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MAGNETIC AMPLIFIER CIRCUIT PROTECTING DEVICES

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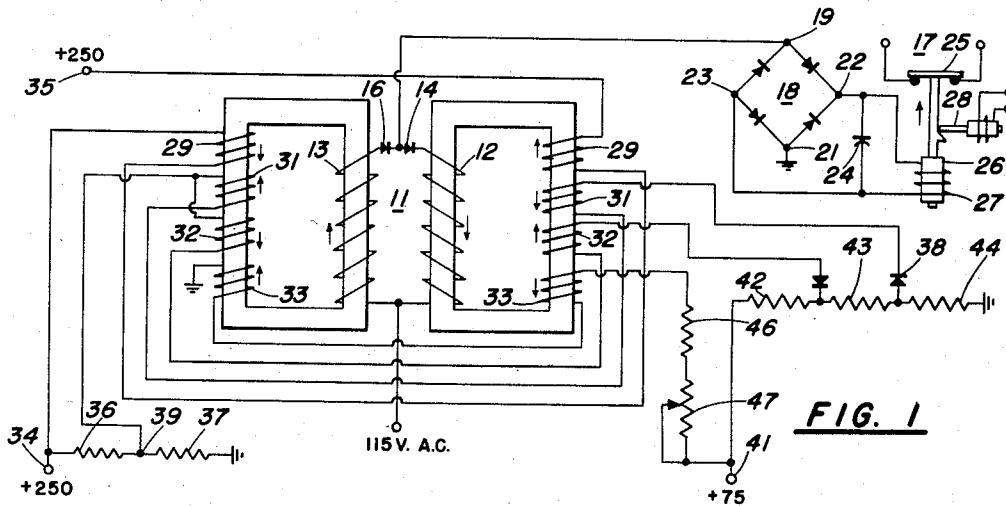


FIG. 1

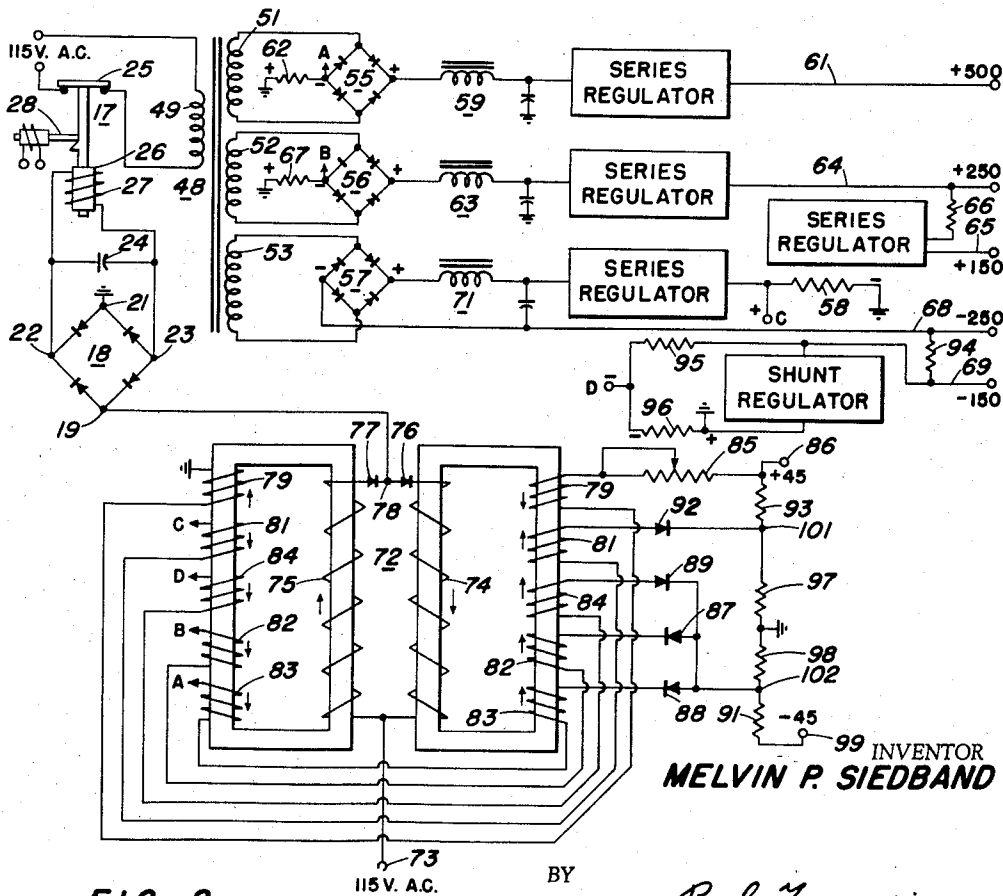


FIG. 2

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2 Claims. (Cl. 317-31)

The present invention relates to magnetic amplifier circuit protecting devices and more particularly to magnetic amplifier circuit protecting devices having overcurrent, undervoltage and/or overvoltage protection.

Circuit protection in apparatus such as radar power supplies consists of placing a fuse in series with each of the supplied voltages and a main fuse. One disadvantage of this arrangement is that one of the fuses in a bias supply circuit, for example, could blow out with plate voltage still maintained: this could cause serious damage to the vacuum tubes. Thus a device is needed to turn off the entire system in the event of loss of bias.

The present invention embodies a magnetic amplifier which is not sensitive to environmental conditions such as temperature, for example, and which operates by the comparison of power supply voltages to a known reliable voltage. The output of the magnetic amplifier operates a relay in response to overvoltage, undervoltage and/or excessive current flow, which opens the main supply circuit and thus prevents damage to the vacuum tubes.

An object of the present invention is the provision of a protective system.

Another object of the invention is to provide an overvoltage, undervoltage, and/or overcurrent protective system.

A further object of the invention is the provision of an overvoltage, undervoltage, and/or overcurrent protective system for radar power supplies.

Still another object of the invention is the provision of a protective system which is not sensitive to environmental conditions.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 shows a schematic diagram of one embodiment of the invention.

Fig. 2 shows a schematic diagram of a second embodiment of the invention applied to a typical radar supply system.

Referring now to the drawings, wherein like reference characters designate like or corresponding elements in each of the two figures, there is shown in Fig. 1 a self-saturating magnetic amplifier 11 having load winding 12, 13, and self saturating diodes 14 and 16. The output of the magnetic amplifier 11 is connected to a solenoid coil 27 of relay 17 through a full wave rectifier 18 having input terminals 19 and 21 and output terminals 22 and 23. A smoothing capacitor 24 is connected across the output terminals 22 and 23. The relay 17 is connected in series with a source, not shown, and has a contact 25 which is mechanically connected to an armature 26 which is actuated by the solenoid coil 27. A solenoid latch 28 is provided to latch the relay in an open position. A remote control, not shown, is provided for resetting the magnetic amplifier.

Each leg of the magnetic amplifier 11 has an over-

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current control winding 29, an undervoltage control winding 31, an overvoltage control winding 32 and a bias winding 33. The overcurrent control winding 29 is connected in series with the circuit to be protected having an input terminal 34 and an output terminal 35. Two dropping resistors, 36 and 37 are connected between the input terminal 34 and ground. Control winding 31 is connected in series with a blocking rectifier 38 between the junction terminal 39 of the resistors 36 and 37 and a terminal 41 of a reference voltage source, not shown, through dropping resistors 42 and 43 and across a dropping resistor 44. The bias winding 33 is connected to the reference voltage terminal 41 through a fixed resistor 46 and a variable resistor 47.

In operation, by way of example, there is shown a +250 power supply for supplying radar circuits. The voltage at the junction of resistors 36 and 37 will be at +50 volts under normal conditions. If this voltage rises or falls ten percent, current will flow in either the overvoltage control winding or the undervoltage control winding, thus causing the magnetic amplifier to saturate which allows a current to flow to operate the relay 17 which will open the supply circuit. The overcurrent winding 29 is connected in series with the +250 volt line, therefore a flux is established which is proportional to the current flowing in the circuit. Resistors 46 and 47 determine a bias current which produces a biasing flux to buck out the effect produced by the overcurrent winding 29 as long as the flux in the winding 29 remains well below the level of the bias flux. As the output current increases, a value will be reached where the bias no longer holds the magnetic amplifier cut off and the relay 17 operates to open the supply circuit.

Fig. 2 shows a transformer 48 having a primary winding 49 and secondary windings 51, 52 and 53. Primary winding 49 is connected to an alternating current source, not shown, through the relay 17. Each of the secondary windings 51, 52 and 53 is connected through bridge rectifiers 55, 56 and 57 respectively to provide power for a plurality of electronic circuits, not shown. The output of rectifier 55 is fed through a filter circuit 59 and a series regulator to a supply lead 61 of an electronic circuit, not shown. A series resistor 62 is connected between the negative terminal of the rectifier 55 and ground. Rectifier 56 is similarly connected to supply lead 64 through the filter network 63. A further output voltage supply lead 65 is provided by a dropping resistor 66 and a series regulator. A resistor 67 is connected between the negative terminal of rectifier 56 and ground.

The output of rectifier 57 is connected to provide negative voltage supply circuits to leads 68 and 69. Supply leads 68 and 69 respectively are connected in series with resistor 58. Thus, the voltage drop across resistor 58 is proportional to the total current flowing in the two supply leads 68 and 69. A voltage divider comprising three series connected resistors 94, 95 and 96 is connected between supply lead 68 and ground. Terminal D is connected intermediate resistors 95 and 96 to provide a negative voltage proportional to the negative supply voltage at 69. A shunt regulator is connected between supply line 69 and ground to maintain the voltage substantially constant. A filter circuit 71 is connected across the output of rectifier 57.

The self-saturating magnetic amplifier 72 is of the two core type and is similar to the amplifier 11 of Fig. 1 with the addition of a fifth winding. Amplifier 72 is provided with an alternating current input 73, load windings 74, 75, and self-saturating rectifiers 76, 77. The output 78 of the amplifier is connected to relay coil 27 through the rectifier 18. Each core of the amplifier is provided with a bias winding 79, current control windings 81, 82, 83 and a voltage control winding 84. One

terminal of the bias winding 79 is connected through a variable resistor 85 to the positive terminal 86 of a bias source, not shown, while the other terminal is connected to ground. Windings 82, 83, and 84 are connected in series with blocking rectifiers 87, 88 and 89 respectively and a resistor 91 between the negative terminals B, A and D respectively and the negative terminal 99 of the bias source. Winding 81 is connected in series with a rectifier 92 and resistor 93 between the positive terminal 86 of the bias source and the positive terminal C of the positive side of resistor 58. Resistors 97 and 98 are provided to give the proper biasing voltage for the control windings at junctions 101 and 102 respectively.

Direction arrows are shown on the drawing to indicate the relative direction of the flux generated by the several control windings.

In operation, under normal operating conditions the magnetic amplifier 72 is biased to cut off. Assume, for purposes of illustration only, that the bias voltage at 102 is -20 volts and the voltage at 101 is +20 volts. Further assume that the voltage drop across resistors 62 and 67 and the voltage at terminal D is -20 volts. Also that the voltage at terminal C is +20 volts. Under the above assumed conditions no current flows in the control windings 81, 82, 83 and 84. Now assume the current flow in lines 61, 64, 68 and 69 increase, the voltage drop across resistors 62, 67 and 58 will increase. The voltage at A and B will be more negative or less positive than the bias voltage at junction 102, and a current will flow from junction 102 through blocking rectifiers 87 and 88 and windings 82 and 83 to the negative terminals of rectifiers 55 and 56 respectively. The voltage at C will be more positive than the voltage at junction 101, therefore a current will flow from C through winding 81 and rectifier 92 to junction 101. With a drop or loss of voltage at D, junction 102 will be less positive than D and current will flow from D through winding 84 and rectifier 89 to junction 102. The current flowing in the control windings will generate a flux sufficient to buck out the bias flux and allow the magnetic amplifier to be turned on and operate the relay 17.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. In a protective system of the character described, relay means; a self-saturating magnetic amplifier comprising load windings and a plurality of control windings, said load windings having input circuit means and output circuit means; one of said control windings being responsive to an overcurrent condition, a second of said control windings being responsive to an overvoltage condition in said circuit to be protected, a third of said control windings being responsive to an undervoltage of said circuit to be protected; circuit means connecting said output means to said relay means; and circuit means for connecting said input means to a voltage source; said

magnetic amplifier being responsive to said plurality of control windings to control the operation of said relay in response to overcurrent, overvoltage and/or undervoltage.

2. A system comprising; a transformer having a primary winding, first, second and third secondary winding, said primary winding being adapted to be connected to a source of alternating current through a relay; a first, second and third full wave rectifier connected across each of said first, second and third secondary winding respectively; an output supply circuit connected to each of said full wave rectifiers; a resistor having a positive and negative terminal connected in series with each of said output supply circuits to provide a voltage drop proportional to the current flowing in the output supply circuit; a magnetic amplifier having input circuit means, output circuit means, and a bias winding; a source of reference potential having a positive and a negative terminal; a first control winding connected in series with a blocking rectifier between said negative terminal of one of said supply circuit resistors and said negative terminal of said bias voltage source, whereby a voltage drop across said resistor greater than the reference potential will cause a current to flow in said first control winding to permit saturation of said magnetic amplifier; a second control winding connected in series with a second rectifier between said positive terminal of another of said supply circuit resistors and said positive terminal of said reference source, whereby a voltage drop across said other resistor greater than said reference potential will cause a current to flow in said second control winding to permit saturation of said magnetic amplifier; a third control winding connected in series with a third rectifier between the negative terminal of a negative supply circuit connected to the negative terminal of said third rectifier and the negative terminal of said bias source; the input of said magnetic amplifier being connected to an alternating current source and the output of said magnetic amplifier being connected to said relay; whereby upon an overcurrent, overvoltage, and/or undervoltage a flux produced by one of said control windings will oppose the bias flux sufficiently to permit said magnetic amplifier to become saturated thus permitting a current to flow in said load winding sufficient to actuate said relay.

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