

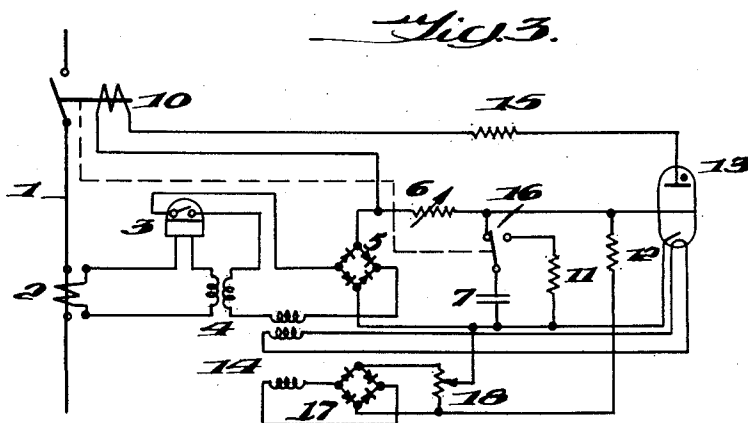
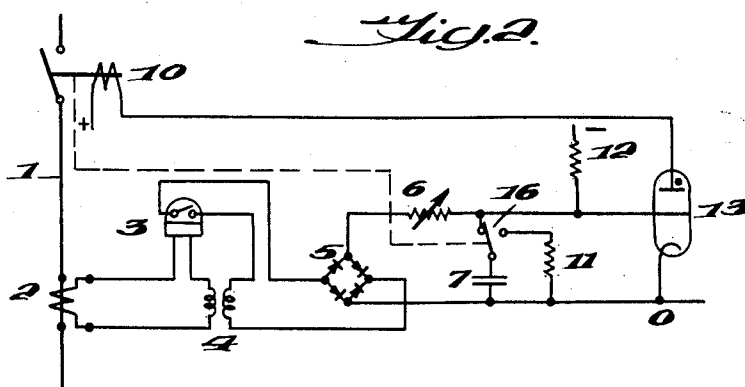
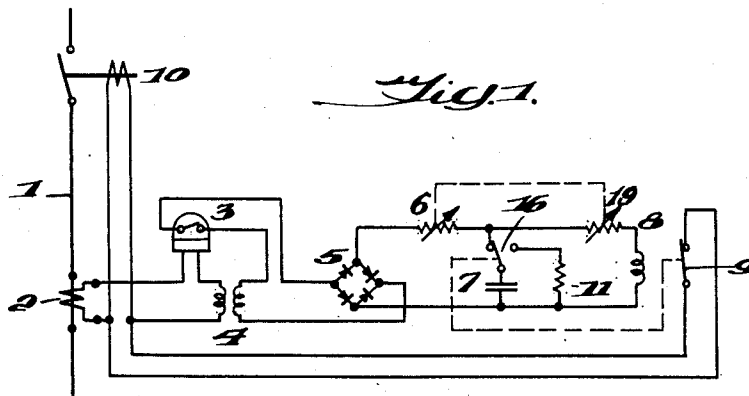
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PROTECTIVE DEVICE

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PROTECTIVE DEVICE

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5 Claims. (Cl. 317—36)

This invention relates to overcurrent protective devices, and is concerned with a device the characteristic of which is a function of the current.

Overcurrent relays with a response time depending on the magnitude of the current, so-called responsive overcurrent relays, have the function of protecting electric installations against short circuits and overloads. Their response time-delay is long in case of low currents, and is short in case of higher currents. The advantage of this type of protective device resides in the fact that transitory overloads below the danger level will not cause a cut-off, while serious short circuits will cause an instantaneous break. In certain types of networks it is also possible to use said relays in the form of stepped protection in order to obtain selectivity by cutting off those elements that are located close to the point of the short circuit. Especially in the case of networks fed by powerful and only slightly variable generators, that is where the current drawn due to a short circuit is determined solely by the impedances of the network, it is possible to obtain an efficient isolation by the use of said relays. Up to the present time the electro-magnetic principle had been used in the design of responsive overcurrent relays. Relays are known that consist of electro-magnets where the armatures are provided with delaying devices such as springs or dampers. Also known are devices where an electro-magnet, with two out-of-phase fluxes, drives a Ferraris disk, or drum, its rotation being a function of the current.

The above described relay types require complicated mechanical constructions and precision work in order to attain the desired accuracy. Said relays also consume a relatively large amount of current.

In order to simplify construction it has been proposed—in connection with other types of relays—to attain the responsive time delay by the use of resistances and capacitors. These elements operate on direct current and the time delay does not become a function of the current. The length of the time delay can be set as desired by varying the resistances. One drawback of the latter type of arrangement is the fact that the time delay becomes a function of the voltage applied; hence steps must be taken either to compensate the voltage responsiveness or to keep the voltage constant within narrow limits.

According to the present invention, an arrangement is proposed which likewise uses a delay network consisting of resistances and capacitors; however, the voltage responsiveness mentioned is utilized to obtain a characteristic which becomes a function of the current supplied. The extraneous effect, which is undesired in cases of relays with a fixed time delay—namely, that the time delay is a function of the voltage—is now utilized to vary the characteristic itself. Since in this manner an influence is eliminated which has been the cause of inaccuracies, it is now possible to attain a very precise method of operation.

Such relays operate as follows:

The current, which is obtained in known manner from a current transformer, is fed through responsive ele-

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ments, which will release the protective device only when the current reaches a certain level, into an intermediate transformer, which converts the current into a proportional voltage. This voltage is rectified and then applied across a resistor-capacitor delay network. The gradual charge of the capacitor determines the time constant of the protective device. The higher the voltage, the faster the capacitor will charge. The voltage across the capacitor can now be fed to a magnetic single-acting relay with high internal resistance, that is of low energy consumption. The relay will respond when the capacitor has reached the response voltage level. The characteristic can easily be adjusted as desired by the varying of the resistances. It may be expedient to connect another, variable, resistance in series with the relay—to be varied simultaneously with the resistance—which is part of the resistor-capacitor network. This arrangement will make it possible to keep the starting point constant regardless of the change of slope of the characteristic.

It is also possible to apply the voltage across the capacitor to the grid of a gas discharge tube which, at a certain voltage level, releases the plate current which in turn activates a release switch. It will be necessary to provide the tube (grid) with a negative bias which will determine the potential at which the tube is to conduct. Adjustment of the bias can be accomplished very easily.

When the above described device has responded, the capacitor will retain its charge for a certain length of time. Now, if the capacitor is energized again before it has discharged completely, the time required to bring the capacitor charge up to the response level will be shortened, consequently the release time will be shortened also. In order to avoid this drawback, it is proposed to switch the capacitor, simultaneously with the release, to a resistor by using the releasing device (relay or tripping contact) for this operation; said resistor then will permit a practically instantaneous discharge.

A D.C. voltage normally is required for the plate current, and the same is not always available as an auxiliary power supply. Therefore, in accordance with the invention it is proposed to obtain the plate voltage likewise from the primary current. This makes the voltage a function of the current—a fact which can be utilized to broaden the time delay of the protective device characteristic even further. In case of low currents the tube will operate at a lower voltage, thereby delaying the release time still further. In order to avoid an overloading of the tube in case of very high currents, the plate voltage can be obtained from saturated transformers. The cathode voltage can also be obtained from the primary current, care being taken that this voltage is kept as constant as possible. Use of saturated transformers will therefore be necessary. The grid voltage can also be obtained from the primary current by means of an additional winding of the auxiliary transformer, and its output be applied, after rectification, to the grid of the tube. Since the grid voltage must be negative with respect to the cathode, it is necessary to shunt the winding with a potentiometer and to connect its sliding arm with the cathode. The grid bias, and thereby the characteristic, can be varied by adjusting the potentiometer. The windings for the cathodes, the plate voltage and the grid bias can be supplied by a single auxiliary transformer if this transformer will already become saturated in case of lower short-circuit currents.

Figures 1, 2 and 3 diagrammatically illustrate practical examples of the invention.

Fig. 1 shows a circuit using a magnetic relay;

Fig. 2 shows a circuit employing a gas discharge tube;

and

Fig. 3 shows a circuit without a separate direct current supply.

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The current which flows through the power line 1 energizes the protective device by means of the current transformer 2. The current flows through a response relay 3 of known construction to the auxiliary transformer 4 which converts the current into a voltage of approximately equal proportion. The secondary circuit of said transformer 4 is connected by the response relay 3, conducting the voltage to the rectifier circuit 5—developed for instance in the form of a bridge network. In this manner a D.C. voltage is obtained which is proportional to the primary alternating current. This voltage is now applied across the resistor 6 and the capacitor 7. The capacitor 7 will charge until it reaches the response voltage of the delay relay 8. Said delay relay will open the contact point 9, allowing the current of the secondary winding of the transformer 2 to flow through the release device 10, thereby releasing the switch. Obviously, it is also possible to provide the relay 8 with an "on" switch to connect the release device with an auxiliary voltage source. Auxiliary switch contact 16 is switched over simultaneously with contact 9, thereby connecting the capacitor 7 with the discharge resistor 11. When the relay 8 is reset, the original positions are restored. The characteristic can be adjusted by varying resistors 6 and 19. The two resistances can be varied simultaneously. Thus it is apparent that the circuit including the relay 8 and the variable resistance 19 constitutes an actuating means connected to the delay network for simultaneously operating the release switch in the main power line and also auxiliary switch 16.

In the circuit shown in Fig. 2 the voltage across the capacitor 7 is applied to the grid of the gas discharge tube 13, which under normal conditions will have a negative bias across the grid resistor 12. The voltage built up across capacitor 7 will counteract this bias. When a certain potential has been reached the tube can fire, whereupon the plate current will flow and activate the release device 10. Said device 10 will switch over the contact 16. The plate—as well as the grid—voltage is obtained from an auxiliary D.C. source (indicated by "+", "-", "0"). Thus the circuit including the gas discharge tube 13 comprises actuating means connected to the delay network for simultaneously operating the power line release switch and the auxiliary switch 16.

Fig. 3 shows a circuit employing discharge tubes without an auxiliary D.C. source. The plate voltage is obtained, and rectified, from the secondary winding of the auxiliary transformer 4. The cathode voltage is obtained from another, saturated, auxiliary transformer 14. Saturation must already be reached there with the response current of relay 3. A third winding of the auxiliary trans-

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former 14 is used for obtaining the grid voltage and is connected over a rectifier circuit 17 to the potentiometer 18 as a load. The sliding arm of the potentiometer is connected with the cathode of the tube 13. The minus pole is connected over the grid resistor 12 to the grid of the tube 13 and the grid voltage can be adjusted thereby. The resistor 6 can also be made variable in order to vary the characteristic.

I claim:

1. An overcurrent protective device for actuating a normally-closed release switch in an alternating-current power line comprising a resistor-capacitor delay network, the resistance of said network being variable for the purpose of altering the time characteristic of said network, a current transformer connected in series in said power line, rectifying means including a response relay connecting said current transformer to said network to apply rectified power thereto proportional to the primary current in said power line, normally-open auxiliary switch means connecting a discharge resistance across said capacitor, and actuating means connected to said delay network to simultaneously operate said release switch and said auxiliary switch to open said power line and to discharge said capacitor.
2. An overcurrent protective device as defined in claim 1 wherein said actuating means comprises a delay relay having an operating winding connected in series with a second variable resistor mechanically coupled to the variable resistance of said delay network.
3. An overcurrent protective device as defined in claim 1 wherein said actuating means includes a gas discharge tube having a negatively-biased control grid connected to the capacitor of said delay network.
4. A device as defined in claim 3 and further including an auxiliary transformer which is already saturated at the time of response of the response relay for supplying the grid and cathode voltages of said gas discharge tube.
5. A device as defined in claim 4 wherein the plate voltage of said gas discharge tube is supplied by an auxiliary transformer which supplies the resistor-capacitor network, said voltage increasing proportionately with the current in the current transformer.

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