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WASHINGTON, D.C. 20546

REPLY TO
ATTN OF: GP

TO: USI/Scientific & Technical Information Division
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General Counsel for
Patent Matters

SUBJECT: Announcement of NASA-Owned U. S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code USI, the attached NASA-owned U. S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U. S. Patent No. : 3,579,041

Government or Corporate Employee : Bendix Aerospace Systems Div Ann Arbor, Mich.

Supplementary Corporate Source (if applicable) :

NASA Patent Case No. : MSC-11277

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:

Yes ☑ No ☐

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of Column No. 1 of the Specification, following the words ". . . with respect to an invention of . . ."

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Enclosure
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United States Patent

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[54] **CIRCUIT BREAKER UTILIZING MAGNETIC LATCHING RELAYS**
3 Claims, 1 Drawing Fig.

[52] **U.S. Cl.** **317/33,** 317/54, 317/60, 317/155.5
[51] **Int. Cl.** **H02h 3/08**
[50] **Field of Search** 317/33, 155.5, 54, 60

[56] **References Cited**
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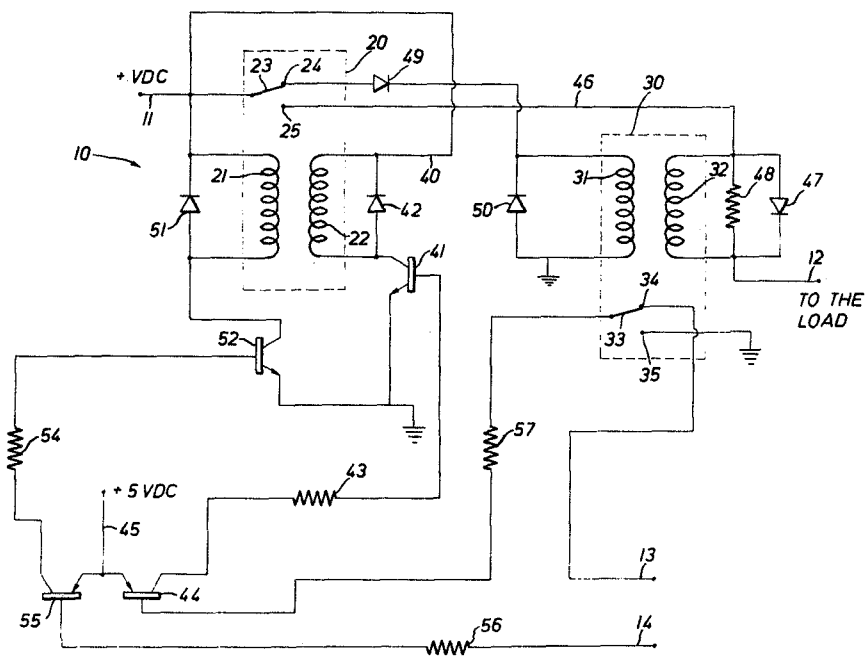
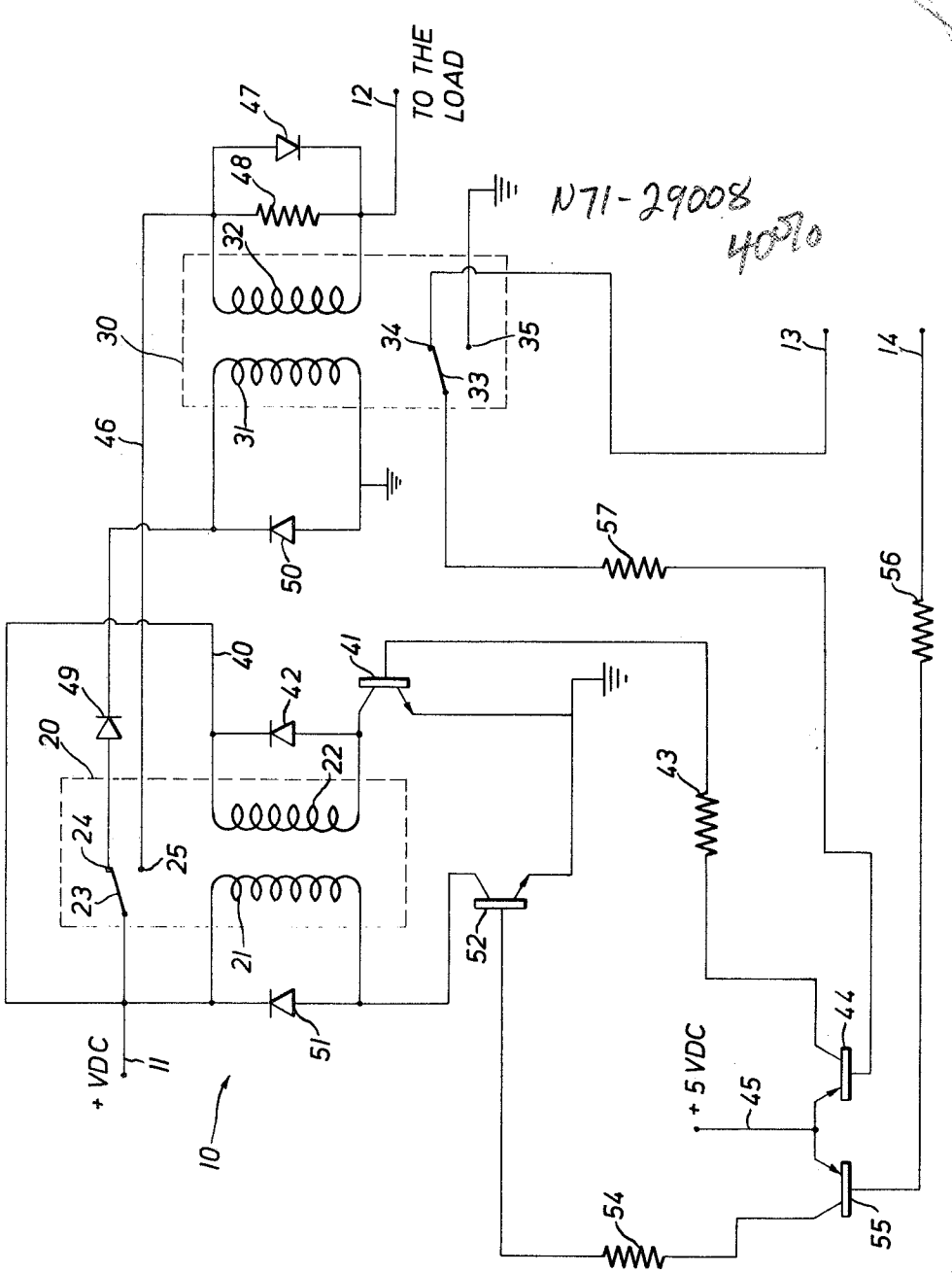
ABSTRACT: In circuit breakers wherein power consumption is significant, a circuit breaker relay being operably controlled by switching transistors normally biased off, the operation of which is triggered by a magnetic latching relay having a coil sensitive to current flow and requiring current flow only on switching.





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CIRCUIT BREAKER UTILIZING MAGNETIC LATCHING RELAYS

The invention described herein was made in the performance of work under a NASA Contract and is subject to the provisions of Section 305 of the National Aeronautics and Space Act of 1958, Public Law 85—568 (72 Stat. 435; 42 U.S.C. 2457.

Relay circuit breakers are normally designed to prevent overload of power sources or other operative conditions which exceed predetermined tolerances. For instance, loss of line voltage is a sufficient reason for operating circuit breakers in some circumstances. Excessive current demands are likewise considered to be a problem, and relay circuit breakers are likewise protective against such events. The apparatus of the present invention is summarized as including a current switching main relay which is magnetically latched to provide a conductive and nonconductive path therethrough for the current device. The apparatus further incorporates a magnetic latching relay which is responsive to overload currents and voltage sensing operations also. The second relay provides control signals for switching transistors which control the power relay, the transistors being biased normally off so that the total power consumption of the entirety of the circuit is limited to the power consumption of the current sensing coil.

Many objects and advantages of the present invention will become more readily apparent from a consideration of the below included specification and single drawing, wherein:

A circuit diagram of the relay circuit breaker of this invention is shown in the single figure of the drawing.

Referring more particularly to the single drawing the circuitry indicated by the numeral **10** comprises the improved relay circuit breaker of the present invention. The numeral **11** indicates a conductor communicating with a suitable power source of any description. The numeral **12** indicates a conductor communicating with load, the nature of which is not significant for purposes of the present invention. The current flows from the conductor **11** to the conductor **12** of the present circuitry, and so long as alarm conditions are absent, the flow is uninterrupted. Additionally, provisions are made for remote control and switching of the relay circuit breaker **10** through the conductors **13** and **14** which supply, respectively, off and on commands to the apparatus.

Considering the invention more in detail, the conductor **11** communicating with the power source is input to a switching relay indicated by the numeral **20**. The relay is enclosed within the dotted line shown in the drawing, which is included to show that the components thereof are suitably encased in a well-known structure which need not be further illustrated. The relay **20** is of the magnetic latching variety as opposed to the conventional relay operated by a solenoid on one side of the contact working against a return spring on the opposite side of the armature. In the present device, and as illustrated, the relay **20** incorporates a coil **21** and a second coil **22**. The illustrated position is a result of operation of the coil **22**. It will be appreciated that the coils **21** and **22** work against one another in moving the armature **23**. The armature **23** is moved between relay contacts **24** and **25**, the relay contact **25** being energized when the breaker **10** is operative. It will be understood that both coils are operated by passing a pulse therethrough, a pulse which need not be sustained to maintain the armature **23** in the switched position corresponding to the selected energized coil.

A sensing relay **30** is likewise illustrated in the single drawing. The relay **30** is quite similar in construction to the relay **20**, and is characterized as being a magnetic latching relay having an armature which is moved to a position by one of two coils, a pulse of current through either coil being sufficient to switch the armature and to maintain the armature at that position even after the current has passes until either of the coils is next again energized. For identification, the relay **30** includes a voltage sensitive coil **31** and a current sensitive coil **32**. The armature is indicated by the numeral **33**. The armature is switched by the coil **31** to the relay contact **34** while the coil

32, on operation, switches the armature to the relay contact **35**. Since other details of the relay **30** are quite similar to those of the relay **20**, it is believed unnecessary to further elaborate on the construction thereof.

The conductor **11** is communicated with a conductor **40** which is connected to the coil **22** and then to the collector of a transistor **41**. An appropriately connected diode **41** **42** prevents damaging peak voltage surges in the coil **22**. The emitter of the transistor **41** is grounded while the base is provided with a signal through a series dropping resistor **43** from the collector of an additional transistor **44**. The transistor **44** is a PNP transistor having its emitter connected with a 5-volt source at **45**. Of course, other suitable small voltages are easily adaptable depending on the specific transistor selected. The transistors **41** and **44** are switching transistors with the transistor **44** controlling operation of the transistor **41**. On application of an appropriate signal to the transistor **44** as will be explained hereinafter, the transistor **41** is rendered conductive, thereby effectively grounding one end of the coil **22**. A pulse of current through the coil **22** switches the armature **23** to the relay contact **24**, the position being maintained even after lapse of the current pulse until the relay coil **21** is energized.

Movement of the armature **23** to the terminal **25** is the conductive position whereby current is communicated from the power source at **11** to the load connected to the conductor **12**. The contact **25** is communicated with a conductor **46** which is then connected to the coil **32**. The coil **32** is a relatively low resistance coil for low voltage drop and low power dissipation. To prevent the possibility of a heavy overload burning open coil **32**, a diode **47** is provided in parallel so that excess current is shunted around the coil **32**. The diode **47** is preferably a heavy duty diode capable of conducting a short circuit current around the coil **32**. The resistor **48** is selected to set the breaker **10** overload trip current to the desired value.

The foregoing traces out the flow path of current in quiescent conditions. However, to complete the description thereof, it should be noted that the relay contact **24** of the relay **20** directs the source current through a diode **49** and then to the coil **31**. The coil **31** is protected against voltage surges by a diode **50**. While the schematic including the coil **31** appears incomplete, the schematic representation is intended to describe the coil **31** in connection for sensing of the normal voltage of the source connected to the wire **11**. Thus, those skilled in the art will appreciate the use and function of the coil **31** in the present invention.

The armature **23** is contacted against the terminal **25** on operation of the coil **21**. The coil **21** is protected by an additional diode **51** in similar in function to the other diodes in protection of the relay coils. The coil **21** is connected in series with the transistor **52**. The transistor is grounded through its emitter as is the switching transistor **41** and operates in the same manner as the transistor **41**.

Control signals for the switching transistor **52** are applied through a base resistor **54** which is derived from an additional switching transistor **55**. The transistor **55** derives its current flow from the low voltage positive source **45** previously described. The transistor **55** is normally biased off but is switched on by a signal applied to the base through a resistor **56** which is connected to the on command conductor **14** which provides remote control capabilities for the present circuit breaker. At this juncture it should be noted that the conductor **13** which provides the off command communicates through the relay **30** in the illustrated position of the relay to a resistor **57** which is input to the base of the transistor **44**. The transistors **44** and **55** are similar in function and operation of the switching transistors **41** and **52**, respectively.

Considering operation of the present invention, the quiescent operative condition is achieved wherein the armature **23** is switched to the relay contact **25**. This provides the needed current flow through the conductor **46** to the low impedance combination of the diode **47**, the resistor **48** and the coil **32** to the load at the conductor **12**. This operative condi-

tion is maintained indefinitely until the current is considered excessive. The apparatus of the present invention is preferably calibrated so that the number of turns in the coil 32, the wire gauge and other parameters of the relay and the value of the resistor 48 governs the triggering point of the circuit breaker apparatus 10. Thus, it can be set to trip at selected high or intermediate current levels as the need may arise. Without regard to the current setting, the coil 32 is sensitive to current flow in excess of the established level considered safe, and consequently, when this level is exceeded, the relay 32 switches the armature 33 to the terminal 35. The terminal 35 provides a ground connection through the resistor 57 to the base of the switching transistor 44. In quiescent conditions, the transistor 44 is biased off; however, on application of ground to the base, current flows in the collector circuitry. The current flow in the collector circuitry provides a positive pulse at the base of the transistor 41. The positive pulse renders the transistor conductive and current flows through the conductor 40 and the coil 22. Such current flows operates the relay 20 in the manner described hereinbefore.

By way of contrast, consider operation of the relay coil 21. The conductors 13 and 14 are preferably communicated with the same voltage level as that provided on the conductor 45, 5 volts DC as described in this preferred embodiment. On application of approximately ground potential on the conductor 14 through the resistor 56, the transistor 55 is biased from off to an on and conducts heavily. Current flow in the collector 52 on. The transistor 52 conducts heavily and the current flow through the coil 21 is established from the power flow source at 11 through the coil 21, the transistor 52 and to ground. Thus, the coil 21 switches the relay 20 in the manner described hereinbefore.

As will be appreciated from the foregoing, one of the major objects of the present invention has been described in operation wherein the switching transistors are normally biased off and only conduct when the operative state of the circuit breaker 10 is altered. Thus in quiescent operative conditions, the present apparatus consumes practically no power with the exception of the slight power losses in the parallel combination of the coil 32 and diode 47 and shunt resistor 48. This is of significant benefit in that the shunt resistor 48. This is of significant benefit in that the inefficiencies of a power consuming circuit breaker are avoided in installations in which power consumption is critical. Moreover, the apparatus provided is essentially free of stress and fatigue factors as the equipment ages. Typically in spring operated or bimetallic equipment, aging and fatigue factors become significant. However, the present invention avoids such problems and further is essentially free of thermal problems during its operation over an extended period of time.

While the foregoing has described the circuit breaker with specified voltages, polarities and specific interconnections, the present teaching includes other arrangements. For instance, the various relay coils of the sensing relay may be responsive to timed power outage, fast occurring peaks of current flow, slow occuring peaks of current flow, and the like. More particularly, the circuit breaker may be extended to three phase protection wherein loss of a single phase operates the apparatus. Further, the preferred embodiment presupposed use of a positive supply; the use of a negative supply voltage creates no particular problem. Of particular interest is the provision of a circuit breaker consuming a minimum of power in the sensing coil, and using transistors normally biased off to thereby provide a circuit breaker which conserves power in operation.

While the foregoing has been directed to the preferred embodiment, the scope of the present invention is determined by the claims appended hereto.

We claim:

1. Circuit breaker apparatus providing overload protection while consuming negligible power during quiescent operating conditions, comprising:

a. a power control relay having connections for interruptably transferring electrical power from a power source to a power consuming load;

b. sensor means responsive to the power consumption of the load for forming a control signal supplied to said power control relay to interrupt power flow to the load in response to overload conditions;

c. means for operating said power control relay in response to the control signal from said sensor means, said means having a quiescent condition in which said means are biased to consume no power, said means consuming power in response to the control signal and thereafter terminating power consumption after operation of said power control relay to interrupt power flow to the load;

d. said power control relay comprising a magnetic latching relay having a first and second coil therein, said coils each operating said relay to a selected position;

e. first and second switching transistor means connected to each of said coils for controlling current flow therethrough; and,

f. said relay maintaining an operative position achieved after flowing current through either of said coils, said position being maintained without further current flow for an indefinite period of time.

2. The invention of claim 1 wherein

a. said power control relay includes a first magnetic latching relay;

b. a second magnetic latching relay included in said sensor means,

c. said transistor means being normally nonconductive and connected to said first relay for operating same to interrupt power flow therethrough; and,

d. said sensor means incorporating said second relay and operating same on overload, said second relay being connected to said transistor means, and supplying a a pulse thereto for causing conduction by said transistor means to operate said first relay.

3. The invention of claim 1 wherein

a. said power control relay includes a first magnetic latching relay;

b. a second magnetic latching relay included in said sensor means,

c. said transistor means being normally nonconductive and connected to said first relay for operating same to interrupt power flow therethrough;

d. a coil in said second relay sensitive to excessive current flow from the source to the load, said coil changing the operative condition of said second relay and,

e. there being connections cooperative with the contacts of said second relay for forming a conductive signal; and,

f. connective means for supplying the conductive signal to said transistor means.