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MAGNETIC AMPLIFIER CIRCUIT BREAKER

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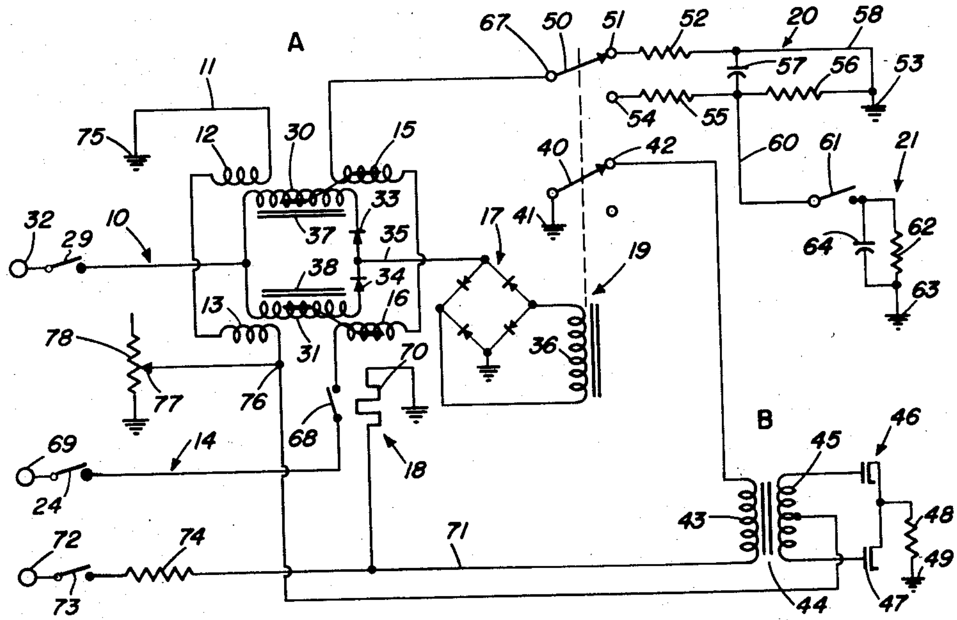

INVENTOR
MELVIN P. SIEDBAND

BY J. Schmitt
R. I. Tompkins
ATTORNEYS

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MAGNETIC AMPLIFIER CIRCUIT BREAKER

Melvin P. Siedband, Baltimore, Md., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Navy

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This invention relates to circuit breakers with special application to protection of electrical apparatus from overloads.

For many uses, such as for protection of radar modulator high voltage apparatus, a circuit breaker should be highly sensitive and at the same time resistant to shock, vibration, temperature change and other environmental conditions which tend to diminish the effectiveness of the device.

Accordingly, a primary object of the invention is to provide a circuit breaker which is highly sensitive in its action. Other objects include provision of a circuit breaker which is resistant to disturbances produced by shock, which functions satisfactorily under conditions of vibration, and which is largely independent of temperature variations.

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 drawing wherein the various apparatus and circuits of the circuit breaker are diagrammatically indicated.

Referring to the figure, there is indicated two circuit sections A and B, A being applied to the circuit breaker section and B to the load unit which, in this disclosure, is a radar modulator high voltage supply unit.

The circuit breaker A includes the full wave self-saturating type magnetic amplifier **10**, the control circuit **11** including control coils **12** and **13**, the bias circuit **14** including bias coils **15** and **16**, the rectifier bridge **17**, the time delay relay **18**, the main relay **19**, the overload tester **20**, and the reset circuit **21**, all appropriately connected for functioning. In greater detail, magnetic amplifier **10** takes the form of two reactor coils **30** and **31** connected in parallel to a source of electric power through manual switch **29**, which, for the indicated use, may be 115 volts alternating current at 400 cycles. Current derived from this source after passing through the coils **30** and **31** and rectifiers **33** and **34** is combined in conductor **35** and led through the full-wave bridge **17**, which may be of the selenium rectifier type, to the cored relay coil **36** of relay **19**. Passage of current as described, however, is contingent on the saturation of the reactor cores **37** and **38** of coils **30** and **31** by the rectified current.

As shown, the relay **19** is in its deenergized position with switch arm **40**, which is grounded at **41**, having connection through contact **42** to the primary coil **43** of the plate transformer **44** in the B-circuit section. In its energized position switch arm **40** is open. Other elements of the B-circuit include the plate transformer secondary **45**, tubes **46** and **47** connected in series with the transformer secondary and the resistor **48** connected to the series circuit between tubes **46** and **47** and grounded at **49**.

In the deenergized relay position, also, the relay **19** has a circuit connection through switch arm **50** from the bias circuit **14** to the overload tester **20** and reset circuit **21**. The overload tester includes switch contact **51** and

resistor **52** connected in series to ground at **53**, and an alternative circuit through contact **54** and resistors **55** and **56** to ground. A capacitor **57**, which may be variable, is connected across these two branch circuits at the grounded ends of resistors **52** and **55**. A conductor **60** leads from a point between resistors **55**, **56** through manual switch **61** and resistor **62** to ground at **63**, a variable capacitor **64** being connected in shunt around resistor **62**. This capacitor-resistor-switch unit constitutes the reset circuit **21**.

The bias circuit **14** is connected at one end to the pivot **67** of relay switch arm **50** and from this point passes through bias coils **15** and **16** and normally open time delay relay switch **68** to a source **69** of direct current through manual switch **24** at 250 volts. The time delay relay switch is actuated by a non-inductive resistor **70** which is grounded at one end and at the other connects to the power line **71**. This line joins the plate transformer primary **43** in the B section to a source terminal **72** through manual switch **73** for power at 115 volts 400 cycles, a 15 second time delay unit **74**, which may be structurally similar to time delay unit **18**, being inserted in line **71**. It is pointed out that the winding direction of bias coils **15** and **16** is such as to unsaturate amplifier coils **30** and **31**, when coils **15** and **16** are energized.

The control circuit **11** leads from a ground connection at **75** through amplifier control coils **12** and **13** to the mid-point of secondary **45** of the plate transformer **44** in the B section. A tap is made in this circuit from the transformer side of control coil **13** at **76** to a slide **77** movable on grounded resistor **78** to secure a desired level of current flow in the control circuit. The winding direction of control coils **12** and **13** is such as to augment the saturating flow in amplifier coils **30** and **31** when coils **12** and **13** are energized.

The operation of the device may now be described. Assume that power is applied to the input terminals **32**, **69** and **72** at the described values. Bias circuit **14**, connecting to the 250 volt direct current source at **69**, remains open because of time delay switch **68** but is subject to closure in 45 seconds. The B-circuit, connecting to source terminal **72**, remains open for 15 seconds due to time delay unit **74**. However, the magnetic amplifier circuit is at once energized, the coils **30** and **31** becoming saturated by the rectified current through these coils and thus permitting current flow through the relay coil **36** of relay **19**. The relay switch **40** is accordingly moved to open position.

In 15 seconds, power is applied from source terminal **72** to time delay unit **18**, the B-circuit remaining deenergized due to open switch **40**. In 45 seconds, power from source terminal **69** is applied to the bias circuit by closure of time delay switch **68**, the direct current of this source passing directly to ground through overload tester resistors **55** and **56** and giving capacitor **57** a partial charge. Thereupon, the saturating flux in the amplifier is reduced by bias coils **15** and **16** to such an extent that relay **19** is deenergized, switch arms **40** and **50** returning to the position as shown in the figure with the B-circuit completed through ground **41** and the bias circuit completed through the alternative tester branch including resistor **52** and conductor **58**. The B-circuit power will now be maintained unless overload values develop in excess of the level set by slider **77** in the control circuit **11**. Should this occur the control coils **12** and **13** add sufficient flux to the amplifier to again saturate it, thereby breaking the B-circuit at relay contact **42** and moving switch arm **50** to contact **54** when capacitor **57** receives another increment of charge.

Since the control coil circuit is opened by the relay action, the bias circuit **14** again becomes effective and again the amplifier is unsaturated and high voltage is applied to the B-circuit by relay movement. If the overload still exists the control circuit 11 again functions and the capacitor again receives an increment of charge. With continued overload this cycle is repeated until the capacitor is charged to the point where unsaturating bias current cannot flow and the B-circuit remains continuously open.

The number of recycling tests may, of course, be varied by the constants of the circuit, including capacitor 57, a four time test being found adequate for most uses. After the test period with the B-circuit remaining open, recycling can be continued by the reset unit 21, the capacitor 64, connected by manual switch 61, forming a shunt to ground around capacitor 57.

It will now appear that the load protecting device, as described, has no elements particularly susceptible to shock, vibration, temperature or other environmental conditions. The device, also, is highly sensitive as compared to conventional systems and is advantageous from the viewpoint of weight and spaced due to absence of differential relays, power contactors, resistance-capacitance nets, and the like. It is pointed out, further, that it is impossible to override the circuit breaker by holding the reset switch closed.

Additional control windings may be incorporated on the reactors such that when the sum of each of the currents in these windings exceeds a neutralization current in an additional winding, the reactor core will saturate, closing the relay. In this manner, the device may protect a number of circuits from overload.

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. A circuit breaker device for circuits susceptible to overloads comprising a load circuit, a first source of alternating current, a manual switch in said load circuit, a normally closed load switch connected in series to said load circuit and current source, a relay for moving said switch to open position, a second source of alternating current, a direct current saturable reactor connected between said second alternating current source and said relay to supply actuating energy thereto, a source of direct current, bias means connected to said direct current source for applying said direct current to said reactor to unsaturate the same whereby the relay is deenergized, control means connected to said load and reactor for neutralizing intermittently said bias means when the load current exceeds a predetermined value, means for terminating the intermittent neutralization of said bias means after a limited number of neutralizations, during continuance of excess load in said load circuit, and time delay means for preventing flow of load current through said normally closed load switch for a time period after closure of said manual switch but before closure of said constant direct current bias circuit.

2. The circuit breaker device as defined in claim 1 with means for starting a second series of bias means neutralizations by said control means and additional means for terminating said second series of bias means

neutralizations, during continuance of excess load in said load circuit, said neutralization terminating means being independent of said first named neutralization terminating means.

3. A circuit breaker device for circuits susceptible to overloads comprising a load circuit, a first source of alternating current, a normally closed load switch connected in series to said load circuit and current source, a relay for moving said switch to open position, a second source of alternating current, a direct current saturable reactor connected between said second alternating current source and said relay to supply actuating energy thereto, a source of direct current, bias means connected to said direct current source for applying said direct current to said reactor to desaturate the same whereby the relay is deenergized, and control means connected to said load and reactor for neutralizing said bias means when the load current exceeds a predetermined value, whereby the load circuit is broken and the control means deenergized, said load circuit including a transformer having a primary coil and a load connected secondary coil, said load switch and first current source being connected in series with said transformer, and said control means being connected between ground and the mid-point of said secondary coil.

4. A circuit breaker device for circuits susceptible to overloads comprising a load circuit, a first source of alternating current, a normally closed load switch connected in series to said load circuit and current source, a relay for moving said switch to open position, a second source of alternating current, a direct current saturable reactor connected between said second alternating current source and said relay to supply actuating energy thereto, a source of direct current, bias means connected to said direct current source for applying said direct current to said reactor to unsaturate the same whereby the relay is deenergized, control means connected to said load and reactor for neutralizing intermittently said bias means when the load current exceeds a predetermined value, and means for terminating the intermittent neutralization of said bias means after a limited number of neutralizations, during continuance of excess load in said load circuit, said load circuit including a transformer having a primary coil and a load connected secondary coil, said load switch and first current source being connected in series with said transformer, and said control means being connected between ground and the midpoint of said secondary coil.

5. The circuit breaker as defined in claim 3 including additionally means for delaying flow of current from said first alternating current source until after current flow is begun in said second alternating current source and means for delaying current flow from said direct current source until after current flow is begun from said second alternating current source.

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