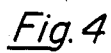
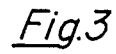
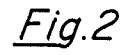
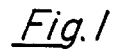


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PROTECTIVE CIRCUIT

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The present invention relates to power supply control systems and more particularly to an associated circuit for protecting electronic systems, such as electronic computers, from damage or inaccurate operation from reduced supply potentials.

In such systems and particularly those involving a multiplicity of relays, switches and the like, a blown fuse, a short circuit or some other circuit interruption leaves the general circuit assembly open to damage by someone attempting to restart the equipment without calling upon maintenance service to properly check restored circuits.

An object of the invention is to provide a protecting system for power supplied circuits of an electrical apparatus;

Another object is to provide means to prevent repaired or restored power circuits from being turned on by present conventional means;

A further object applies specifically to the replacement of blown fuses by an operator of an electronic computer to prevent such operator from restarting the equipment without proper rechecking by qualified personnel;

A still further object is to provide novel means for starting or closing a circuit after failure of power to an electrical system; and

To provide other improvements as will hereinafter appear.

In the accompanying drawings Fig. 1 represents a control circuit for a power supply system equipped with a protective system embodying one form of the invention and showing the initial relation of the circuit elements with the voltage supply line open;

Fig. 2 represents the same circuit in operated condition with the voltage supply line closed;

Fig. 3 represents an illustrative power supply circuit to which the protective circuit is responsive in case of a power circuit failure, and

Fig. 4 is a detailed circuit diagram of a typical set of protective contacts used in the system with the power supply circuit of Fig. 3.

Referring to the drawings, and particularly to Fig. 1, the line conductors 10 and 11 of the circuit are supplied from a source of voltage through a control switch S-3 which when closed starts the power control cycle by energizing relay K2 through closed contacts K16a and K3a to close the circuit for the D. C. power supply of Fig. 3. The solenoid of relay K2 is in series with relay contacts K16a which remain normally closed and relay contacts K3a which are replaced in operation with the relay contacts Ks as shown in Fig. 4 when normal voltages exist in the circuit of Fig. 3. The contact K3a thus is in parallel with the normally open relay contact Ks, which is a series of any suitable number of sensing relay contacts such as used in power supply circuits for computers or other equipment as illustratively shown in Fig. 4. Thus there are two circuit controlled paths one by way of contacts K16a and K3a and the other by way of

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contacts K16a and Ks, the former two functioning for the initial closing of the D. C. power and the latter two maintaining a closed path upon operation of the power supply energization cycle. The relay contacts K16a are included in the protective circuit of the invention as will be explained, and thus are only opened after a failure of power when the energization cycle has been completed.

For operating the contacts K16a to break the line circuit through the relay K2, when trouble develops in the output circuit of relays K6 to K9 of Fig. 3, a latching relay K16 is provided, which is normally de-energized to hold contact K16a closed when either one or both relay contacts K14a and K15a are open. Latching relay K16, which holds contacts K16a open when latched, is in line series relation with the relay contact K14a and K15a, respectively open and closed at the initial conditions of Fig. 1. Initially, the open relay contact K14a is arranged to be closed by its time delay relay K14 to lead line voltage to relay K3 for opening relay contact K3a after the power supply of Fig. 3 operates to close relay contacts Ks. Contact K15a is opened by relay K15 in parallel with relay K2, thereby serving to open the circuit to relay K16 whenever relay K2 is energized and to prevent operation of relay K16 whose contact K16a with either contact K3a or Ks maintains the power supply in operation. Thus, as long as conditions are normal in the circuit of Ks after the power is on, the relay K16 remains de-energized and in unlatched condition. When the output circuit is interrupted by some abnormal condition such as shorting of leads 12, or opening of fuse 13 to open one of the Ks contacts, the relay K16 becomes energized and becomes automatically latched in open position to prevent improper restoring of any of the circuits until the trouble has been corrected. A release coil R19 is provided in an auxiliary line circuit 20 under control of a push button switch 23 or the like for manual operation. Preferably in practical use the switch 23 is under the control panel and operated by a key only available to an authorized serviceman, as an additional safeguard against restoring the circuits.

The general operation of the control cycle is described in connection with both Figs. 1 and 2. With switch S3 closed, the line voltage causes the relay K2 and K15 to close through the normally closed contacts K16a and K3a, as shown in Fig. 1, while simultaneously the time delay relay K14 starts in operation. Due to this delay, the contact K14a is still open and relay K3 is held in its de-energized state so that the relay K16 remains de-energized even though contact K15a is closed at the instant the switch S3 is closed. The line voltage through K2, contact K16a and K3a energizes the D. C. power supply of Fig. 3, while at the same time the relay K15 opens contact K15a allowing K16 to remain de-energized even after the pre-determined delay interval of K14 permits the contact K14a to close, whereupon relay K3 opens contact K3a and passes control to the series contacts Ks. However, since the various voltages of the D. C. power supply are now up to value, all of the sensing relays K6 to K9 are energized to thereby close contacts K6a to K9a of Ks and allowing the circuit through relays K2 and K15 to remain complete. The circuits are now as shown in Fig. 2 and so remain as long as all power output circuits are closed and functioning properly.

Now in case of circuit failure in which one or more of the D. C. voltages is reduced sufficiently, due to a blown fuse or other cause, to open the corresponding sensing relay K6 to K9, thereby causing contact Ks to open whereby relays K2 and K15 drop out. The dropping out of K2 turns off the D. C. power supply, while the dropping out of K15 causes the contact K15a to return to its normally closed position. Since switch S-3 is closed, contact K14a is still closed and the closing of

contact K15a energizes and latches the relay K16 and consequently opens the contact K16a which is in series with the coil of K2 thereby preventing restoration of the D. C. supply. Since the relay K16 is latched the circuits controlled by it must remain open until the switch S-5 is closed to energize the release coil R-10 and restore conditions so that K2 can operate to turn on the D. C. power supply again. As long as the relay K16 is latched the relay K2 cannot function even though the switch S3 be opened and then closed.

In Fig. 3 of the drawings one form of electrical system is illustrative of the type with which the circuit of the invention is associated, and as shown includes a plurality of power circuits to which the initiating circuit is connected and supplies power thereto by way of relay contact K2. This system includes a plurality of sensing relays having series connected contacts K6, K7, K8 and K9 as shown in Fig. 4, whereby the output contact Ks is opened by the failure of any of the relays K6 to K9. A type of power supply circuit shown in Fig. 3 is described and claimed in the co-pending application of Richard C. Weise, Serial No. 595,884, filed July 5, 1956, and assigned to the same assignee as the present application.

In a computer circuit designed for halting after an error is detected, the push button 21 and relay 22 may be used for re-starting the machine whenever the error is not due to the failure of a power supply potential which would open one of the contacts Ks.

What is claimed is:

1. A protective circuit for electrical apparatus, said protective circuit comprising: a pair of leads energizable by a source voltage; first, second and third branch circuits connected in parallel between said leads, said first branch circuit comprising the winding of a first relay in series with the normally-closed contacts of a second relay and in further series with the normally-closed contacts of a third relay, said first branch circuit also including, in shunt with the first-relay winding, the winding of a fourth relay, said first branch circuit also including, in shunt with said third-relay contacts, the normally-open contacts of a plurality of sensing relays, said sensing-relay contacts being connected in series, said first relay having normally-open contacts which when closed connect a power supply to said apparatus, the windings of said sensing relays being parallel connected to pass current there-through in response to said power supply being connected to said apparatus, said second branch circuit compris-

ing the winding of a time-delay relay whose actuation in response to said source voltage lags behind that of said sensing relays in response to said power supply, said third branch circuit comprising the normally-open contacts of said time-delay relay in series with the winding of said third relay, said third branch circuit also including, in shunt with said third-relay winding, the normally-closed contacts of said fourth relay serially connected to the winding of said second relay, said second relay being of a type which when energized latches in open-contact position; and means for unlatching said second-relay contacts, said unlatching means comprising a release winding on said second relay separately energizable under the control of a separate control switch.

2. In a power supply system, a protective circuit comprising: a pair of leads energizable from a source of voltage; a first switch for connecting said leads to said source; a first circuit connected between said leads, said first circuit including means responsive to said voltage on said leads for energizing a second switch to connect a power supply to the apparatus to be protected; a normally-closed series element included in said first circuit; a second circuit connected between said leads, said second circuit including means which, in response to said voltage on said leads and after a delay, opens said series element in said first circuit; sensing means included in said apparatus to be protected which in response to said power supply provides a shunt path around said first-circuit series element, said sensing means operating, in response to a power failure in said apparatus, to open said shunt path; a third circuit connected between said leads, said third circuit including the winding of a latching relay whose contacts are serially included in said first circuit, said latching-relay contacts being normally closed when said latching relay is in de-energized condition; means included in said third circuit which in response to current flow through said first circuit prevent the energization of said latching relay when said leads are connected to said voltage source; and means, including a release coil on said latching relay separately energizable under control of a third switch, for unlatching said latching relay to return said first circuit to closed-circuit condition.

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