

Nov. 7, 1939.

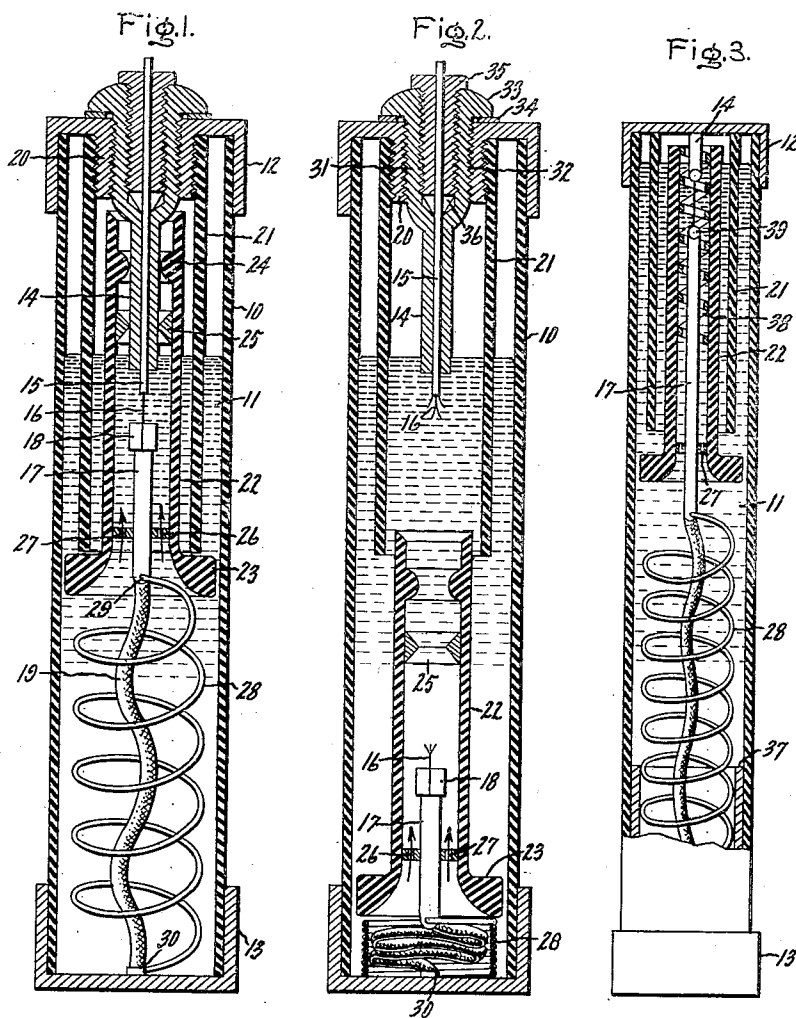
G. W. MÜLLER

2,179,342

PROTECTIVE MEANS FOR ELECTRIC CIRCUITS

Filed Dec. 3, 1935

2 Sheets-Sheet 1



Inventor:
Gustav W. Müller,
by *Harry E. Dunham*
His Attorney.

Nov. 7, 1939.

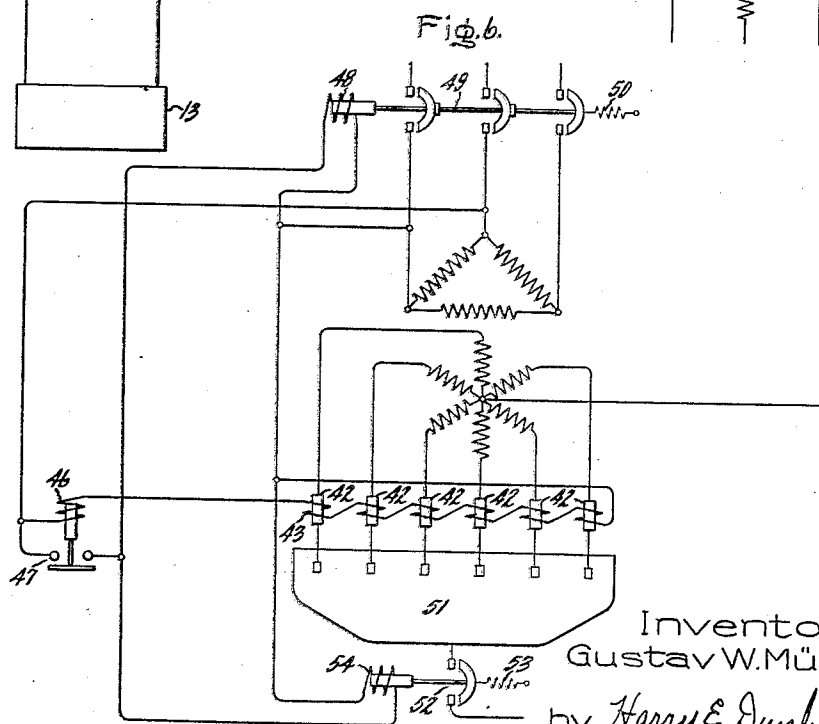
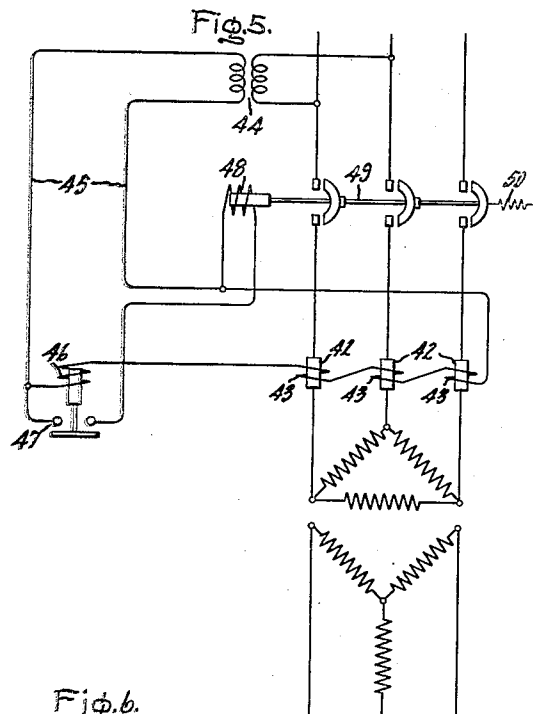
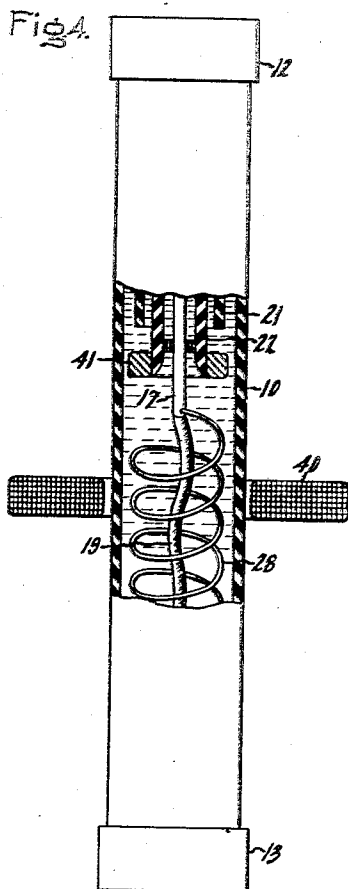
G. W. MÜLLER

2,179,342

PROTECTIVE MEANS FOR ELECTRIC CIRCUITS

Filed Dec. 3, 1935

2 Sheets-Sheet 2



Inventor:
Gustav W. Müller,
by Harry E. Dunham
His Attorney.

UNITED STATES PATENT OFFICE

2,179,342

PROTECTIVE MEANS FOR ELECTRIC
CIRCUITS

Gustav W. Müller, Berlin-Charlottenburg, Germany, assignor to General Electric Company, a corporation of New York

Application December 3, 1935, Serial No. 52,711
In Germany December 20, 1934

8 Claims. (Cl. 200-117)

The present invention relates to protective means for electric circuits and particularly to an improved construction for a fuse device suitable for interruption of high tension circuits.

Heretofore fuses suitable for high tension duty have been constructed with the fusible element arranged in a tube filled with arc quenching liquid and with provision made for the drawing apart of the fuse terminals or contacts upon fusing of the fuse element to effect thereby extension of the arc path. The employment of a restricted chamber for the quenching of the arc has been another expedient. However, when such arrangements have been employed in the past, there has been encountered among others the disadvantage that the arc has been drawn out of the chamber when the contacts were separated, so that the quenching action has taken place only partially in the chamber with the greater part of such action taking place in the tube filled with liquid.

The present invention has for one of its objects the provision of improvements for increasing the effectiveness and safety of operation of fuses of the liquid-filled type having means for effecting separation of the fuse terminals upon fuse operation.

A further and important object of the present invention is the provision of an improved fuse construction wherein the pressure resistant arc quenching chamber is extended coincidentally with the separation of the fuse terminals so that the lengthened arc is made to remain in the pressure resistant chamber to be quenched, thereby avoiding the disadvantages attendant upon the use of the previously known constructions outlined above.

Another object of the invention is the provision of a fuse construction suitable for employment in the practice of the invention of my application Serial No. 200,956, filed April 8, 1938, which said application is a division of the present application and is assigned to the same assignee as the present invention.

Other objects and the details of that which I consider to be novel and my present invention will be apparent from the following description and the claims appended thereto, taken in conjunction with the accompanying drawings in which

Fig. 1 is a longitudinal section through a fuse device constructed in accordance with the present invention showing the parts of the device in the positions they assume when the fusible element is intact,

Fig. 2 shows the parts of the fuse device in the positions they assume after rupture of the fusible element,

Fig. 3 is a partially diagrammatic longitudinal sectional view of a modified form of fuse device embodying the invention,

Fig. 4 is a view, partially in cross section, of a further modification of the fuse device,

Fig. 5 illustrates diagrammatically a protective arrangement for an electric circuit incorporating a fuse device of the type illustrated in Fig. 4, and

Fig. 6 is a diagrammatic illustration of a protective arrangement incorporating a fuse device of the type illustrated in Fig. 4 and designed for the isolation of electric conversion apparatus.

Referring to Figs. 1 and 2 of the drawings, 10 denotes a hollow tubular casing of suitable insulation material in which is disposed a body of oil or other arc quenching liquid 11. The upper and lower ends of the casing are provided with metallic end caps 12 and 13 respectively. In the upper cap 12 is mounted a connection terminal or contact 14 through which passes the supporting shank 15 of a fusible element 16. The lower end of the fusible element is attached to a connection terminal or contact 17 in any suitable manner as, for example, by means of a screw cap such as that indicated at 18. The lower end of the terminal 17 is connected by means of the flexible extension conductor 19 to the lower end cap 13.

End cap 12 is provided with an inwardly extending flange 20 having an outer screw threaded portion upon which is mounted a tubular casing 21 of suitable insulation material which extends downwardly in and substantially coaxially of the outer casing 10 to a point considerably below the liquid level line. A third tubular member or casing 22 of insulation material is disposed within the casing 10 and is shown in Fig. 1 as being telescoped within the tube 21. The inner tube 22 is arranged to slide within the casing 10 into and out of the tube 21 and is provided with an outwardly extending shoulder 23 which serves to guide the tube in the casing 10. The tube 22 is also formed with an inwardly projecting portion 24 and is provided with an inwardly projecting annular metallic ring 25, which projections aid, when the parts of the fuse device are in the position shown in Fig. 1, in maintaining the tube 22 substantially coaxial with the tube 21 and the casing 10. Adjacent the lower end of the tube 22 is rigidly mounted a disc 26 having apertures 27 for a purpose to be pointed out hereinafter. This

disc supports rigidly the lower connection terminal 17 and constrains this terminal to move with the tube 22. 28 denotes a tension spring having one end connected to the connection terminal 17 as indicated at 29 and the other end connected to the end cap 13 as indicated at 30.

In order that the fusible element may be renewed, the upper portion 31 of the connection terminal 14 is made thimble-shaped with the outer surface 32 screw threaded to engage cooperating screw threads on the inner surface of the flange 20 of the screw cap 12. The upper end of the thimble-shaped portion is provided with an outwardly extending flange 33 which cooperates with the gasket 34 and the upper surface of the cap 12 to provide a seal for the upper end of the casing 10. The inner surface of the thimble-shaped portion 31 is also provided with screw threads to receive the screw-threaded clamping plug 35 which has an axially extending passage to receive the supporting shank 15 of the fusible element. This plug 35 is arranged to press downwardly upon the wedge-shaped member 36, also centrally bored to receive the shank 15, and to thereby effect a strong clamping action upon the shank. When the upper connection terminal is removed from its mounting in the end cap, an opening through the flanged portion 20 is provided through which the screw cap 18 of the movable terminal 17 can be unscrewed by means of a long screw driver. A new fusible element and its supporting shank may then be inserted through the opening in the cap 12 and the lower end of the fusible element may be clamped to the terminal 17 by means of the screw cap 18. Terminal 14 is slipped over the supporting shank of the fusible element and is screwed into place as previously indicated. The projecting end of the shank 15 is then pulled out to a sufficient extent to bring the shoulder 23 of the tube 22 into engagement with the lower end of the tube 21 whereupon the shank is clamped in place by means of the wedge-shaped member 36 and the screw plug 35.

When the element 16 fuses, the spring 28 fixed to the movable terminal 17 draws the terminal and also the tube 22 downwardly to the position shown in Fig. 2. It will be seen that the two tubes 21 and 22 serve as an arc quenching pressure resistant chamber which is extended as the arc is extended. Tube 22 has such length that it is not completely withdrawn from the lower end of the tube 21. Thus the arc drawn between the terminals 14 and 17 is forced to remain within the pressure chamber until quenched. The ring-shaped metallic projecting member 25, it being understood that several of these rings may be provided if desired, serves to provide the arc with additional points of attachment so that fresh arcing, as for example in the case of alternating current, is hindered. Furthermore, during the downward drawing of the tube 22 under the influence of the spring 28, streams of the oil or other arc quenching liquid 11 are projected by means of the apertures 27 in the direction indicated by the arrows into proximity to the end of the terminal 17 and into the arc path so that metal particles are driven away from the terminal and from the arc path. A better quenching action is secured thereby and also fresh arcing is hindered.

Fig. 3 shows a modified construction in which the movable pressure tube 22 is not drawn out to the bottom of the casing 10 but is prevented in this construction from being completely with-

drawn from the tube 21 by means of the projecting stop 37. Furthermore, in order to obtain a better quenching action at quite high voltage, a projecting baffle 38 is wound spirally upon the inner surface of the tube 22 in order to give the liquid discharged through the apertures 27 a screw-like motion. In this manner the tearing away of the metal particles from the point of attachment 39 of the arc is made to take place to a greater degree than would be provided by the simple flow of the liquid upwardly through the tube 22. The projection 24, of which there may be several, provided on the inner surface of the tube 22 as shown in Fig. 1 is capable of fulfilling substantially the same purpose as the screw-like baffle shown in Fig. 3.

Fig. 4 illustrates a modification of the fuse constructions of Figs. 1-3, which modification is particularly adapted for employment in the practice of the invention of my divisional application, hereinbefore identified. In this last construction an inductive coil 40 is mounted in any suitable manner upon the casing 10 and concentrically with relation to the casing. This coil may be connected in an alternating current circuit as will be pointed out hereinafter. The lower end of the movable tube 22 is provided with a core member 41 of iron or other suitable magnetizable material so that when the tube 22 is drawn downwardly under the influence of the spring 28 subsequent to rupture of the fusible element, the core member is also drawn downwardly and into the magnetic field of the coil 40. This has the effect of reducing the reluctance of the magnetic path of the coil with a consequent increase in the inductance of the coil.

The action of the fuse device illustrated in Fig. 4 may be utilized to great advantage in the actuation of switching mechanism in the manner described in detail and claimed in my previously identified divisional application. In Fig. 5 is illustrated diagrammatically the manner in which such a fuse device may be employed as a protective device for a polyphase alternating current circuit. Three fuses 42, of the type illustrated in Fig. 4, are connected one in each of the phase conductors of the three phase circuit and each of the fuses has associated therewith an inductive coil 43 similar to that designated by the numeral 40 in Fig. 4. A source of potential 44 supplies current through conductors 45 and the inductive coils 43 to the coil 46 of relay 47, the contacts of which relay are connected in series with the operating or holding coil 48 of the circuit interrupting device 49 which is arranged to interrupt all three phases of the three phase circuit. 50 designates a spring for biasing the movable contacts of the interrupting device 49 to open position. Under normal conditions sufficient current flows in the circuit of coil 46 to maintain relay 47 closed so that holding coil 48 is energized to maintain the circuit interrupter 49 closed. Upon the occurrence of a fault in any one of the phases of the three phase circuit, the corresponding fuse 42 operates and the core 41 thereof (shown in Fig. 4) is drawn downwardly into the magnetic field of its associated coil 43 thus increasing the inductive reactance of the circuit in which the coils 43 are connected and reducing the current flow through the relay coil 46. The coil 46 thereupon permits relay 47 to drop out and thereby open its contacts to effect deenergization of the holding coil 48 and opening of the three phase circuit interrupting switch 49 under the influence of spring 50. In Fig. 5 the elements

of the electric circuit are shown in the state which they assume subsequent to operation of one of the fuses 42 so that the circuit interrupting switch is in open position and the whole circuit is deprived of current.

In Fig. 6 is illustrated diagrammatically a protective arrangement in which a fuse of the type illustrated in Fig. 4 is employed for effecting the sectionalizing of an electric circuit or more specifically for the isolation of electrical converting apparatus, which may be either a rectifier or an inverter, upon the occurrence of a fault therein. In this case the fuses 42 are connected in the phase conductors of the alternating current side of a conversion apparatus 51 and have associated therewith the inductive coils 43 in a manner similar to that illustrated in Fig. 5. The alternating current circuit interrupting switch 49 and the control circuit therefor incorporating the inductive coils 43 are also substantially the same as illustrated in Fig. 5. In addition, the direct current side of the conversion apparatus is provided with an interrupting switch 52 which is biased to open position by means of a spring 53 and which is provided with an operating or holding coil 54 which is connected to relay 47 in parallel with the coil 48 of the interrupting device 49. Upon operation of any one of the fuses 42 due to a fault in its corresponding phase, the relay 47 drops out in a manner similar to that described in connection with the arrangement of Fig. 5 and both the holding coils 48 and 54 are deenergized so that the interrupting devices 49 and 52 respectively are operated to open position to thereby effect isolation of the conversion apparatus from the remainder of the electric circuit.

What I claim as new and desire to secure by Letters Patent in the United States is:

1. An electric protective device comprising an enclosing casing, a pair of hollow tubes in telescoped relationship in the casing and providing a pressure resistant arc quenching chamber interiorly of the tubes, at least one of the tubes being longitudinally movable relative to the other, a pair of terminals associated respectively with said tubes and having a fusible element connected therebetween so as normally to restrain the tubes in a relatively close coupled telescoped relationship, means operative upon rupture of said fusible element to effect relative movement apart of said terminals and also longitudinal relative movement apart of said tubes so as to extend said chamber, and means for interposing arc quenching medium between said terminals, said tubes having such length relative to each other that they are not completely withdrawn one from the other upon relative movement apart of the tubes, thereby to insure that an arc formed upon rupture of said fusible element remains solely within said chamber until quenched.

2. An electric protective device comprising an enclosing casing, arc quenching liquid therein, a pair of hollow tubes in telescoped relationship in the casing and providing a pressure resistant arc quenching chamber interiorly of the tubes, at least one of the tubes being longitudinally movable relative to the other, a pair of terminals associated respectively with said tubes and having a fusible element connected therebetween so as normally to restrain the tubes in a relatively close coupled telescoped relationship, means operative on rupture of said fusible element to effect partial withdrawal of said one tube from telescoped relationship with said other tube so as to extend said chamber, liquid directing means

associated with said one tube for directing a stream of said liquid between said terminals, and means operative to prevent complete withdrawal of said one tube from telescoped relationship with said other tube.

3. A protective device for an electric circuit, including in combination a hollow tubular casing having closed ends and a body of electric arc quenching liquid disposed therein, a pair of telescoped hollow tubular members disposed in said casing with one of said members fixedly mounted and the other of said members axially slidable with relation to the fixed member, fuse contacts mounted one in each of said tubular members, a fuse element extending between said contacts and operative normally to maintain said members in telescoped relationship, spring means in said casing operative upon fusion of said element to draw said slidable member at least partially out of said fixed member, means providing apertures in said slidable member for directing streams of said arc quenching liquid into proximity with the contact in the slidable member upon movement of the slidable member due to fusion of said fuse element, and baffle means disposed on the inner surface of the slidable member for more effectively directing said streams of liquid into the arc path between said contacts.

4. A protective device for an electric circuit, including in combination a hollow tubular casing having closed ends and a body of electric arc quenching liquid disposed therein, a pair of telescoped hollow tubular members disposed in said casing with one of said members fixedly mounted and the other of said members axially slidable with relation to the fixed members, contacts mounted one in each of said members, fusible means extending between said contacts and operative normally to maintain said members in telescoped relationship, means in said casing operative upon rupture of said fusible means to draw said slidable member at least partially out of said fixed member, means providing apertures adjacent the outer end of said slidable member for directing streams of said arc quenching liquid into the space between said contacts upon movement of the slidable member due to rupture of said fusible means, and means providing an inwardly projecting baffle wound spirally on the inner surface of the slidable member for creating a screw-like flow of the liquid discharged through said apertures.

5. A protective device for an electric circuit including in combination a fixedly mounted hollow tubular casing having one end open, a second hollow tubular casing telescoped within said first casing and axially slidable with respect thereto, a fusible element having one end affixed in each of said casings and normally operative to maintain said second casing telescoped within said first casing, said casings cooperating to provide a pressure resistant arc quenching chamber within the interior thereof, means for withdrawing said second casing from said first casing upon rupture of said fusible element, and stop means mounted for preventing complete withdrawal of said second casing from said first casing in order that an arc formed upon the rupture of said fusible element will be quenched solely within the pressure resistant chamber formed by said casings.

6. A protective device for an electric circuit including in combination a hollow tubular casing of insulating material having one end open, a second tubular casing of insulating material dis-

posed substantially coaxially of and telescoped within said first casing and axially slidable with respect to the first casing, a pair of connection terminals mounted one in each of said casings, a fusible element extending between said terminals and normally operative to maintain said second casing telescoped within said first casing, said casings cooperating to provide a pressure resistant arc quenching chamber within the interior thereof, spring means operatively connected for withdrawing said second casing from said first casing upon rupture of said fusible element, and means providing an inwardly extending metallic projection on the inner surface of said second casing at a suitable point for providing an additional point of attachment for an arc formed between said terminals upon rupture of said fusible element.

7. In a protective device for an electric circuit, a pair of hollow tubes telescoped one within the other and relatively movable, an elongated rod-like terminal element supported rigidly with respect to the outer of said tubes and extending a substantial distance into and substantially along the axis of said tubes, a terminal element carried by the inner one of said tubes, said terminal elements being adapted to support a fusible element connected therebetween for maintaining said tubes in telescoped relationship, means ar-

ranged to effect longitudinal movement of said tubes relative to each other to draw said terminal elements apart upon rupture of a fusible element connected therebetween, and means carried by said inner tube arranged to slidably engage said rod-like terminal element during a substantial portion of the relative movement between the tubes. 5

8. In a protective device for an electric circuit, a hollow tubular casing, a hollow tube rigidly supported substantially coaxially within said casing, a second hollow tube movably telescoped in one end of said first tube, a pair of terminals carried one by each of said tubes and adapted to support a fusible element connected therebetween for maintaining the tubes in telescoped relationship, means arranged to draw said tubes apart to increase the distance between said terminals upon rupture of a fusible element connected between the terminals, and a radially extending shoulder carried by the outer end of said second tube and arranged to abut against the said one end of said first tube when the tubes are in telescoped relationship, said shoulder also extending into relatively close proximity with the wall of said tubular casing for slidable cooperation therewith to insure substantially pure axial movement of said second tube in said casing. 10 15 20 25

GUSTAV W. MÜLLER.