

July 17, 1934.

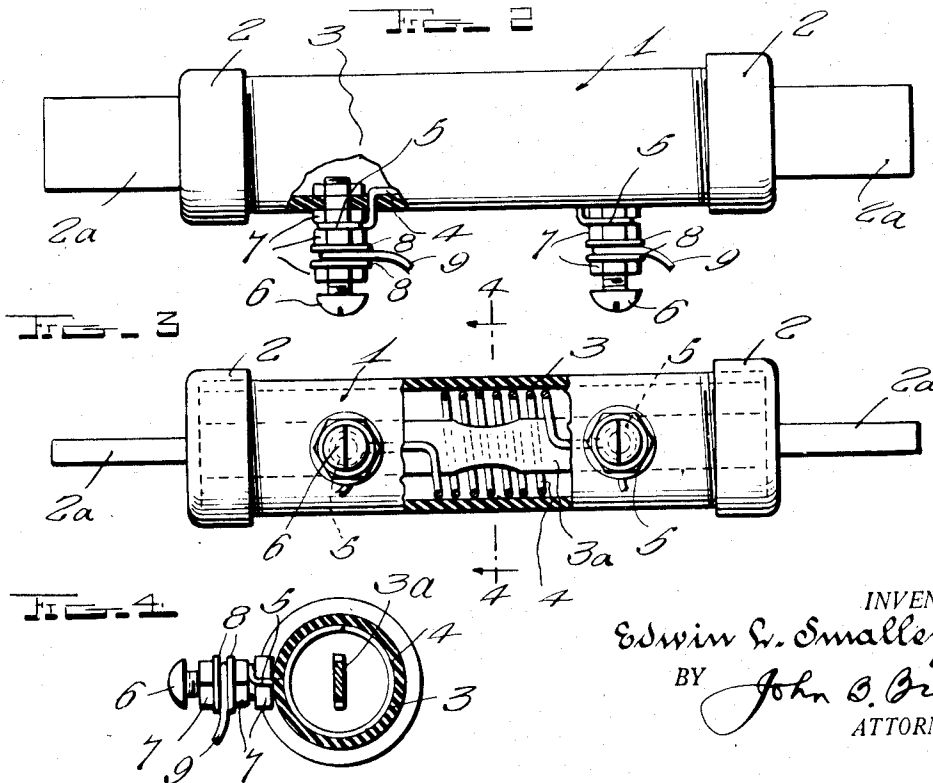
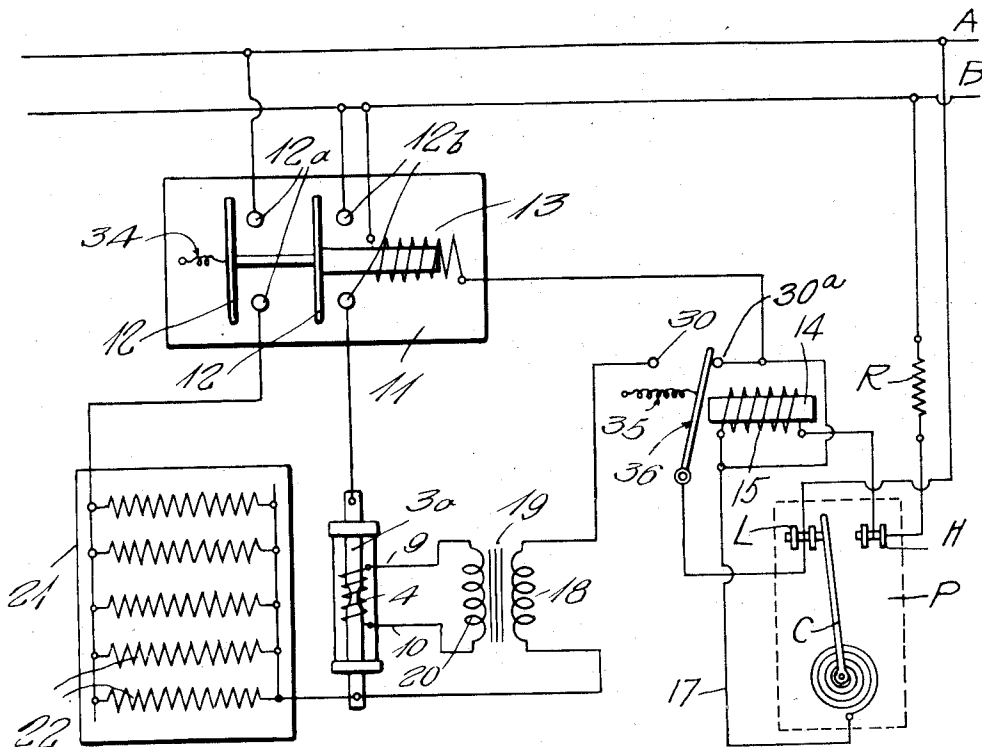
E. L. SMALLEY

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ELECTRICALLY HEATED ELECTRIC FUSE CIRCUIT

Filed Dec. 23, 1930

2 Sheets-Sheet 1



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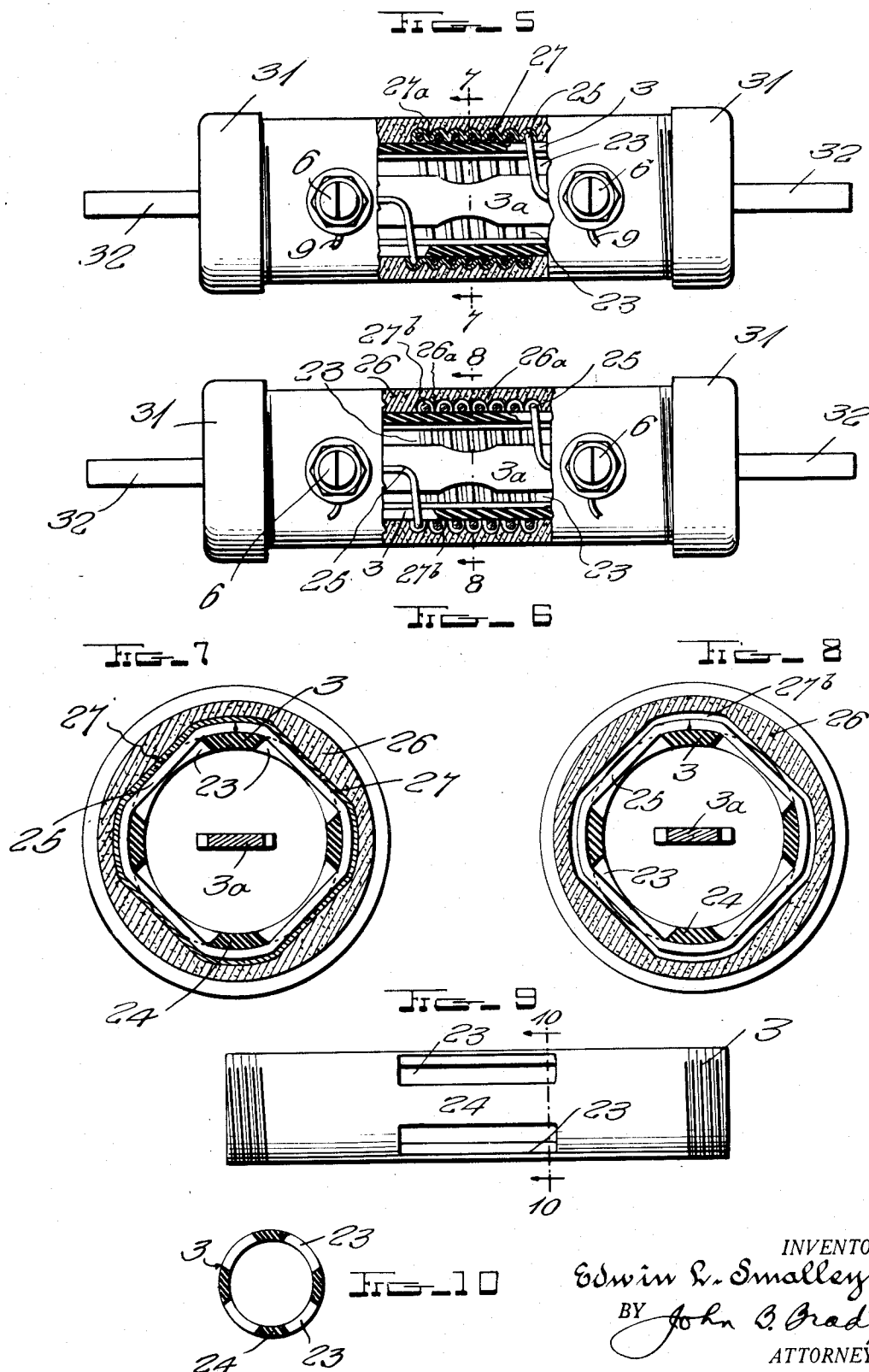
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UNITED STATES PATENT OFFICE

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ELECTRICALLY HEATED ELECTRIC FUSE
CIRCUITEdwin L. Smalley, Whitefish Bay, Wis., assignor
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Wis., a corporation of Wisconsin

Application December 23, 1930, Serial No. 504,352

7 Claims. (Cl. 219-20)

My invention relates broadly to electrical protective systems and more particularly to a circuit arrangement and a method of operating a fused protective system.

5 One of the objects of my invention is to provide means for increasing the protection offered by an electric fuse in an electrical system and facilitating the opening of the power supply circuit to a load in the event that emergency or other equipment should fail to function.

10 Another object of my invention is to provide a construction of protective electric fuse having an electric heating element wound adjacent the fuse for subjecting the fuse to thermal action in addition to the normal heating obtained by the passage of the current through the fuse to the load for melting the fuse in the event of a contactor in the circuit failing to operate to open the circuit as under normal expectations.

20 A further object of my invention is to provide a construction of electric fuse in which a fusible link is mounted within a container and surrounded by an electrical heating element adapted to raise the temperature of the fusible link to the melting point in the event of failure of other automatic or emergency equipment connected in circuit with the load to function for protecting an electrical system against injury.

30 Other and further objects of my invention reside in the method of protecting electrical circuits and the construction of a fuse as set forth more fully in the specification hereinafter following by reference to the accompanying drawings, in which:

35 Figure 1 diagrammatically illustrates the protective system of my invention; Fig. 2 is a plan view of the fuse with a portion broken away to show the connection of the heating coil therein; Fig. 3 is a side elevation of the fuse shown in Fig. 2 with a central portion thereof broken away to show the interior of the fuse housing and the position of the fusible link and heating coil therefor; Fig. 4 is a cross-sectional view through the fuse construction of Fig. 3 taken on line 4-4 of Fig. 3; Fig. 5 is a side elevation of a modified construction of fuse embodying my invention partially broken away to show the interior construction thereof prior to the application of current to the heating coil surrounding the fuse; Fig. 6 is a view similar to Fig. 5 after heating current has been applied to the heating coil surrounding the fusible link; Fig. 7 is a cross-sectional view taken through the 55 fuse on line 7-7 of Fig. 5; Fig. 8 is a cross-sectional view through the fuse taken on line 8-8 of Fig. 6; Fig. 9 is a side elevation of the fuse housing over which the heating coil in the form of the fuse shown in Figs. 5-8 is wound; and Fig. 10 is a cross-sectional view taken through the fuse housing on line 10-10 of Fig. 9.

The electrically heated electric fuse system of my invention may be applied to various forms of loads in electric circuits. I have illustrated my invention as forming part of a protective circuit for an electric furnace. In electric furnace use today there are safety devices such as excess temperature cutouts to prevent the overheating of an electric furnace due to the failure of the automatic control instrument to function because of such causes as the breakage of the pyrometer couple, freezing of contacts on the contact table, permitting the application of current to the furnace when the pyrometer should have caused the pyrometer relay to open contact, and other like conditions. In such systems, the furnace circuit is opened under all conditions except in the case of the contactor failing to open after the holding coil is deenergized. This failure of the contactor to open may be caused by friction in the hinge being in excess of the gravity force, and in some cases due to "freezing" or locking together of the laminated copper leaves forming part of the contact.

The object of my invention is to break the circuit in an emergency where other equipment fails to function, as for example, the contactor as above described.

Fig. 1 shows the general relation of the electric fuse 3a in circuit with an electric furnace. In order to understand the method employed in the system of my invention, reference will first be made to the construction of the fuse as shown in Figs. 2 and 3.

In Fig. 3, reference character 1 shows an assembled fuse of the replaceable type having ferrules 2 with knife blade 2a and cylindrical tube 3 enclosing the renewable fuse 3a. Wound within tube 3 is shown a heating coil 4, preferably made of a nickel-chromium composition and of a size that momentarily will withstand high temperature. Terminals 5 of coil 4 are shown connected to binding post 6 with contacts made effective by nuts 7 and washers 8. Wire 9 connects to an electrical source of current. This source may be a bell ringing transformer, an instrument transformer as usually supplied for automatic pyrometer control systems, or it may be a special transformer to give a low voltage,

such as 5 or 6 volts, for raising the relatively small heating coil 4 to the required temperature.

In Fig. 2, the arrangement of the binding posts 6 has been shown in plan as projecting from one side of the casing 1 for establishing connections to the heating coil in tube 3. Figs. 2 and 3 show a fuse where the casing is provided with knife blade contacts. It will of course be understood that the fuse construction of my invention may be applied to any form of cartridge fuse, such as the ferrule contact type of fuse where the ends of the fuse do not have blades projecting therefrom.

Fig. 4 shows the arrangement of the heating coil 4 as snugly fitting against the inside walls of the tubular casing 3 and connected to the binding posts which project laterally from the casing. It will be observed that the heating coil directly radiates heat to the fusible link 3a for melting the link under circuit conditions which will be described hereinafter in detail.

Figs. 5, 6 and 7 show the application of the heating coil 25 on the outside of the cylindrical tube 3, such tube having openings or slots 23 formed in part by the portions 24 remaining as part of tube 3. The fuse is shown at 3a. At 26 is indicated a cement coating. In using the external coil 25, I find it preferable before applying the coating 26 to apply to the outside of coil 25 a relatively thin and relatively loose paper covering shown at 27. In applying cement the paper 27 between the strands of the helix forming the heating coil will be slightly depressed as shown at 27a by the application of the cement. By applying heat to the coil the paper is burned away as shown at 27b in Figs. 6 and 8, thus leaving the slight protuberances of cement at 26a between the strands of the coil to serve as electrical separators, and leaving a major portion of the coil completely free to radiate its heat.

In the construction of fuse shown in Figs. 5-10, the end caps 31 may fit over the cement portion 26 of the cartridge and are provided with the projecting blades 32 for establishing connection between the load or power supply circuit. The ferrule type of cartridge fuse may also be used in the arrangement of Figs. 5 to 10.

In Fig. 1, the line supply is shown at A and B. 11 is a contactor having two contactors 12A and 12B coacting with sets of contacts 12a and 12b and a holding or actuating coil 13 which operates against the spring 34 which tends to hold the contactors in open position. Reference character 14 represents a relay which is controlled by the automatic temperature control pyrometer P through lines 16 and 17 leading to holding coil 15 of relay 14. The electromagnetic winding 15 coacts with armature 36 and operates against the action of spring 35 which tends to hold the armature 36 against contact 30. Reference character 19 designates a transformer having primary coil 18 and secondary coil 20, furnishing power to heating coil 4 by means of lines 9 and 10. In the diagram, relay 14 is shown with winding 15 energized and armature contactor 36 shifted against contact 30a forming a circuit from A through armature contactor 36, through actuating coil 13 in the position illustrated in Fig. 1, thereby closing the sets of contacts 12a and 12b, and supplying current when close, to heating coils 22 within electric furnace 21.

Deflecting contact "C" of pyrometer P is actuated from the usual form of thermocouple (not

shown) in the furnace 21. With deflecting contact "C" in contact with "L", as when the furnace is cold, current flows from "A" through "L", through "C", through wire 17 to actuating coil 15 of relay 14, then through wire 16, contact "H" and resistance "R" to line "B". The energizing of coil 15 moves armature contactor 36 and closes contact 30a of relay 14 in circuit with actuating coil 13. An increase of temperature to normal operating temperature in furnace 21 causes deflection of deflecting contact "C" away from contact "L" and toward contact "H", but out of connection with either contact. Current then flows from line "A" through contact "L" to armature contactor 36 of relay 14 to contact 30a to the holding coil 13 of the contactor 11 to line "B"; a parallel circuit also existing from contact 30a through holding coil 15, line 16, contact "H" and resistance "R" to power line "B".

When a temperature in excess of the desired operating temperature in the furnace has been attained, deflecting contact "C" of pyrometer "P" deflects to contact with "H" of pyrometer. In the latter position, no difference of polarity exists in the circuit through holding coil 15 of relay 14, so that tension spring 35 draws armature contactor 36 into connection with contact 30, and thereby de-energizing holding coil 13 of contactor 11.

Under normal operation with contactor 36 in contact with 30, the circuit should be opened at 12A-12a and 12B-12b by the de-energizing of the actuating coil of contactor 13. If however, due to any mechanical misadjustment the contactor system fails to open, as for example due to excessive friction preventing the opening of the contactor system, a circuit then exists from line "A" through contact "L" of the pyrometer, through relay arm 36 to contact 30 and primary 18 of transformer 19 to fuse link 3a to line "B". A current is then developed in secondary coil 20 of transformer 19 and energizing heat coil 4 surrounding fuse link 3a by means of lines 9 and 10. The heat thus developed in heating coil 4 surrounding fuse link 3a added to the heating effect of fuse link 3a by means of current flowing through heating elements 22 causes a melting of fusible link 3a and thereby opening circuit through heating elements 22.

If the automatic temperature control instrument fails, deenergizing relay coil 15, contact would be made between the circuit from A through armature contactor 36 to contact 30, thereby energizing primary coil 18. In normal cases opening of the pyrometer relay 14 will deenergize holding coil 13, and the poles 12 of contactor 11 should open. However, due to the causes hereinbefore outlined, the poles 12 of the contactor 11 may fail to open, thereby leaving in electrical circuit the transformer 19. In an exceptionally short time, such as two or three seconds, the heat released from heating coil 4, augmenting the heat generated in the fuse 3a by the flow of normal current to the furnace will release sufficient heat to melt fuse 3a, thereby opening the furnace or other circuit to which the electrically heated electric fuse may be applied.

In the drawings only one fuse is shown, but obviously a multiple number of heating coils 4 in parallel could be used with a multiple number of fuses as might be required for both sides of

the line of a single phase circuit or in each of the three lines of a three phase circuit.

While I have described my invention in certain of its preferred embodiments, I desire that it be understood that modifications may be made, and that no limitations upon my invention are intended other than are imposed by the scope of the appended claims.

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

1. In a protective system, a furnace, heating coils in said furnace, a pyrometer for controlling the temperature within said furnace, a relay including an actuating winding, a pair of contacts, an armature contactor movable under control of said actuating winding to either of two positions for establishing connection with either of said contacts, connections between the actuating winding of said relay and said pyrometer, a main contactor coactive with said relay under normal conditions for completing the circuit between the power source and the heater winding in said furnace, a fuse included in said circuit, a heater winding surrounding said fuse, said heater winding being connected to the power source through one of the contacts on said relay, the operation of said pyrometer controlling the operation of said relay for the energization of said heater winding for melting said fuse when said main contactor fails to open under emergency conditions.

2. In a protective system, a power supply circuit, a load, a main contactor disposed in said power supply circuit for opening and closing the circuit to the load, an electromagnetic winding for actuating said main contactor, a fuse disposed in circuit with the load, a heater winding adjacent said fuse, a pyrometer, and means controlled by said pyrometer for energizing said electromagnetic winding, and other means controlled by said pyrometer for energizing said heater winding for melting said fuse when said main contactor is de-energized and fails to open under conditions of excess temperature of said load.

3. In an electrical system which includes a power supply circuit, a heater coil circuit, a fuse connected in the heater coil circuit, a contactor for making and breaking connection between said power supply circuit and said heater coil circuit, an automatic control pyrometer controlling the actuation of said contactor, means for protecting the heater coil circuit comprising a heating device adjacent said fuse and a circuit connecting said heating device through said

contactor for energizing said device and supplying heat to said fuse independently of the current path therethrough for melting said fuse and opening the heater coil circuit when the contactor while deenergized fails to open said heater coil circuit.

4. A protective system comprising a power supply circuit, a heater load operated from said power supply circuit, a contactor for completing connections between said power supply circuit and said heater load, an electric fuse disposed in circuit with said contactor and said heater load, a heating element disposed adjacent said electric fuse, means for energizing said heating element, and an automatic temperature control pyrometer controlling the actuation of said contactor under normal conditions and controlling the energizing means of said heating element under emergency conditions for melting said electric fuse.

5. In a protective system, a load, a power circuit for supplying the load, a fuse interposed in said circuit and thermally responsive to excess currents for normally protecting said load, means auxiliary to said fuse for increasing the temperature of said fuse under emergency conditions and a temperature actuated device for controlling the connection of said power circuit to the load and activating said means for melting said fuse when the connection between said power circuit and said load fails to open.

6. A protective system comprising a power supply circuit, an electric furnace, a fuse having a heater winding disposed in circuit with said furnace, an electromagnetic contactor establishing connections between said power supply circuit and said furnace, a relay, a pyrometer selectively controlling the actuation of said contactor through said relay under normal temperatures in the furnace, and the energization of said heater winding through said relay when said contactor fails to open while de-energized.

7. A protective system comprising a power supply circuit, an electric furnace, a fuse having a heater winding disposed in circuit with said furnace, an electromagnetic contactor establishing connections between said power supply circuit and said furnace, an electromagnetic relay, a pyrometer selectively controlling the actuation of said contactor through said electromagnetic relay under normal temperatures in the furnace, and the energization of said heater winding through said electromagnetic relay when said contactor fails to open while de-energized.

EDWIN L. SMALLEY.