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15 The present invention concerns a switching device according to the preamble of claim 1.

20 Generally speaking, it is suited to all systems using a switch in which it is required to sense and possibly to signal transient phases during opening or closing.

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25 It is particularly suited to implementing multipole switching devices for feeding capacitive loads in which the load currents are established initially through limiter resistors shunting main switches that are still open by means of auxiliary switches in series with the resistors, the main switches then being closed by a control member which previously closed the auxiliary switches.

30 These switching devices, which are in particular used in installations where it is required to improve the load factor, may malfunction due to the aging of the contact parts.

35 The operating sequence mentioned above is usually achieved, e. g. in the way described in European patent application EP-A-0 058 235, by means of a control member

- which is coupled to the solenoid armature and operates the moving parts of the switches simultaneously. Because of the different distances between the mobile contacts of the two sets of switches and the corresponding fixed contacts, the same movement first closes the auxiliary switches and then closes the main switches which therefore establish only lower currents and then a constant current representing the steady state condition.
- 10 When, due to the de-energisation of the solenoid in order to decouple the capacitive load, a retrograde movement is imparted to the control member, the main switches open first, and as the auxiliary switches are still closed, their rupture capacity is virtually negligible. The
- 15 auxiliary switches provide the major part of the rupture capacity and shorten the service life of the device because they are not so well rated for this function.
- 20 The fixed and moving parts of the main switches never close or open at full load and so do not benefit from erosion caused by electrical arcing, the consequence of which is a gradual increase in the pollution of the contact surfaces accompanied by an abnormal increase in the contact resistance and sometimes failure of
- 25 electrical contact at the main poles. The increased resistance can in turn disrupt the thermal equilibrium of the switching device, in particular of the auxiliary switch and resistors.
- 30 In this type of application, one object of the invention is to provide a switching device operating as described above upon closing, but reversing the sequence of contact member switching of the main and auxiliary switches upon opening in order to reliably transfer current flow from
- 35 the auxiliary switches to the main switches.

To achieve these results, the invention proposes a switching device comprising at least one main switch adapted to move from an open position to a closed position during a transient closing phase and from a closed position to an open position during a transient opening phase, said two phases being commanded by respective displacements of a control member, and at least one auxiliary switch comprising at least one fixed contact and a mobile contact coupled to said control member by a mechanical linkage.

According to the invention, this device is characterised in that said mechanical linkage comprises a releasable coupling adapted to move from a coupled position to an uncoupled position during the transient closing phase by closing the auxiliary switch before closing the main switch and by opening the auxiliary switch after closing of the main switch, and then to return from said uncoupled position to said coupled position during a subsequent passage of the main switch through the other transient phase.

Said releasable coupling is advantageously of the snap-release type and is designed to release when the control force transmitted to the auxiliary switch by the control member of the main switch exceeds a predetermined threshold.

In a first embodiment of the invention, said releasable coupling comprises spring snap-release means.

In a second embodiment adapted to alleviate possible wear of surfaces rubbing together during frequent coupling and uncoupling, said releasable coupling utilises at least two magnetically coupled parts.

Finally, in an arrangement which has advantages in either of the above two embodiments, the auxiliary switch and the associated return spring are disposed in a housing independent of the body of a contactor device comprising the main switch, an armature return spring and the solenoid providing the actuation function for the two types of switch.

The invention and embodiments to which it lends itself will be better understood from the following description and the appended drawings which show :

In figure 1, an electrical circuit diagram of a circuit for connecting a capacitive load to a three-phase electrical mains power supply using a device in accordance with the invention ;

In figure 2, a schematic view of the two systems of switches when unoperated ;

In figure 3, a first embodiment of a removable mechanical coupling between two contact-holders aligned with each other ;

In figure 4, a state of the switching device representing a phase of operation in which the main switches are closed and the auxiliary switches are open ; and

In figure 5, a second embodiment of a removable magnetic coupling between two facing contact-holders.

A circuit 1 for connecting a capacitive load 2 in the form of three capacitors - C1, C2, C3 - to a three-phase electrical mains power supply - R, S, T - is shown in figure 1.

One type of remote control device shown in this figure by way of example provides this connection on the one hand by virtue of an electromagnetic contactor device 3 comprising in a housing 26 a solenoid 4, a mobile armature 5, a return spring 5' which urges the mobile armature towards a rest position and a control member 6 which may advantageously be an insulative rake or contact-holder on which are disposed the mobile parts of a set of three-pole main switches 7, 8, 9 and, on the other hand, a housing 11 associated mechanically with the housing 26 and comprising a set of auxiliary switches 13, 14, 15 actuated by a second control member 12 which may also be in the form of an insulative rake or contact-holder and is acted on by a respective return spring 12' the effect of which is to tend to open the switches.

The two control members which are advantageously, but not necessarily, aligned with each other in this embodiment, are coupled together by a releasable coupling 20 whose operation will be described below.

It must be clearly understood that the use of a contactor device is here relevant only to a requirement for remote control and that manual control means could be used in place of the solenoid in a device having the same mechanical and electrical function, possibly combined in a single housing or casing appropriate to this end ; in this case, known mechanical means may be disposed between a manual control member and an actuator member for the contact-holder so as to impart to the latter sufficiently rapid opening and closing movement.

The auxiliary switches 13, 14, 15 are in series with respective limiter resistors - R1, R2, R3 - each of these series-connected circuits shunting a respective main switch 9, 8, 7.

Each resistor R1 may be in the form of two series-connected resistors R1a, R1b disposed one on each side of the respective auxiliary switch 13; the resistors which in this embodiment are outside the housing 26, 11 are advantageously connected to the external terminals of the switches by means of their connecting conductors so that heat is dissipated effectively and so that the manufacturer is not required to modify conventional housings available to him in order to accommodate the contactor and the auxiliary contact assembly (see figure 1).

In the unoperated state of the device in this figure the two sets of main and auxiliary contacts are held open by the return spring.

Because the contact-holder 6 and the contact-holder 12 are associated with each other by virtue of the coupling 20 which is active in the unoperated position, any movement of the former in the direction F will cause a simultaneous displacement of the latter when the solenoid is energised.

To prevent instantaneous load currents which would assume high values during direct connection of the electrical mains power supply to the load flowing in the main power supply circuit 21 comprising the main switches, reduced load currents are diverted into the auxiliary power supply circuit 22 at the time of energisation because the auxiliary switches are closed beforehand.

They are closed a few milliseconds before the main switches and allow only small initial currents to flow through the three resistors. They are closed by virtue of the different closure distances appropriate to the

contact members of the main and auxiliary switches, respectively the distances  $e_2$  and  $e_1$ , the latter being smaller.

5 The required result is achieved in this instance by an appropriate choice of the travel of the two contact-holders, the travel  $c_1$  of the auxiliary rake being made less than that  $c_2$  of the main contact-holder through the intervention of a mechanical abutment to stop the former  
10 but allow the latter to continue on its travel (see figure 2).

This difference in travel is used to procure automatic releasing of the coupling 20 and therefore of the two  
15 contact-holders so enabling release of the auxiliary contact-holder and enabling the latter to return to its rest position when the main contact-holder has already closed the corresponding switches.

20 For the complete device to return to a rest state identical to that before the solenoid was energised, the return of the main contact-holder to the rest position quickly re-engages the coupling 20 due only to the effect of its respective return spring, so reconstituting the  
25 original coupling together of the two contact-holders 6, 12.

A first type of removable coupling 20 seen in the coupled state in figure 3 when the complete device is unoperated  
30 uses simple mechanical means that can be moulded or overmoulded during manufacture or can be obtained by assembling appropriate parts.

An extension 16 of the contact-holder 6 passes through an  
35 opening 27 in the housing 26 of the contactor and

projects from one surface 30 of the latter (its front or side, for example). It features a recessed portion 28 the opposite edges 24, 24' of which are narrower at the entry than the transverse dimension of a subsequent housing 29.

The contact-holder 12 of the auxiliary contact housing 11 comprises a forked extension 19 with spring branches 17, 18 the ends 17', 18' of which are wider than the preceding portion. The springiness of this fork, the required stiffness of which may make it necessary to use an additional metal spring member 23, enables it to disengage from the housing if sufficient longitudinal traction is supplied between the two contact-holders and to engage in the latter if longitudinal thrust is exerted by the contact-holder 6 towards the contact-holder 12.

In the associated state of the two housings which may be obtained by claws 32, 33 on the facing surfaces 30, 31 and in the unoperated position of the two contact-holders 6, 12 the return spring 12' urges the latter against a respective abutment 25' of the housing 11 by exerting a relatively low force and the armature return spring 5' has moved the contact-holder 6 in the same direction into its rest position.

When the contact-holder 6 moves in the direction F because the solenoid is energised a first travel  $c_1$  of the contact-holder 12 which compresses the spring 12' is necessary to close the switches 13, 14 and 15 and to establish an appropriate contact pressure. This movement is continued until the contact-holder 12 bears against and stops against a first abutment surface 25 on its housing 11 (see figure 2).

Because the travel  $c_2$  of the main contact-holder is greater than  $c_1$  the fork 19 is disengaged from the housing 29 and from the branches 24, 24' enabling the return spring 12' to urge the contact-holder 12 in the direction G against the abutment 25'; it is clear that consequential releasing of the coupling 20 and opening of the auxiliary switches occur only if the main switches are themselves closing and the contact pressure of their moving parts has already reached a sufficient value (see figure 4).

De-energisation of the solenoid of the contactor which enables the return spring 5' to return the contact-holder 6 towards its rest position - in the direction G - brings the edges of the recessed portion 28 into contact with the fork 19 and communicates to the latter by a percussion effect a transverse squeezing up which enables it to slide inside the housing 29 so that the coupling 20 is again engaged ready for the next operating cycle (see figure 2).

For this coupling to be effected without longitudinal play, failing which the sequence of successive closures of the switches could be compromised, there may be advantageously disposed in the housing 29 a spring plate 29' which imparts to the fork a calibrated penetration and longitudinal squeezing up so that the relative positions of the contact-holders are accurately defined.

The means just described are effective only if the characteristic of the solenoid has been carefully chosen so that the decelerations caused by the expenditure of energy needed to release the coupling 20 and by compressing the spring 12' are not too high.

Also, the energy developed by the expansion of the armature return spring 5' must be sufficient for the fork to enter the housing irrespective of the orientation of the device.

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In a second embodiment of the removable coupling 40 seen in figure 5 the two contact-holders 38, 39 are associated with each other by virtue of the attraction of a magnetised part 37 and a magnetisable part 36 made from ferrite and soft iron, for example.

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The magnetisable part and the permanent magnet may be placed on either of the contact-holders to meet constraints imposed by manufacturing convenience or reduction of technical costs.

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It is essential to guarantee a consistent coupling force for each manoeuvre. Thus at least one of the parts 36, 37 may be allowed to orient itself, for example by using an elastomer material to retain it or by fixing it to moulded and articulated parts of the contact-holder(s).

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It is clear that the rest positions of the two contact-holders must be sufficiently close together for automatic magnetic coupling to occur but not so close as to allow contact with the permanent magnets.

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The positions of the abutment surfaces to enable the magnetic and magnetisable parts to release when the solenoid is energised are determined by considerations analogous to those governing the mechanical coupling.

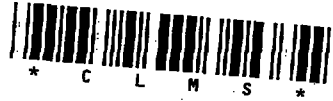
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Other types of releasable coupling may be substituted for those that have just been described without leaving the scope of the invention as claimed.



## Claims

1. Switching device comprising at least one main switch  
5 (7, 8, 9) adapted to move from an open position to a closed position during a transient closing phase and from a closed position to an open position during a transient opening phase, said two phases being commanded by respective displacements of a control member (6), and at  
10 least one auxiliary switch (13, 14, 15) comprising at least one fixed contact and a mobile contact coupled to said control member (6) by a mechanical linkage, characterised in that said mechanical linkage comprises a releasable coupling (20) adapted to move from a coupled  
15 position to an uncoupled position during the transient closure phase by closing the auxiliary switch (13, 14, 15) before closing the main switch (7, 8, 9) and by opening the auxiliary switch (13, 14, 15) after closing the main switch (7, 8, 9) and then to return from said  
20 uncoupled position to said coupled position during a subsequent passage of the main switch (7, 8, 9) through the other transient phase.
2. Switching device according to claim 1,  
25 characterised in that the mobile contact of the auxiliary switch (13, 14, 15) is movable between two positions, namely an open position and a closed position, and in that the mobile contact is urged towards one of said positions by spring means (12').
- 30 3. Switching device according to claim 1, characterised in that said releasable coupling (20) is of the snap-release type and is adapted to release when the control force transmitted to the auxiliary switch (13,  
35 14, 15) by the control member (6) of the main switch (7, 8, 9) exceeds a predetermined threshold.



4. Device according to claim 3,  
characterized in that said releasable coupling (20)  
consists in spring snap-release means (24, 24', 29 ; 17,  
18).

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5. Device according to claim 3,  
characterised in that said releasable coupling (20)  
comprises two magnetically coupled parts (36, 37) one of  
said two parts being coupled to the control member (6) of  
10 the main switch (7, 8, 9) and the other part being  
coupled to the mobile contact of the auxiliary switch  
(13, 14, 15).

6. Device according to claim 1,  
15 characterized in that said two switches (7, 8, 9 ; 13,  
14, 15) are disposed in the same housing, said control  
member (6) being displaced manually.

7. Device according to claim 1,  
20 characterised in that the main switch (7, 8, 9) and the  
auxiliary switch (13, 14, 15) are multipole switches and  
in that said mechanical linkage comprising the releasable  
coupling (20) couples the mobile assemblies of the two  
switches (7, 8, 9 ; 13, 14, 15).

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8. Device according to claim 1,  
characterized in that said main switch (7, 8, 9) is part  
of a contactor whose solenoid (4) is coupled to said  
control member (6).

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9. Device according to claim 7,  
characterized in that said contactor is accomodated in a  
first housing (26) and in that the auxiliary switch (13,  
14, 15) is accomodated in a second housing (11)  
35 optionally mechanically associated with the first housing  
(26).



10. Device according to claim 1,  
characterized in that the main switch (7, 8, 9) commands  
the energisation of a capacitive load (2) and the  
auxiliary switch (13, 14, 15) shunts the main switch (7,  
5 8, 9) to energise the load (2) through limiter resistors  
(R1, R2, R3) in the moment preceding the closure of the  
main switch (7, 8, 9).