June 17, 1941. E. SCHRÖDER 2,246,324

OVERLOAD PROTECTIVE RELAY

Filed Sept. 7, 1939

Fig. 1.

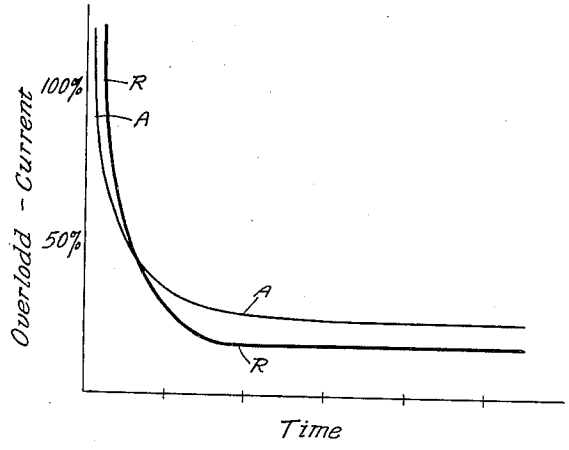


Fig. 2.

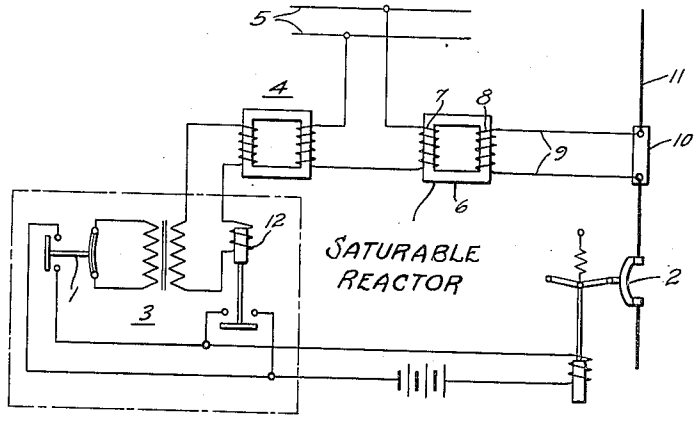
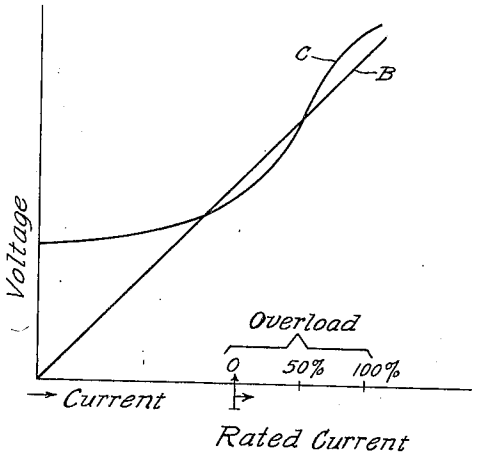


Fig. 3.



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OVERLOAD PROTECTIVE RELAY

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12 Claims. (Cl. 175—294)

My invention relates to a protective system and particularly to an overload protective system for electrical apparatus. In its more specific aspects, my invention relates to a protective system in which a relay, such as a thermal bimetal relay, operates during overloads on the electrical apparatus to be protected with a time delay dependent on the magnitude of the overload.

Electrical apparatus which is subject to overload has a very definite time-overload curve from which may be determined how long a time a definite overload may be maintained without exceeding the maximum permissible heating in the apparatus. Likewise a definite curve may be drawn showing the relationship between the amount of overload and the time that overload must exist before an overload time-delay relay operates to open the circuit. A complete protection of the apparatus is attained if the overload relay has an operating curve which precisely corresponds with the overload curve of the apparatus. However, the adapting of the operating curve of the protective relay to the overload curve of the apparatus is frequently not possible to the desired extent. This applies in particular to power rectifier apparatus which, in general, can carry relatively small overloads for comparatively long intervals of time but must be disconnected from higher overloads after a very short time.

It is an object of my invention to secure improved overload protection by attaining closer correspondence between operating curve of the overload relay and the overload curve of the apparatus to be protected than has heretofore been possible.

Other objects of my invention will become evident from the following detailed description taken in conjunction with the accompanying drawing, in which:

Figure 1 shows graphs of the overload curve of the apparatus to be protected and the operating curve of a thermal protective relay of a known type.

Fig. 2 shows a circuit arrangement exemplifying my invention, and

Fig. 3 shows curves in which variations of the potential across the shunt in the load circuit and the potential across the intermediate transformer are plotted against variations in the load current.

The relationships previously discussed as obtained by prior art devices are reproduced in Fig. 1 of the drawing, wherein the overload is represented in percentage of rated power as a function of the permissible overload interval or operating time. In this graph, A represents the overload curve of a rectifier while R represents the operating curve of a bimetal relay. It will be evident that the curves A and R do not correspond closely enough to afford complete protection since the relay will open earlier than necessary for small overloads but too late to avoid injury to the apparatus in the case of high overloads.

In Fig. 2 a thermal over-current relay 1 controls the operating circuit for the trip device of breaker 2. The control circuit for the relay 1 is supplied through a current transformer 3, the primary coil of which is energized from the secondary coil of an intermediate transformer 4, the primary coil of which is energized, in turn, from an alternating potential source 5 which has approximately constant potential. In the protection of a rectifier, for example, the alternating potential source may be one phase of the alternating current network supplying the rectifier.

In order to modify the voltage impressed upon the transformer 4 in proper relation to the varying load current, a saturable reactor or choke coil 6 is provided, the voltage winding 7 of which is placed in series circuit with the source 5 and the transformer 4. A premagnetizing or control winding 8 of this reactor is energized, in a preferred form, by current derived from a pair of shunt leads 9 from a metering shunt or resistance 10 placed in series with one main load line 11.

A quick acting relay 12 may be placed in series circuit with the secondary coil of transformer 3 to close the circuit to the breaker 2 independently to the thermal relay 1 upon the occurrence of an abnormally high overload.

The potential of the alternating current source 5 is distributed over the coil 7 of the saturable reactor 6 and the primary winding of the transformer 4 in the ratio of their inductances. As long as the current in the shunt 10, and accordingly the current in the magnetizing coil 8, is small, the inductance of the coil 7 is comparatively large so that a large portion, or the largest portion, of the alternating potential from the source 5 is impressed across its terminals.

As long as the current in the winding 8 is insufficient to cause the core of the reactor 4 to approach saturation, the potential across the winding 7 changes very little. If, however, with increasing current, the choke core approaches saturation, the inductance of the coil 7 begins to decrease more rapidly so that the potential on the primary winding of the transformer 4 rises. If,

after this, the reactor core is fully saturated, the potential impressed across the intermediate transformer 4 rises only a little with further increase of the load current in the shunt 10.

In Fig. 3 the potential change in the transformer 4 is plotted in curve C as a function of the current through the shunt 10. The potential on the shunt 10 is, on the other hand, represented by the straight line B. It will be noted that for the selected relationship that in the region between approximately rated load and fifty percent overload, the potential on the transformer 4 is less than, and does not vary in proportion to, the voltage across the shunt 10. Thus, between these load values the potential, and consequently the current through the relay 1, will be less than if they varied directly with the amount of overload. As a result, the time delay relay will require more time before operating and the operating curve R of Figure 1 will be raised between the points of zero and fifty percent overload to correspond more closely to the overload curve A. For overloads above fifty percent the curves of Fig. 3 show that as a result of the reactance coil 6, the voltage of transformer 4 is greater, and consequently the relay 1 will operate after a shorter time interval, than that shown in Fig. 1. Thus the operating curve R of Fig. 1 will be shifted to the left for values above fifty percent overload to more closely correspond to overload curve A.

Of further advantage is the fact that the thermal relay, as curve C in Fig. 3 also shows, is, in the region between zero load and the rated load or current, supplied by a current which even in the zero load condition corresponds approximately to half the rated load. As a result of this the thermal relay is always in a heated condition propitious for operation so that inaccuracies in the release time, as a consequence of varying initial temperatures, are avoided.

It will be evident that the operating curve of the relay may be further changed and adapted to other operating conditions by changing the characteristics of the premagnetizing winding 8.

Although I have shown and described certain specific embodiments of my invention, I am fully aware that modifications thereof are possible. My invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In a protective system, a load circuit, a circuit interrupter interposed therein, voltage controlled delay means for effecting operation of said circuit interrupter, a magnetizable core, a reactance coil on said core, a magnetizing coil on said core and means connecting it for energization from said load circuit in proportion to the varying current therein, a constant voltage supply circuit and means connecting it in series circuit with said reactance coil, and means connecting said voltage controlled delay means for energization from said series circuit.

2. In a protective system for a load circuit, a main breaker, relay means to control the operation of said breaker, voltage controlled delay means for effecting operation of said relay means, a magnetizable core, a reactance coil on said core, a magnetizing coil on said core and means for energizing it from said load circuit in proportion to the varying current therein, a constant voltage supply circuit, means connecting said reactance coil in series circuit with said constant voltage supply circuit, and means connecting said voltage controlled delay means for energization from said series circuit.

3. A protective system according to claim 2, wherein the voltage controlled delay means comprises a thermal element.

4. A protective system according to claim 2, wherein is provided a second relay means and means connecting it for energization from said series circuit to control the operation of said breaker upon the occurrence of high overloads in said load circuit, said second relay means being operable to open the main breaker prior to operation of the first named delayed relay upon the occurrence of abnormal circuit loading.

5. In a protective system for a direct current load circuit, a main breaker, relay means to control the operation of said breaker, voltage controlled thermal delay means for effecting operation of said relay means, a magnetizable core, a reactance coil on said core, a magnetizing coil on said core, a shunt in said load circuit, means for energizing said magnetizing coil from said shunt in proportion to the varying current in said load circuit, a constant voltage supply circuit and means connecting it in series circuit with said reactance coil, and means connecting said voltage controlled thermal delay means for energization from said series circuit.

6. In a protective system for a load circuit, a main breaker, relay means to control the operation of said breaker, voltage controlled thermal delay means for effecting operation of said relay means, a magnetizable core, a reactance coil on said core, a magnetizing coil on said core and means for energizing it from said load circuit in proportion to the varying current therein, a constant voltage supply circuit, a transformer including a primary winding and a secondary winding, means connecting said reactance coil and said primary winding in series circuit with said constant voltage supply circuit, and means connecting said voltage controlled thermal delay means for energization from said secondary winding.

7. In a protective system for a direct current load circuit, a main breaker, relay means to control the operation of said breaker, voltage controlled thermal delay means for effecting operation of said relay means, a magnetically saturable core, a reactance coil on said core, a magnetizing coil on said core means for energizing it in proportion to the varying current in said load circuit, a constant voltage supply circuit, and a transformer including a primary winding and a secondary winding, means connecting said reactance coil and said primary winding in series circuit with said constant voltage supply circuit, and means for energizing said voltage controlled thermal delay means from said secondary winding.

8. In a protective system for a direct current load circuit, a main breaker, relay means to control the operation of said breaker, voltage controlled thermal delay means for effecting operation of said relay means, a magnetically saturable core, a reactance coil on said core, a magnetizing coil on said core, a shunt in said load circuit, means connecting said magnetizing coil for energization from said shunt in proportion to the varying current in said load circuit, a constant voltage supply circuit, a transformer including a primary winding and a secondary winding, means connecting said reactance coil and said primary winding in series circuit with said constant voltage supply circuit, means connect-

ing said voltage controlled thermal delay means for energization from said secondary winding, a second relay means and means connecting it for energization from said secondary winding to control the operation of said breaker prior to the operation of the thermal delay means upon the occurrence of abnormally high overloads in said load circuit.

9. In a protective system for a load circuit, a main breaker, relay means to control the operation of said breaker, voltage controlled thermal delay means for effecting operation of said relay means, a magnetically saturable core, a reactance coil on said core, a magnetizing coil on said core, and means for energizing it from said load circuit in proportion to the varying current therein, a constant voltage supply circuit, means connecting said reactance coil in series circuit with said constant voltage supply circuit, and means connecting said voltage controlled delay means for energization from said series circuit, said magnetically saturable core and said magnetizing coil being so dimensioned as compared to the impedances in said series circuit that the current acting on said delay means between approximately zero and fifty percent overload on said load circuit is smaller than the current linearly dependent on said overload current and for values of said overload current above fifty percent is larger than the current linearly dependent on said overload current.

10. In a protective system for a load circuit, a main breaker, relay means to control the operation of said breaker, voltage controlled delay means for effecting operation of said relay means, a magnetizable core, a reactance coil on said core, a magnetizing coil on said core and means for energizing it from said load circuit in proportion to the varying current therein, and a constant voltage supply circuit, means connecting said reactance coil in series circuit with said constant voltage supply circuit, and means connecting said voltage controlled delay means for energization from said series circuit, said magnetizable core being designed to be saturated by the current in said magnetizing coil when the overload in said load circuit is greater than one hundred percent.

11. In combination with a protective system according to claim 9, a second relay means and means for connecting it for energization from said series circuit to effect operation of said breaker immediately upon the overload current in said load circuit reaching approximately one hundred percent.

12. In a protective system for a load circuit, a main breaker, relay means to control the operation of said breaker, voltage controlled delay means for effecting operation of said relay means, a magnetizable core, a reactance coil on said core, a magnetizing coil on said core and means for energizing it from said load circuit in proportion to the varying current therein, a constant voltage supply circuit and means connecting it in series circuit with said reactance coil, and means connecting said voltage controlled delay means for energization from said series circuit, said magnetizable core being so designed that the steepest portion of its saturation curve occurs approximately between full load current and one hundred percent overload current in said load circuit.

ERNST SCHRÖDER.