwards act in order to inject an impulse into transformer 38 whose secondary circuit feeds winding 39 of the relay 10; as well as
- preconstituted cavities placed on the container wall of the apparatus, on the same side of stand 40, where it can be subsequently added the aforesaid self-checking module, after the removal of the cut parts for the preconstituted cavities which allow the penetration of the following parts, projecting out of the self-checking module:
- core 26 acted by electro-magnet 25 in order to move axis 14 and press spring 34;
- slide 33 acted by electro-magnet 31 which drives the counter-clockwise rotation of half-lever 20 and which also bears contact 29;
- the connector to be plugged into end elements 36 and 37.

For a better comprehension of the present description figure 4 shows a flow-chart of the C.P.A., which in its turn represents a well-known technique, namely:

- Nr. 40: is the starting step for the counting between two checks;
- Nr. 41: continues the counting;
- Nr. 42: discerns two different cases: (a) if the counting does not come to an end for lack of tension to the C.P.A. (e.g. because the breakes has been manually switched) he cycle resets and then starts again; (b) on the contrary, if the counting ends, it follows Nr. 43 wherein electro-magnet 25 moving axis 14 is energized;
- Nr. 44: end elements 36 and 37 are short-circuited with a consequent feeding of transformer 38, of relay 10 and a final switching on of contact 29;
- Nr. 45: the switching on of contact 29 allows the cycle prosecution; on the contrary, its possible failure provokes the C.P.A. stop and the transmission of the signals for the emergency procedure (alarms, etc) (Nr. 50);
- Nr. 46: removes the short-circuit between end terminals 36 and 37;
- Nr. 47: energizes electro-magnet 31 which leads half-lever 20 to its starting point and loads again disconnecting device 10;
- Nr. 48: sequentially de-energizes electro-magnets 25 and 31;
- Nr. 49: resets the counting thus allowing the cycle to start again with Nr. 40.

The check of a regular working can be effected in a very short while (around 2 seconds). The lapse between two checks may vary from some seconds to one month, according to the apparatus, its functions and its requirements.

Figure 5 shows a second embodiment of the device according to the present invention. In that case a free space is available inside the apparatus and it is necessary an alteration to the normal mechanism of figure 1. Remark that the relay 10 is fixed on one side to the axis 51 around which it could rotate, were it not stopped by spring 52. If, on the contrary, the external electro-magnet 53 is energized when the C.P.A. decides to start the periodical check, the relay 10 is called back by the anchor of electro-magnet 53 through tie 54 and rotates around axis 51 thus pushing pusher 11 outside the field of action of arm 55 of disconnecting lever 13. If, in this new position, the relay 10 is energized by means of the C.P.A., pusher 11 engages lever 56 by making it rotate around axis 57 with an angle sufficient to set in motion a contact, both a metallic contact 58 or a static one.

The consent signal reported by contact 58 to the C.P.A. starts the following step which consists of loading lever 56 by energizing electro-magnet 59 which swallows up its mobile core and of re-starting the protection by ordering the de-energization of electro-magnet 53 which makes come back the relay 10 to its starting position. On the contrary, if pusher 11 had not come out when the C.P.A. had sent the electric impulse to the disconnecting device 10, lever 56 would have not rotate and contact 58 would have not switched on. Receiving no signal, the C.P.A. would have stopped and would have started the foreseen emergency measures.

If provided with elementary alterations and adjustments the showed embodiment is valid in all cases, namely if the relay 10 does not rotate, but shifts or is lifted, if its motion is a combined rotation and shifting or if the relay is definite while the disconnecting chain partly rotates or shifts.

The third embodiment of the present invention, which manually works, is described as follows with a particular reference to a residual current circuit breaker; however, with obvious adjustments, this system can also apply to other electrical apparatuses to keep under control. The test button releases a half-lever thus verifying the detecting and disconnecting function (differential transformer, relay and disconnecting chain) without interrupting the supply, as hereinafter described with reference to figures 6 and 7.

In said two figures the button is marked with 60. The button upper part 61 protruding out of the breaker carter is pushed by the user. Letter T 62 graved on said button upper part 61 is prescribed by the rules and means "test". 63 and 64 are two button side wings, which, shifting along the two fixed grooves of the switch, lead the button in its shifting downwards. The button cylindrical lower part 66, which can shift inside the sleeve 67, integral to the breaker, guides the reaction spring 68. In figures 6 and 7 it is also remarkable the presence of the wall 40 supporting the switch mechanism, particularly axis 14 of half-lever 20, free to rotate but integral to said switch mechanism by means of two stops 22, 23.

As above said, axis 14 shifts rightwards by means of an external action on its left end and comes back to its starting position thanks to spring 34.

Figure 6 shows as the pressure on the button shifts the aforesaid axis 14. In fact, on wall 40 the bent part 69 is to be noticed, to which the fixed axis 70 is integral; the free lever 71 is hinged on said axis 70, said lever being frictionally pressed by spring 72 and stop 73. The upper end of lever 71 can be placed by the user either on the free space 74, comprised in the main body of the switch corresponding to: "Check without switch click", or on the contiguous space 75, corresponding to "Check with switch click".

In fact, the lower end of lever 71 is provided with a tailpiece 76 compelling cam 77 (free to rotate on axis 93 integral to button 60), to stop in the position indicated in figure 6, when lever 71 is placed in the free space 74.

By pushing the button, the right side of cam 77 engages the end of axis 14 and pushes it rightwards, thus shifting half-lever 20 and its tailpiece 78 bent downwards. Arm 79 is integral to button 60 and it is therefore shifted downwards in the opening 80. The end 81 of arm 79 will then have the same vertical position of tailpiece 78, but below it. Supposing that the relay 10 of figures 1 and 2 has been energized by the actions hereinafter described, the pusher 11 rotates half-lever 20 downwards. If the user releases button 60, it will come back upwards because of spring 68. Then also arm 79 and its end 81 will come back to their starting position thus leading upwards also half-lever 20 which will press on the pusher 11 re-energizing the relay 10. The end 81 has a springy tailpiece 82, on which the lower end of tailpiece 78 shifts when axis 14, because of spring 34, brings back half-lever 20 to its usual rest position, namely integral to lever 21, cam 77 being come back to the position of figure 6.

The electrical functions performed by button 60 in the meanwhile are reported in figure 7, which shows said button 60 rotated 90° counter-clockwise in order to clear up said functions.

Figure 7, beside the parts already described in figure 6 with the same references, shows that:

- a sensitive contact 83, 84 which can be differently carried out, e.g. statically by means of a photodiode, moved by arm 30 of half-lever 20;
- a metallic conducting plate 85, immerged in the isolating button 60, which, when it is engaged with sliding brushes 86, 87, 88 closes the relevant electrical circuits;
- a signalling lamp 89 with relative ballast 90;
- the differential transformer 38 with its relevant secondary winding 39 feeding the relay 10;
- a resistor 91 limiting the current flowing in the primary spoil of transformer 38.

By pushing button 60, beside the aforementioned mechanical functions, the following electrical actions occur:

- first, plate 85 engages sliding brushes 86, 87, thus linking the feeding circuit 92 to a circuit composed by the following parts: the aforesaid sliding brushes 86, 87, lamp 89 with its relevant resistor 90, sensitive contacts 83, 84 now already open;

- then, plate 85 also touches sliding brush 88 thus switching on also the circuit composed by: feeding circuit 92, sliding brushes 86, 87, 88, primary winding of transformer 38, resistor 91 limiting the test current of the breaker.

Said test current generates a current in the secondary winding 39 of transformer 38 which energizes the relay 10 and draws out pusher 11 of figure 2, thus rotating counter-clockwise lever 20, which, in the meantime, had been shifted rightwards by axis 14 pushed in its turn by cam 77 of figure 6, and is released from half-lever 21. Arm 30 of half-lever 20 switches on contacts 83, 84 which, in their turn, switch on the circuit of lamp 89 which lights up, thus confirming to the user that the differential transformer, the relay and the first half-lever work correctly.

When the user releases the button, together with the above described mechanical actions for the restoration of half-lever 20, all electrical circuits come to their starting "switched off" position. In this way the manual check of the most sensitive components takes place without interrupting the electrical supply. Together or apart from the present invention, the breaker could also be provided with a timer programmed with delays corresponding to one month, or to a different lapse of time in case of particular necessities; at the expiry of the programmed time said timer lights up a visual signal, or an acustic one, which indicates to the user that he must press the test button.

If the user wishes to check all functions of the switch, he just has to move lever 71 from position 74 to position 75. In this case, in fact, the tailpiece 76 of lever 71 goes away from cam 77 which, during the pressure of the finger on button 60 shifts to the end of axis 14 without moving it and then leaving the two half-levers 20, 21 integral to each other.

In this case, by moving downwards and closing the contacts 86 and 88 button 60 starts the relay 10 which rotates both half-levers 20 and 21, thus provoking the disconnecting of the whole mechanism and the following switching on of the breaker, whereas lamp 89 does not light up because arm 30 of the half-lever 20, which has not moved, does not engage the contact 84. It is also to be noticed that the particular shape of plate 85 provokes only a temporarily switching on of contact 88 which feeds transformer 38 so that the limiting resistor 91 is not damaged if the user presses the test button for a long time.

Claims

1. Device to automatically or manually test the efficiency of the most sensitive components of an electrical apparatus, in particular of a residual current circuit breaker, also keeping the contacts of the main circuit in normal working order; said device being characterized in that the lever (13), which usually trasmits the motion from the pusher of the relay to the hooking means usually stopping the disconnecting mechanism of the breaker, is doubled in two half-levers (20, 21);

2. Device according to claim 1, characterized in that said lever (13) is doubled in two half-levers (20, 21) hinged on the same axis (14) but having two possible mutual positions:
   (a) a first position, corresponding to the normal working order, without the action of external agents, wherein said two half-levers (20, 21) are integral to each other, thus forming a single lever, which can rotate releasing the disconnecting mechanism and commanding the switching off of the switch;
   (b) a second position of said two half-levers (20, 21), being caused by the action of external agents when the interruption of the click mechanism is wished, said second position being obtained by shifting the axis (14) of said two half-levers (20, 21) , so that the dragging half-lever (20) shifts integrally with said axis (14) because of two stops (22, 23) on said axis (14), whereas the dragged half-lever (21) stops because it is linked to the stand (12) and is free regarding the axis (14); thanks to the shifting of said axis (14), the tailpiece (27) of the dragging half-lever is located inside a free space (28) of the dragged half-lever (21) and then, during the test, the pusher (11) of the relay may freely rotate said half-lever (20) till switching on a contact (29) which confirms that the protection system is efficient, while the other half-lever (21) and the hooking mechanism are still.

3. Device according to claim 1, characterized in that the link between said two half-levers (20, 21) is performed by means of a pin or a lock introduced in suitable bores placed on side walls of said two half-levers which may become independent from each other only when an external agent, like an electro-magnet, removes said pin or lock from at least one of said half-levers.

4. Device according to claim 1, characterized in that said two half-levers (20, 21) are integral to each other through magnetic means.

5. Device according to claim 1, characterized in that said two half-levers (20, 21) are integral to

each other during the normal working order, whereas during the test they become independent from each other by means of hydraulic or pneumatical devices applied to said half-levers and externally guided.

6. Device according to claim 1, characterized in that the interruption of the disconnecting chain is obtained by rotating, or shifting, or both, the relay (10) by means of an external device (52, 53, 54), so that said relay (10) reaches during the test a different position wherein the pusher (11) of the relay (10) acts a lever (56) in order to switch on the contact (58) confirming the protection efficiency.

7. Device according to claim 2, consisting of a button (60) to be externally manually pressed which, beside the electrical contacts necessary to inject a simulated current of failure provoking the intervention of the apparatus under control, supports a cam (77) apt to shift an axis (14) which, in its turn, shifts a half-lever (20) free to rotate on said axis (14) and which, after this shifting, looses its link to a second half-lever (21).

8. Device according to claim 7, characterized in that the cam (77) provoking the shifting of the axis (14) on which both half-levers (20, 21) rotate is blocked in its position relevant to the button (60) by a lever (71) hinged on the fixed part of the apparatus which, sliding on a side of said cam (77), links it to its position even when the pressed button (60) shifts, said lever (71) having two stable positions, one being the above mentioned and the other being rotated with any angle with respect to the first which detaches it from said cam (77) and then does not link it any longer, so that the button (60) can perform any other function, but the one the cam (77) is committed to.

9. Device according to claim 7, characterized in that it is provided with simple means to subsequently act two electrical circuits, the one being the circuit of a signalling lamp (89), and the other apt to simulate a failure current, said circuits being synchronized with the mechanical actions previously described.

10. Device according to the previous claims 7, 8, 9, characterized in that the button (60) is replaced by any other actuator (e.g. lever or rotating knob) and, anyway, carried out and acted.

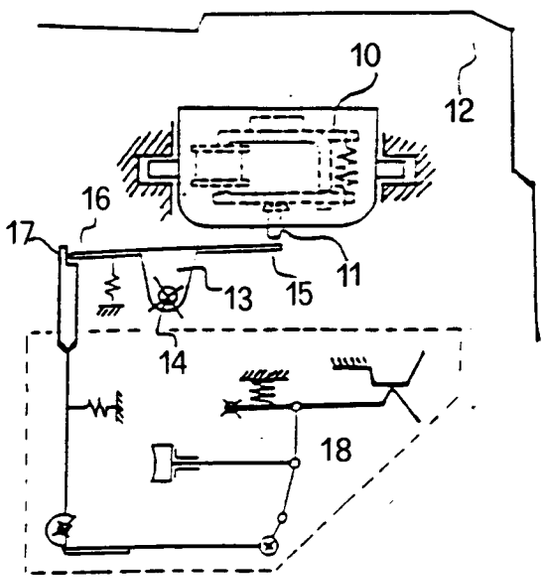


FIG. 1

FIG. 2

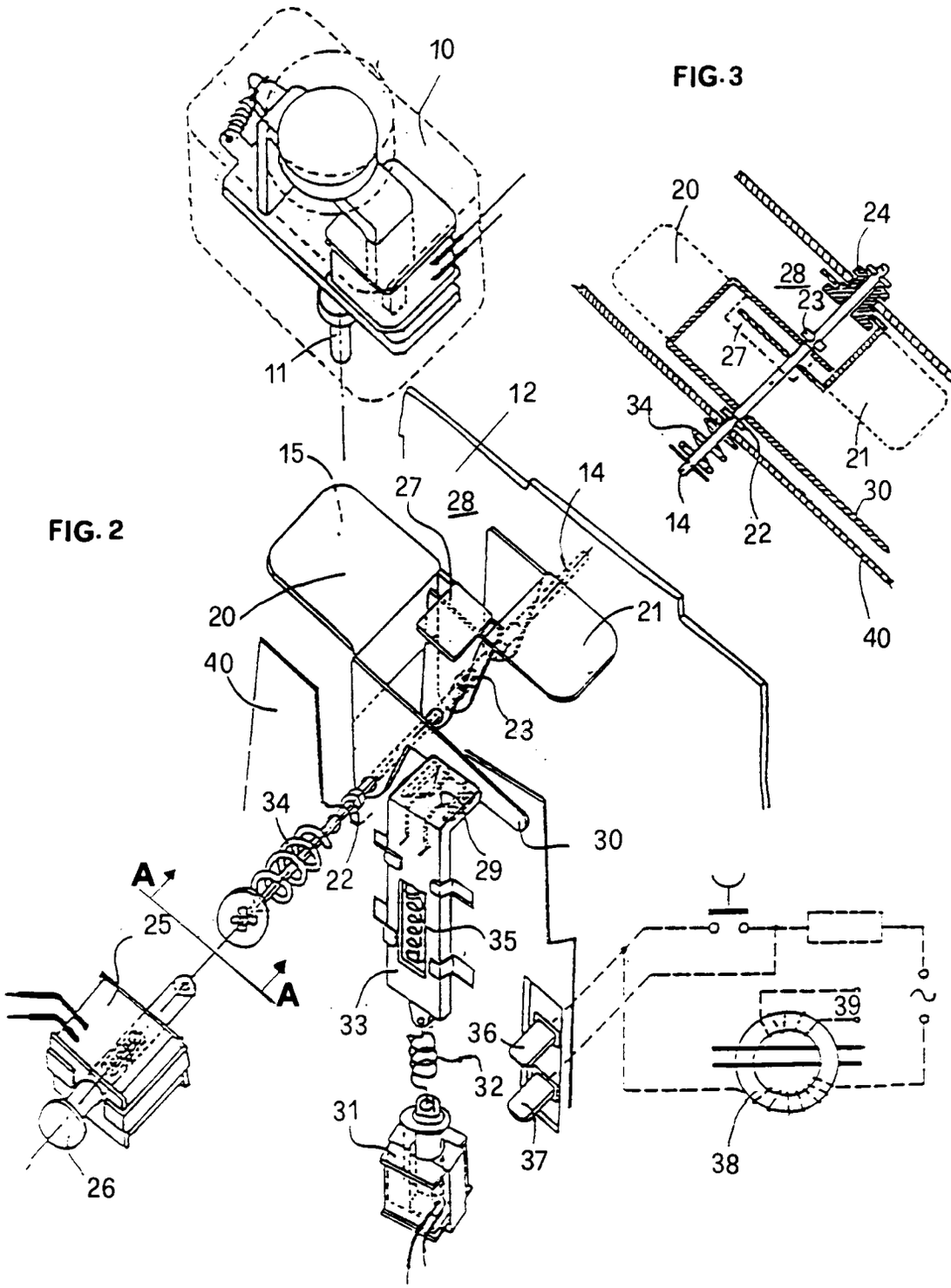

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FIG. 3

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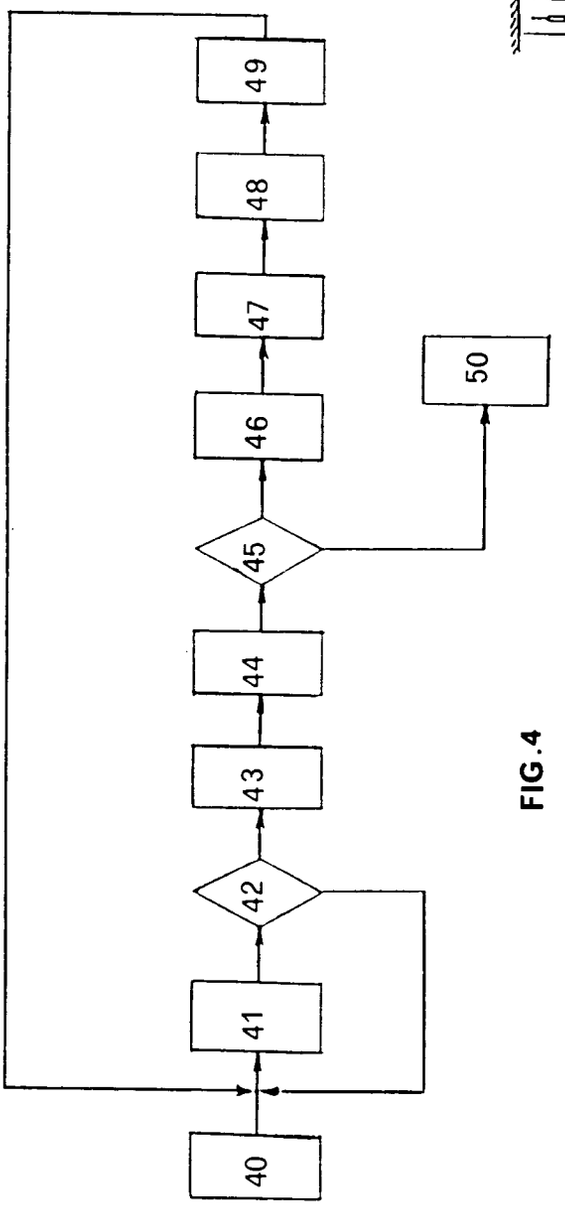

FIG.4

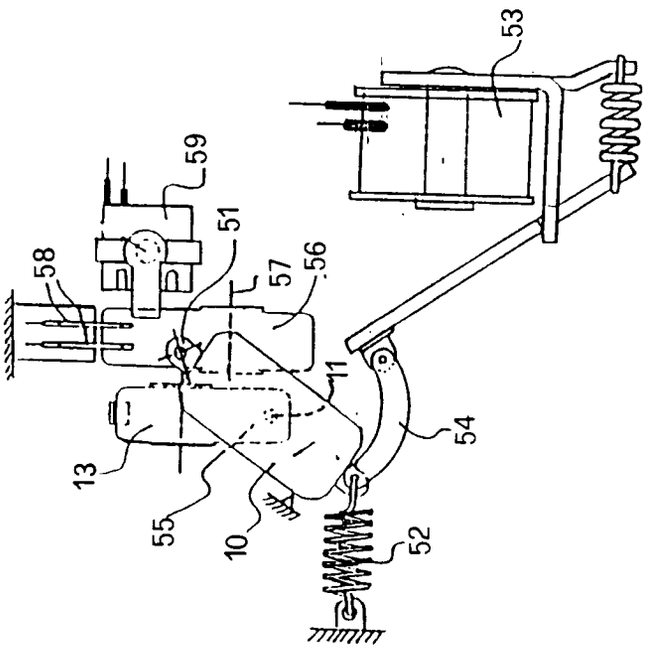

FIG.5

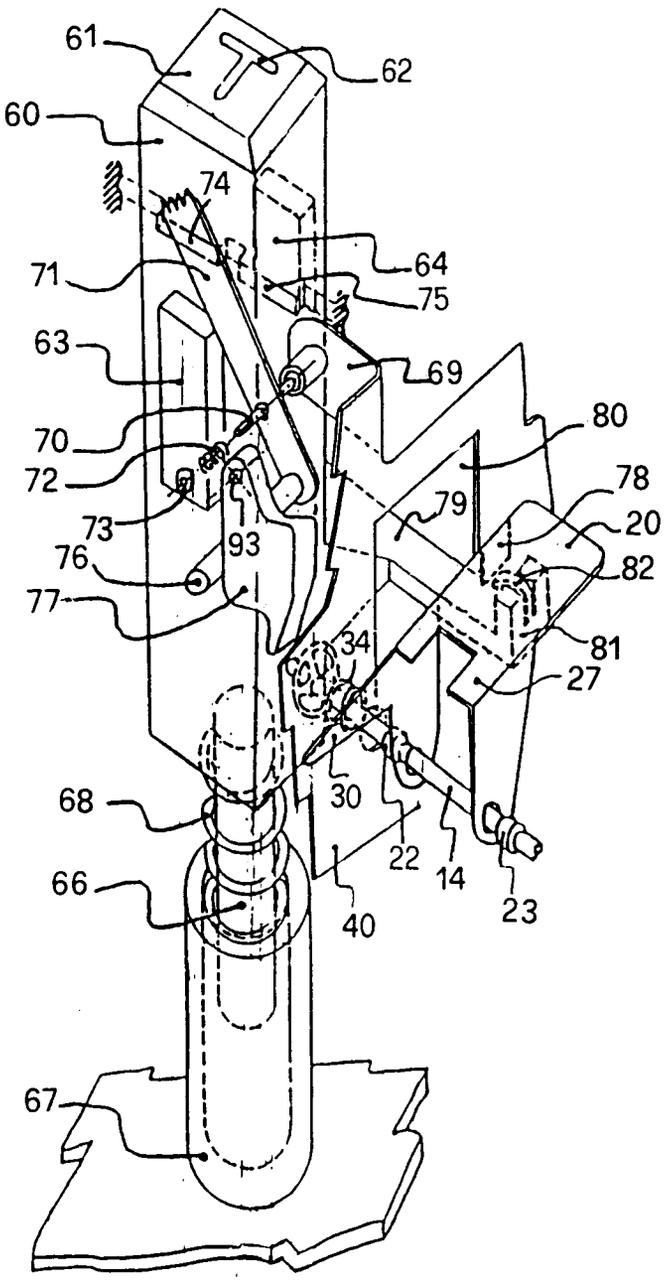
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FIG. 6

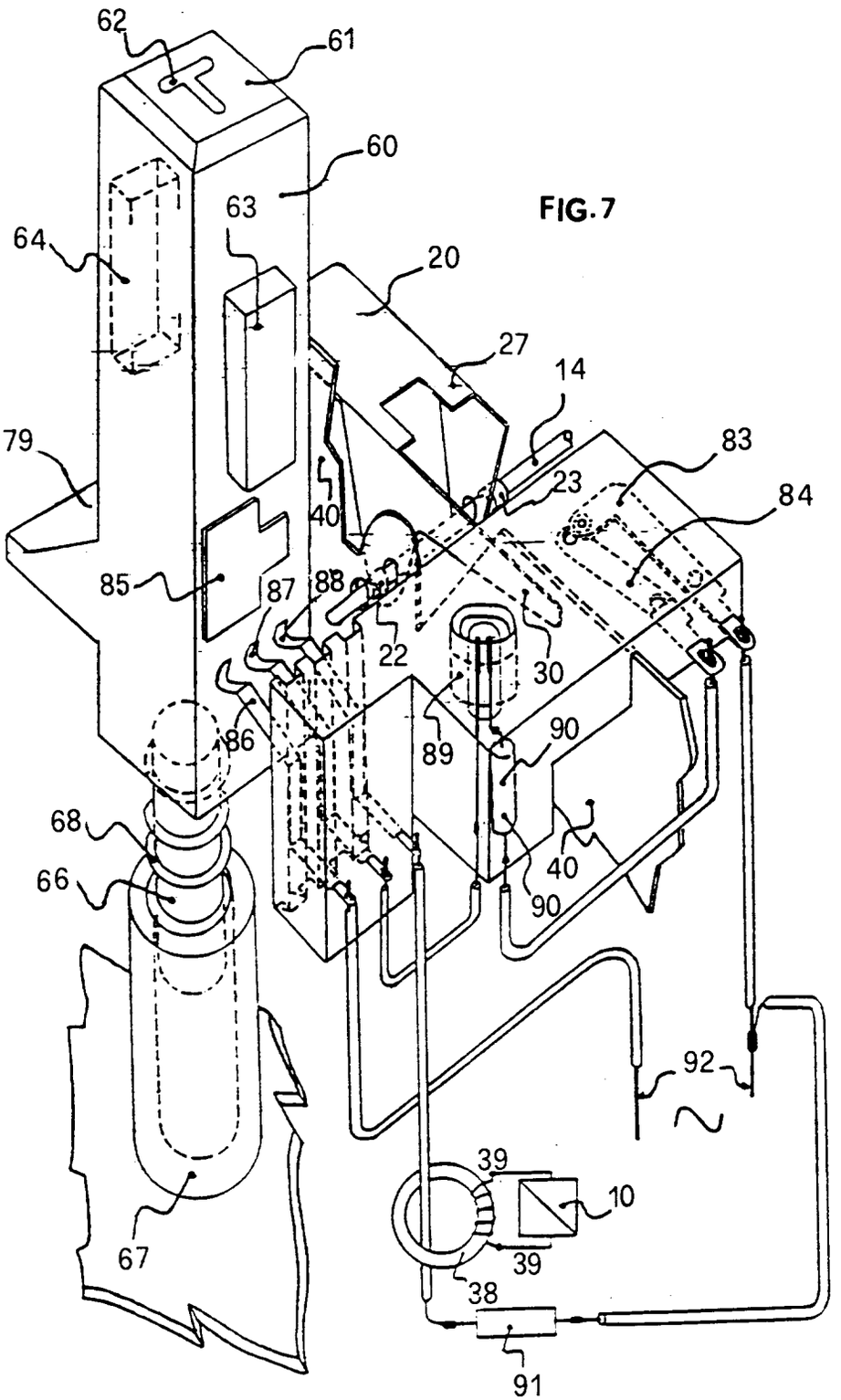
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FIG.7