

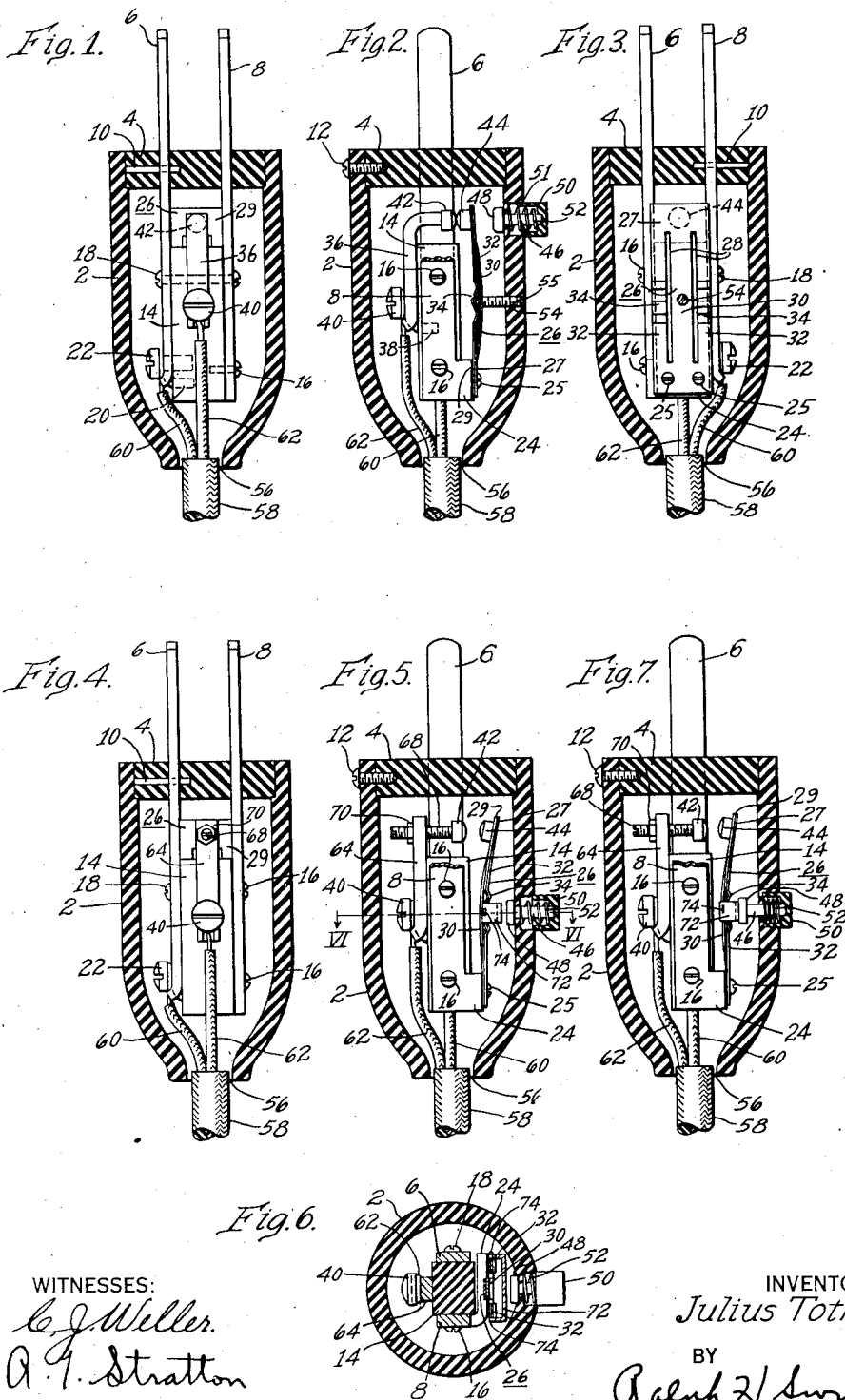
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ELECTRICAL APPARATUS

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WITNESSES:

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ELECTRICAL APPARATUS

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This invention relates to electrical apparatus in general, and especially to electric circuit interrupting apparatus for the protection of electric apparatus adapted to be plugged into an electric circuit. This invention contemplates, in its specific aspect, the incorporation of automatic electric circuit interrupting apparatus in electric plugs.

It has been proposed heretofore that electric attachment plugs be provided with some protective means such as a fuse element, or even a simple thermal strip element for automatically interrupting the circuit on overloads. The reason why such a protective means is desirable for electric plugs, is that the cords attached to electric apparatus, such as household appliances, are generally of smaller size than the permanent wiring into which they are plugged, so that the protective devices usually designed to protect such permanent wiring, may not be adequate in all cases to protect the apparatus plugged in and its attached cord. Moreover, while the apparatus itself may be adequately protected by built-in protective means, this still provides no protection for their extension cords.

Attachment plugs having fuse elements therein are objectionable because of the time and expense involved in the renewal of fuse elements, and while plugs having simple bimetal strips therein do not require renewal on each operation, these are essentially slow-make and slow-break devices and consequently are limited in interrupting ability, and are subject to relatively rapid deterioration of the contacts due to excessive arcing.

Attempts have also been made in the past to provide in attachment plugs circuit interrupting means having relatively complex snap-acting mechanisms for actuating the contacts of the interrupter, but because of space limitations, such devices have not been practical.

Accordingly, it is one object of this invention to incorporate relatively simple yet efficient circuit interrupting means having snap-acting contacts in an electric attachment plug, without materially increasing the plug dimensions.

Another object of this invention is to utilize a snap-acting bimetal element in an electric attachment plug in a novel manner, to provide automatic protection for the cord and apparatus attached to the plug.

Another object of this invention is to provide a novel plug structure of the type described having novel snap-acting automatic circuit interrupting means therein which is resettable from the

exterior of the plug without disturbing the plug.

Another object of this invention is to provide a plug of the type described having automatic circuit interrupting means incorporated therein, with resetting means accessible at the exterior of the plug, which resetting means is trip-free of the interrupter contacts.

A still further object of this invention is to provide a novel plug structure of the type described having a snap-acting bimetal element incorporated therein, with novel means for adjusting the automatic operation of said element.

These and other objects of this invention will become more apparent after consideration of the following detailed description of preferred embodiments thereof, when taken in connection with the attached drawing in which:

Figure 1 is a longitudinal section of an electric plug constructed in accordance with this invention;

Fig. 2 is a longitudinal section of the plug shown in Fig. 1 taken substantially at right angles to the section of Fig. 1;

Fig. 3 is a longitudinal section of the plug shown in Figs. 1 and 2 looking at the opposite side of the structure within the plug from that shown in Fig. 1;

Fig. 4 is a longitudinal section of an electric plug illustrating a modified form of the invention;

Fig. 5 is a longitudinal section of the plug shown in Fig. 4 taken at right angles to Fig. 4;

Fig. 6 is a transverse section of the plug shown in Figs. 4 and 5 taken substantially on the line VI—VI of Fig. 5; and

Fig. 7 is a longitudinal section like Fig. 5, but illustrating certain of the parts in a different position.

The invention is illustrated on the drawing as being embodied in an electric connection plug adapted to be plugged into the conventional wiring outlet. The plug illustrated comprises a generally tubular plug body 2, having a closure disk 4 for closing one end of the plug body. The plug body and closure disk 4 may be of any desired insulating material, preferably a molded insulating material. Closure disk 4 is provided with spaced openings for receiving contact prongs 6 and 8, respectively, with at least the contact prong 6 being secured against movement relative to the closure disk, for example as by a locking pin 10 which may be driven into the disk and into an aperture provided in the contact prong. Closure disk 4 may be removably secured in place at the open end of the plug body, as viewed in the draw-

ing, by any desired releasable securing means, such for example as by one or more screws 12. When closure disk 4 is assembled in position in the upper end of the plug body 2, contact prongs 6 and 8 have their inner ends positioned within the plug body, and a supporting block 14 is secured in position within the plug body between the inner ends of the contact prongs. Supporting block 14 may also be of any desired insulating material, such for example as fiber or a molded insulating material. Supporting block 14 may be secured in position between the inner ends of the contact prongs 6 and 8, by any desired means, such for example as screws 16 used to secure contact prong 8 to the supporting block, and a screw 18 used to secure contact prong 6 to the supporting block. In order to prevent pivotal movement of the contact prong 6 relative to the supporting block about screw 18, the inner end of this contact prong is turned inwardly as at 20 to be seated in a cavity provided in the supporting block. The inner end of contact prong 6 is provided with a terminal screw 22 for directly securing a conductor thereto.

Contact prong 8 is provided at its inner end with a laterally extending supporting portion 24 on which may be mounted one end of a snap-acting bimetal element 26, as by screws 28. The bimetal element 26 is made to operate with a snap-action, by the provision of a pair of spaced slotted openings 30 extending longitudinally of the element and terminating short of the ends thereof. These slotted openings divide the intermediate portions of the bimetal element into a central leg 30 and side legs 32 and the side legs have their intermediate portions corrugated as at 34, or otherwise deformed to foreshorten these legs and cause central leg 30 to assume a bowed position as clearly shown in Fig. 2. Bimetal element 26 may be constructed in any manner well known in the art, of a pair of laminations 27 and 29 of conducting materials having different coefficients of thermal expansion, with the laminations secured in intimate engagement by any desired means, such for example as by welding or the like. For this particular application, bimetal lamination 27 should be of a material having a low coefficient of thermal expansion compared with the coefficient of thermal expansion of bimetal lamination 29, so that upon heating of the bimetal element the curvature of central leg 30 will be reversed from the position shown in Fig. 2.

An angled conducting bar 36 is mounted on the opposite side of supporting block 14 from bimetal element 26, with one leg thereof having its end portion deflected as at 38 into a cavity formed in the supporting block, and may, if desired, be molded therein, when the block is formed of a molded insulating material. The other leg of conducting bar 36 extends above supporting block 14 and terminates in an enlarged contact head 42 adapted to cooperate with a contact 44 secured to the upper end of bimetal element 26.

It will be noted that while the contact prong 6 is provided with a terminal 22 directly mounted thereon, the circuit between terminal 40 and contact prong 8 extends from terminal 40 through conductor bar 36, contact 42, contact 44, and through bimetal element 26 to contact prong 8. Accordingly, contacts 42 and 44 and bimetal element 26 are connected in series circuit relation between terminal 40 and contact prong 8.

With the parts positioned as shown in Figs. 1 to 3 of the drawing, it will be apparent that upon the passage through the circuit of currents above

a predetermined magnitude, bimetal element 26 being in series in the circuit, will be eventually heated an amount sufficient to cause reversal of curvature of central leg 30 thereof, and consequent movement of contact 44 carried by the bimetal element out of engagement with stationary contact 42. Bimetal element 26 has two static positions, one being the position shown in Fig. 2 wherein contacts 42 and 44 are in engagement, and the other being a position wherein contact 44 is disengaged from contact 42 and wherein the curvature of central leg 30 is reversed. Because it is necessary to reverse the curvature of central leg 30 of the bimetal element in order to separate contacts 42 and 44, the actual separating movement of the contacts will take place at a very rapid rate, because energy will be stored up in the bimetal element with substantially no movement thereof until central leg 30 is at a neutral point in reversing its curvature and thereafter it will quickly snap to its reverse curvature position in a toggle-like manner, to thereby separate the contacts with a snap action.

In order to reclose contacts 42 and 44 after an automatic circuit interrupting operation by the bimetal element such as that described above, an aperture is provided in plug body 2 at a point opposite the contacts for receiving a reciprocating rod 46 having an enlarged head 48 formed on the inner end thereof and having a push button 50, generally cup-shaped in form, threaded on the outer end thereof for sliding in the countersunk portion 51 through the aperture of the plug body. A coil compression spring 52 is engaged between push button 50 and the plug body to normally bias the push button to a raised position relative to the plug body and to maintain head 48 out of engagement with bimetal element 26.

It will be readily apparent that when bimetal element 26 has been heated an amount sufficient to cause reversal of curvature of central leg 30 thereof, to move contact 44 out of engagement with fixed contact 42, that the contacts may be reengaged merely by depressing push button 50 to engage the upper end of the bimetal element and move it towards contact 42 so as to move the upper end of bimetal element an amount sufficient to move the upper ends of side legs 34 overcenter with respect to central leg 30 and cause it to reverse its curvature back to the position shown in Fig. 2 thereby causing a snap-acting closure of contacts 42 and 44.

In order to calibrate the bimetal element so as to be automatically responsive to a certain value of current and separate contacts 42 and 44 to interrupt the circuit, an adjusting screw 54 is threaded into an opening provided in the plug body opposite substantially the mid portion of central leg 30 of the bimetal element, so that the curvature of the central leg may be lessened by taking up screw 54, thereby prestressing the bimetal element, and lessening the force required to reverse the curvature of central leg 30. This, of course, means that as adjusting screw 54 is taken up, less heating of the bimetal is necessary to effect reversal of the curvature on the central leg, and consequently the bimetal element will operate to interrupt the circuit at progressively lower currents. The head of the screw 54 is sealed with wax 55 or the like to prevent tampering with calibration when the plug is in use.

The end of plug body 2 opposite closure disk 4 is provided with a smaller opening 56, for receiving a conductor cord 58 having conductors 60 and 62 therein for connection to terminals 22

and 40, respectively. With the structure illustrated in Figs. 1, 2 and 3, an extremely simple device is provided within the small dimensional limitations of an electrical connector plug, involving the use of but a single moving part to automatically interrupt the circuit in response to the presence of overloads, with interruption and circuit closing occurring at a rapid rate or with a snap-acting opening of the circuit, to provide an extremely efficient protective means of small size. Moreover, it will be noted that the entire structure is supported by closure disk 4 so that the contact prongs 6 and 8, bimetal element 26, contacts 42 and 44, and terminals 22 and 40 are removable with the closure disk as a unit from plug body 2.

The plug construction illustrated in Figs. 4 to 7 is like that shown in Figs. 1 to 3 in most respects, and consequently, like reference characters will be used to designate like parts. This plug structure differs from that previously described in that the conductor bar 64 mounted on the side of supporting block 14 opposite bimetal element 26, is provided at its upper end above the upper end of the supporting block with a threaded opening for receiving a threaded shank 68 on contact 42, and a lock nut 70 is provided for shank 68 to lock contact 42 in any position to which it is adjusted relative to conductor bar 64. Another difference is that bimetal element 26 is adapted to be manually reset by push button 50 having the head 48 thereof engageable with a bridge member 72 secured to side legs 32 of the bimetal element. Bridge member 72 is substantially channel shaped in form and has the leg portions thereof secured to the outside edges of side leg 32 of the bimetal element in any desired manner, such for example as by lugs 74 integral with the bimetal element. Operating bridge 72 for the bimetal element is secured to the side legs of the element substantially at their midpoint, and push button 50, in this embodiment of the invention, is located on the wall of the plug body at a point opposite bridge 72.

A circuit interrupting operation of the device shown in Figs. 4 to 7 takes place in substantially the same manner as a circuit interrupting operation in the embodiment of the invention previously described, and accordingly, will not be repeated. This embodiment of the invention differs, however, in the operation of manually reclosing the circuit breaker contacts in that when the circuit has been opened and the parts assume the position shown in Fig. 5 of the drawing, it will be apparent that when push button 50 is depressed to engage operating bridge member 72, that the side legs 32 of the bimetal element will be moved to the left to bring the outer end of the bimetal element over-center with respect to middle leg 30 and cause the latter to reverse its curvature suddenly with a snap action, and close contacts 42 and 44 very rapidly. In the event that push button 50 is held in the depressed position shown in Fig. 7, the bimetal element may still operate to interrupt the circuit, because middle leg 30 may still reverse its curvature, and cause a separation of the contacts, with the bimetal element pivoting substantially about the center thereof rather than about the supported end, as is the case when push button 50 is not held depressed. This separation, as viewed in Fig. 7, is not as great as the separation obtained when the push button is not held depressed, but it will be sufficient to interrupt the circuit in all cases. When bimetal element 26 is heated an

amount sufficient to cause reversal of curvature thereof and move the free end thereof, for example from the position in Fig. 2 to that shown in Fig. 5, it will not be immediately reset by push button 50 if the push button is depressed right away, because under these conditions, a greater force is required to reverse the curvature of the bimetal element, and consequently side legs 32 would have to be moved to the left a greater distance than they are capable of being moved by the push button 50 in the embodiment of the invention shown in Figs. 4 to 7, in order to effect reversal of curvature. It will be observed that push button 50 in Fig. 7 is prevented from moving any further to the left by engagement with the bottom of countersunk portion 51 of the aperture in the plug body, and at this position the push button cannot reverse the curvature of the central leg of the bimetal element when it is heated enough to cause it to separate the contacts. In other words, if push button 50 is maintained depressed, bimetal element 26 will automatically open the circuit, and after some cooling thereof will automatically reclose the circuit, and this will continue as long as the button is held depressed. Push button 50 therefore is in effect trip free of the bimetal element, because the bimetal element is capable of opening the circuit even when the push button is held in its contact closing position.

Calibration of the bimetal element is obtained in this embodiment of the invention by adjusting contact 42 toward and away from contact 44 carried on the bimetal element to exert more or less stress on the bimetal element at the closed circuit position of the contacts. As previously indicated, contact 42 may be locked in any adjusted position by tightening lock nut 70.

It will be apparent from the foregoing, that this invention provides different forms of protective means for incorporation in an electric plug, which are capable of efficiently protecting the electric cord and apparatus with which the plug is associated, without, however, substantially increasing the dimensions of conventional types of plugs. Moreover, in both embodiments of the invention disclosed, there is provided means for adjusting the current at which interruption will automatically occur, as well as means for manually reclosing the circuit following an automatic interruption. Moreover, in the embodiment of the invention shown in Figs. 4 to 7 of the drawing, interruption will occur upon predetermined current conditions even though the manual reset means is held in its circuit closing position.

Having described preferred embodiments of the invention as required by the patent statutes, it should be understood that the invention is not to be limited to the particular embodiments disclosed herein, inasmuch as it will be obvious, particularly to persons skilled in the art, that many changes and modifications may be made in these particular structures without departing from the broad spirit and scope of this invention as defined in the appended claims.

I claim as my invention:

1. In a plug, a hollow plug body of insulating material, spaced contact members at one end of said body, a pair of conductors extending into said body from substantially the opposite end thereof for connection to said contact members, respectively, separable contacts in the connection of at least one of said conductors and its corresponding contact member, a snap-acting bimetal

element in said body having a movable portion for actuating said separable contacts, said movable portion of the bimetal element being movable between spaced static positions at which said separable contacts are engaged and disengaged, respectively, said bimetal element being heated in response to currents above a predetermined value in at least one of said conductors to actuate said movable portion from the static position where said contacts are closed to the other of said static positions to separate said contacts with a snap action, said bimetal element remaining at said other static position irrespective of the amount it cools down, manual reset means movable through a side wall of said plug body for actuating said bimetal element to move said movable portion from said other static position to said one static position to close said contacts with a snap action, and said reset means being trip-free of said bimetal element, whereby said element may separate said contacts even though said reset means is held in its contact closing position.

2. In apparatus of the type described, a bimetal element which is longitudinally slotted to form legs at least one of which is deformed to be of a different length than another leg so that the longer of said legs is longitudinally bowed in form, means rigidly supporting one end of said element, a contact mounted on said supporting means, a cooperating contact mounted on the opposite end of said bimetal element, said opposite end of said bimetal element being movable from one static position to another with a snap action upon reversal of curvature of said bowed leg to open and close said contacts with a snap action, said bimetal element being responsive to predetermined heating thereof to reverse the curvature of said bowed leg in a direction to cause movement of said opposite end of said element from the static position at which said contacts are closed to the other static position at which said contacts are open and cause snap-action separation of said contacts, said bimetal element remaining at said other static position irrespective of the amount it cools down, and manually operable reset means engageable with the shorter of said legs to cause reversal of curvature of said bowed leg portion in a direction to cause engagement of said contacts.

3. In apparatus of the type described, a bimetal element which is longitudinally slotted to form legs at least one of which is deformed to be of a different length than another leg so that the longer of said legs is longitudinally bowed in form, means rigidly supporting one end of said element, a contact mounted on said supporting means, a cooperating contact mounted on the opposite end of said bimetal element, said opposite end of said bimetal element being movable from one static position to another with a snap action upon reversal of curvature of said bowed leg to open and close said contacts with a snap action, said bimetal element being responsive to predetermined heating thereof to reverse the curvature of said bowed leg in a direction to cause movement of said opposite end of said element from the static position at which said contacts are closed to the other static position at which said contacts are open and cause snap-action separation of said contacts, said bimetal element remaining at said other static position irrespective of the amount it cools down, manually operable reset means engageable with the shorter of

said legs to cause reversal of curvature of said bowed leg portion in a direction to cause engagement of said contacts when said bimetal element has cooled down, and means limiting resetting movement of said reset means to an amount less than that necessary to cause reversal of curvature of said bowed leg when said bimetal element is heated said predetermined amount, whereby said bimetal element may automatically operate to open said contacts even though said reset means is held at its resetting position.

4. In apparatus of the type described, a bimetal element having spaced, generally longitudinally extending openings intermediate the ends thereof forming side legs and a central leg with said central leg having a greater effective length than said side legs to normally be longitudinally bowed in form, means rigidly supporting one end of said element, a contact mounted on said supporting means, a cooperating contact mounted on the opposite end of said bimetal element, said opposite end of said bimetal element being movable from one static position to another with a snap action upon reversal of curvature of said bowed leg to open and close said contacts with a snap action, said bimetal element being responsive to predetermined heating thereof to reverse the curvature of said bowed leg in a direction to cause movement of said opposite end of said element from the static position at which said contacts are closed to the other static position at which said contacts are open and cause snap-action separation of said contacts, said bimetal element remaining at said other static position irrespective of the amount it cools down, and manually operable reset means engageable with said side legs to cause reversal of curvature of said bowed leg portion in a direction to cause engagement of said contacts.

5. In apparatus of the type described, a bimetal element having spaced, generally longitudinally extending openings intermediate the ends thereof forming side legs and a central leg with said central leg having a greater effective length than said side legs to normally be longitudinally bowed in form, means rigidly supporting one end of said element, a contact mounted on said supporting means, a cooperating contact mounted on the opposite end of said bimetal element, said opposite end of said bimetal element being movable from one static position to another with a snap action upon reversal of curvature of said bowed leg to open and close said contacts with a snap action, said bimetal element being responsive to predetermined heating thereof to reverse the curvature of said bowed leg in a direction to cause movement of said opposite end of said element from the static position at which said contacts are closed to the other static position at which said contacts are open and cause snap-action separation of said contacts, said bimetal element remaining at said other static position irrespective of the amount it cools down, manually operable reset means engageable with said side legs to cause reversal of curvature of said bowed leg portion in a direction to cause engagement of said contacts when said bimetal element has cooled down, and means limiting resetting movement of said reset means to an amount less than that necessary to cause reversal of curvature of said bowed leg when said bimetal element is heated said predetermined amount, whereby said bimetal element may automatically operate to open said

contacts even though said reset means is held at its resetting position.

6. In a plug, a hollow plug body of insulating material, spaced contact members at one end of said body, a pair of conductors extending into said body from substantially the opposite end thereof for connection to said contact members, respectively, separable contacts in the connection of at least one of said conductors and its corresponding contact member, a snap-acting bimetal element in said body having a movable portion for actuating said separable contacts, said movable portion of the bimetal element being movable between spaced static positions at which said separable contacts are engaged and disengaged, respectively, said bimetal element being heated in response to currents above a predetermined value in at least one of said conductors to actuate said movable portion from the static position where said contacts are closed to the other of said static positions to separate said contacts with a snap action, said bimetal element remaining at said other static position irrespective of the amount it cools down, manual reset means movable through a side wall of said plug body for actuating said bimetal element to move said movable portion from said other static position to said one static position to close said contacts with a snap action, and means accessible from the exterior of said plug body for adjusting said bimetal element to vary the value of current to which said element will respond.

7. In a plug, a hollow plug body having an opening, a closure member of insulating material adapted to be removably secured to said body in

a position to close said opening, an opening in said body for cord conductors spaced from said first mentioned opening, spaced contact members extending through said closure member, terminals for said contact members to which said cord conductors may be secured, means serially connected between at least one of said terminals and its corresponding contact member which is responsive to currents above a predetermined value in at least one of said contact members for interrupting the circuit, and said contact members, terminals and interrupting means being supported from said closure member so as to be removable as a unit with said closure member from said plug body.

8. In a plug, a hollow plug body having an opening, a closure member of insulating material adapted to be removably secured to said body in a position to close said opening, an opening in said body for cord conductors spaced from said first mentioned opening, spaced contact members extending through said closure member and secured thereto, terminals for said contact members to which said cord conductors may be secured, means serially connected between at least one of said terminals and its corresponding contact member which is responsive to currents above a predetermined value in at least one of said contact members for interrupting the circuit, and said terminals and interrupting means being supported by said contact members so as to be removable as a unit with said closure member from said plug body.

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