Aug. 15, 1967 E. P. CARTER 3,336,504

OVER-CURRENT PROTECTIVE DEVICE

Filed Nov. 18, 1964

FIG. 1

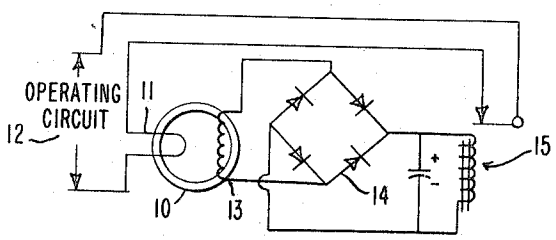
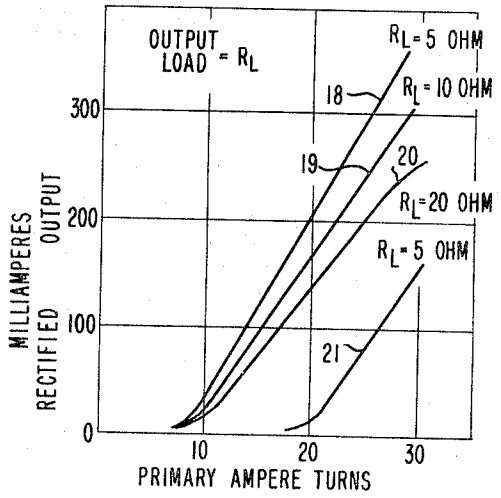


FIG. 2



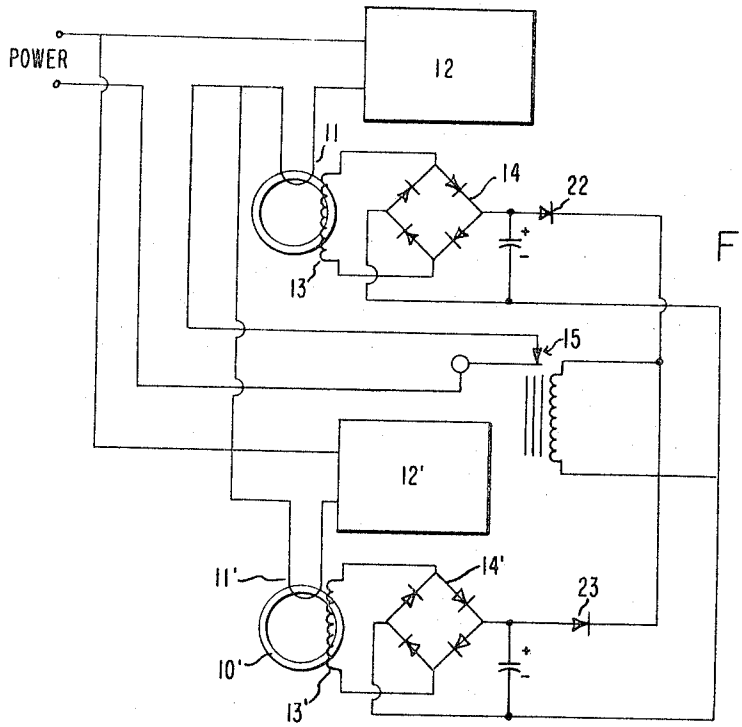


FIG. 3

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OVER-CURRENT PROTECTIVE DEVICE

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This invention relates to an over-current regulator effective at audio frequencies.

In some forms of electric equipment, presently available devices for prevention of currents above a certain level are inadequate to provide the necessary protection to the apparatus or to a product in process. An example of such is in the electrical discharge treatment of polymeric organic films to improve the adhesion of printing inks. The preferred type of apparatus employs frequencies above the conventional 60 cycles per second at the treating unit, with individual subunits operating from a common power supply which in turn may be driven by the conventional 60 cycles per second line power. Obviously, it is not desirable to interrupt the line power to the generator in the event of excessive current in one of the subunits, but existing protective equipment does not perform well at the higher frequencies employed in the individual subunits.

Replaceable fuses in a film production plant manned by operators of varying crafts and skills lead to manpower problems and frequent interruptions of production; thermal circuit breakers are too slow to protect against arc-over; and magnetic circuit breakers will not operate above 400 cycles per second.

The principal object of the present invention is, therefore, provision of an over-current protective device which will not suffer from the aforesaid deficiencies, and which will provide reliable protection at audio and higher frequencies.

In accordance with the present invention, there is now provided apparatus for the interruption of current above a preselected level in an electrical operating circuit comprising a transformer and current-actuated means to interrupt the current in said operating circuit, said transformer having its primary in said operating circuit, and having its secondary in a circuit with said means to interrupt the current in said operating circuit, said transformer having a core of a magnetizable material of high coercive force, whereby a current in said primary must exceed said preselected level to cause a current in said secondary to actuate said current interruptive means.

The critical element of the present invention is the transformer core having a high coercive force to provide a threshold level of current in the primary below which no current in the secondary appears. This is provided by use of a core of high coercive force and a low resistance primary winding in the operating circuit to be controlled. In operation, current in the secondary circuit actuates a relay which in turn interrupts the current to the primary circuit, but by virtue of the high coercive force of the core, no flux, and thus no current in the secondary, appears until the primary current exceeds a given level.

The understanding of the present invention is facilitated by reference to the drawings, wherein:

FIG. 1 is a schematic diagram of a preferred form of the present invention;

FIG. 2 graphically illustrates the effect of adjustment of several parameters in the present invention; and

FIG. 3 illustrates the use of one or more protective devices with a common circuit interruptive device to control one or more units in a circuit.

The basic elements of the present invention are shown in FIGURE 1. Toroid core transformer **10** is shown with its primary **11** in operating circuit **12** to be controlled. The secondary **13** of this transformer is coupled in a circuit employing bridge-type rectifying circuit **14** and relay **15**, shown only in the coil form. In a typical form the secondary has 50 turns of wire uniformly distributed around the entire core, and a primary of three turns, placed at any convenient location on the core, coupled in the operating power circuit. The core, a torus, has a relatively high coercive force (2.1 oersteds), and in a typical application has a core length of 3.14 inches. This circuit coupled to a relay **15** (for example a Sigma model 41R5 which has a 5 ohm coil, adjusted to pull in at 90 milliamperes), will control effectively a maximum current of 8 amperes. The current level at which the control system is actuated may be controlled by two means: (1) by the magnetic path length in the core; and (2) by the number of turns in the primary.

FIG. 2 illustrates the effect of lengthening the magnetic core, the curves shown in the diagram, curves **18**, **19** and **20** representing load resistances of 5, 10 and 20 ohms respectively. These are based on a core length of 3.14 inches. The torus core, a ferrite, was "Feramic Q1," manufactured by General Ceramics Corp., a subsidiary of Indiana General Corp. Increasing the path length of the core to 5.11 inches shown as curve **21** increased the primary ampere turns at which a current appears in the secondary to a value almost double that at which it appeared with a core length of 3.14 inches. From this, it is seen that the threshold current at which the protective device is operative depends on the magnetic path length. Obviously, by increasing the number of primary turns, the primary current level at which the control system is actuated is reduced.

FIG. 3 illustrates the use of decoupling diodes shown as **22** and **23** in the multiple circuits operating a single relay to interrupt the power to all circuits. These blocking diodes decouple, or prevent feedback from one circuit to another. Duplicate elements are represented by the primed members.

The apparatus disclosed exemplifies the basic invention, i.e., the employment of a transformer requiring the primary current to exceed a threshold before current is induced in the secondary. Variations from the disclosed design can be effected without departing from the spirit of the invention. For example, a multiple-tap primary, employing low resistance windings, may be employed so as to vary the primary ampere turns and thus the current at which the system is actuated.

Having described my invention,

I claim:

Apparatus for the interruption of an electrical, alternating current operating circuit when the current therein exceeds a preselected level which comprises essentially a

transformer and an alternating current-actuated means to interrupt the alternating current in the operating circuit, said transformer having its primary in said operating circuit and its secondary in a circuit with said means to interrupt the current, said transformer having a core of a magnetizable material of high coercive force, whereby a current in said primary must exceed said preselected level before a current is induced in the secondary.

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