PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :		(11) International Publication Number:
H02H 3/087	A1	WO 99/40663
		(43) International Publication Date: 12 August 1999 (12.08.99)

(21) International Application Number: PCT/US99/02261

(22) International Filing Date: 3 February 1999 (03.02.99)

(30) Priority Data:
09/019,766 6 February 1998 (06.02.98) US

(71) Applicant: RAYCHEM CORPORATION [US/US]; 300 Constitution Drive, MS 120/1A, Menlo Park, CA 94025–1164 (US).

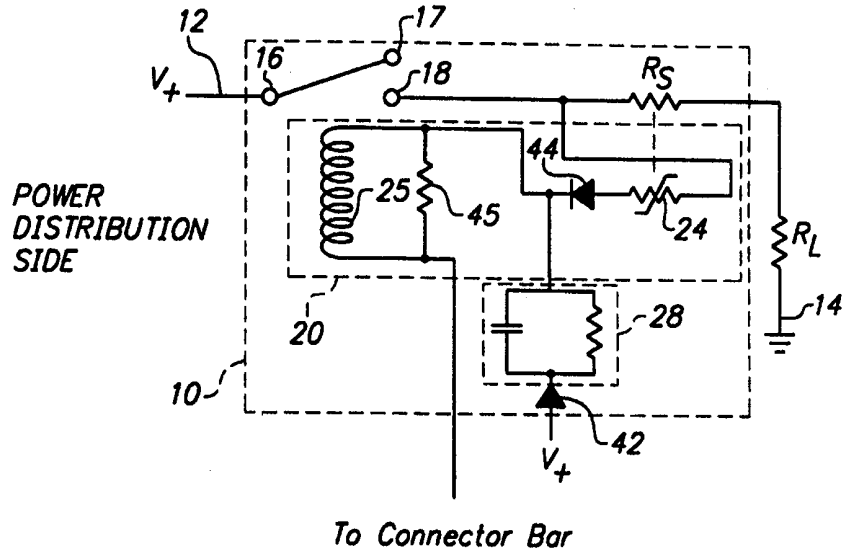
(72) Inventor: MYONG, Inho; 36617 Spruce Street, Newark, CA 94560–2162 (US).

(74) Agents: RICHARDSON, Timothy, H., P. et al.; Raychem Corporation, Intellectual Property Law Dept., 300 Constitution Drive, MS 120/1A, Menlo Park, CA 94025–1164 (US).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: ELECTRICAL SYSTEMS



(57) Abstract

Electrical protection systems which contain a resistor and a relay in series with a load, and a PTC device which is connected in parallel with the load and in series with a coil which controls the relay. The PTC device is thermally linked to the resistor and in consequence the relay opens if an overcurrent heats the resistor. The relay coil can be activated remotely by means of an RC circuit, and a diode or other electrical component permits current to pass through the RC network to the relay coil but prevents it from flowing in the opposite direction.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	**ES**	Spain	**LS**	Lesotho	**SI**	Slovenia
AM	Armenia	**FI**	Finland	**LT**	Lithuania	**SK**	Slovakia
AT	Austria	**FR**	France	**LU**	Luxembourg	**SN**	Senegal
AU	Australia	**GA**	Gabon	**LV**	Latvia	**SZ**	Swaziland
AZ	Azerbaijan	**GB**	United Kingdom	**MC**	Monaco	**TD**	Chad
BA	Bosnia and Herzegovina	**GE**	Georgia	**MD**	Republic of Moldova	**TG**	Togo
BB	Barbados	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tajikistan
BE	Belgium	**GN**	Guinea	**MK**	The former Yugoslav Republic of Macedonia	**TM**	Turkmenistan
BF	Burkina Faso	**GR**	Greece			**TR**	Turkey
BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
BY	Belarus	**IS**	Iceland	**MW**	Malawi	**US**	United States of America
CA	Canada	**IT**	Italy	**MX**	Mexico	**UZ**	Uzbekistan
CF	Central African Republic	**JP**	Japan	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Netherlands	**YU**	Yugoslavia
CH	Switzerland	**KG**	Kyrgyzstan	**NO**	Norway	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Romania		
CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
DE	Germany	**LI**	Liechtenstein	**SD**	Sudan		
DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

ELECTRICAL SYSTEMS

This invention relates to electrical systems which contain positive temperature coefficient (PTC) circuit protection devices, particularly such systems in automobiles and other wheeled vehicles.

PTC devices are well known. Particularly useful devices contain PTC elements composed of a PTC conductive polymer, i.e. a composition comprising an organic polymer and, dispersed or otherwise distributed therein, a particulate conductive filler, e.g. carbon black, or a metal or a conductive metal compound. Such devices are referred to herein as polymer PTC, or PPTC, devices. Other PTC materials are also known, e.g. doped ceramics, but are not as generally useful as PTC conductive polymer, in particular because they have higher resistivities. PTC devices can be used in a number of different ways, and are particularly useful in circuit protection applications, in which they function as remotely resettable fuses to protect electrical components from excessive currents and/or temperatures. Components which can be protected in this way include motors, batteries, loudspeakers and wiring harnesses in automobiles. The use of PPTC devices in this way has grown rapidly over recent years, and continues to increase. Reference may be made for example to U.S. Patent Nos. 4,237,441, 4,238,812, 4,315,237, 4,317,027, 4,426,633, 4,545,926, 4,689,475, 4,724,417, 4,774,024, 4,780,598, 4,800,253, 4,845,838, 4,857,880, 4,859,836, 4,907,340, 4,924,074, 4,935,156, 4,967,176, 5,049,850, 5,089,801, 5,378,407, 5,451,919, 5,451,921, 5,831,510, 5,852,397 and 5,864,281.

More recently, it has been proposed to combine PTC devices with other electrical components to provide circuit protection systems which respond to faults in ways which make use of the characteristics of both the PTC device and the electrical component. Reference may be made for example to U.S. Patent Nos. 5,666,254 and 5,689,395, and to International Publication Nos. WO 97/10636, WO 97/20372, WO 98/31084, WO 98/02946, WO 98/02947 and WO 98/56014, all of which International Publications were published after the priority date of this application.

PCT Publication Nos. WO 98/02946 and WO 98/02947 describe protection systems which comprise a sensor element (typically a resistor) and a circuit interruption element (typically a relay) in series with the load, and a control element (typically a PTC device in parallel with the sensor element) which links the sensor element and the circuit interruption element so that an overcurrent is detected by the

sensor element, and causes a change in the control element, which in turn causes a change in (typically opens) the circuit interruption element. Depending on the arrangement of these and other components, the system can (a) latch in an open state, either with or without a trickle current to keep the PTC device in a tripped condition, or (b) reclose if the overcurrent has gone away or cycle between open and closed positions if the overcurrent remains. PCT Publication No. WO 98/56014 describes particularly useful devices for use in the protection systems of PCT Publication Nos. WO 98/02946 and WO 98/02947.

In the copending commonly assigned U.S. Application Serial No. 09/019,767 filed February 6, 1998, and the corresponding PCT application filed contemporaneously with this application, there are described a number of improved protection systems based on those disclosed in PCT Publication Nos. WO 98/56014, WO 98/02946 and WO 98/02947. The present invention provides further improvements in the systems disclosed in that patent application and those International Publication Numbers.

As disclosed in U.S. Application Serial No. 09/019,767, and the corresponding PCT application, the manually-operated relay switch disclosed in PCT Publication Nos. WO 98/02946 and WO 98/02947 can advantageously be replaced by a remotely operated system, preferably an RC circuit in the line to the relay coil. However, we have discovered that if there is a short circuit in the load when the relay contacts are closed, there are some conditions under which the relay contacts can chatter (i.e. continually open and close) and, which can, therefore, lead to the contacts welding shut, and to catastrophic failure. This occurs when the fault resistance is such that the current which can flow through the short circuit exceeds the current that the power source can supply. Under these circumstances, when the relay closes onto the short circuit, the system voltage (e.g. battery voltage), drops drastically. This voltage drop causes the relay to drop out, thus restoring the battery voltage. Immediately after this, since the battery voltage has been recovered, the relay picks up, again reducing the battery voltage, and the cycle continues.

The chattering is primarily due to the fact that as the system voltage drops, the voltage across the capacitor in the RC network discharges in the reverse direction, causing the relay coil to drop out.

We have realized, in accordance with the present invention, that this problem can be solved by adding to the system a diode which will prevent the capacitor from discharging in this way, and thus will keep the relay coil energized, and the relay contacts closed, for long enough to trip the PPTC and open the relay in the desired way.

An embodiment of the invention comprises an electrical protection system which can be connected between an electrical power supply and an electrical load to form an operating circuit, the operating circuit having an on state and an off state and comprising a current carrying line and a return line, and which when so connected protects the circuit from overcurrents, the system having a normal operating condition and a fault condition, and comprising:

a. a set of relay contacts which, when the system is so connected, is connected in series between the power supply and the load, and has:

   i. a closed state which permits the flow of a normal current, I_{NORMAL}, when the system is in the normal operating condition, and

   ii. an open state which permits the flow of at most a reduced current, substantially less than I_{NORMAL}, when the system is in the fault condition;

b. a resistive device which, when the system is so connected, is connected in series with the set of relay contacts and the load, and has

   i. a normal state, when the current in the system does not exceed the normal current, I_{NORMAL}, by a predetermined current amount, and

   ii. a fault state, when the current in the system exceeds the normal current, I_{NORMAL}, by the predetermined amount;

c. a control element which comprises a series combination of

   i. a PTC device thermally coupled with the resistive device; and

   ii. a relay coil coupled with the relay contacts;

the series combination being connected across the power supply, between the current carrying line and the return line, with the PTC device connected to the current carrying line and the relay coil coupled to the return line;

the set of relay contacts changing from its closed state to its open state, thereby causing the system to change from its normal operating condition to its fault condition, when the resistance of the PTC device increases by a predetermined resistance amount in response to the resistive element changing from its normal state to its fault state;

d. a resistance-capacitance network through which current can be supplied to the relay coil, so that if the relay contacts are open, the only way in which they can be closed is by supplying current to the relay coil through the resistance-capacitance network; and

e. a diode or other electrical component which permits current to pass through the resistance-capacitance network to the relay coil but which prevents it from flowing in the opposite direction.

As illustrated in Figure 1, this invention provides an electrical protection system which can be connected between an electrical power supply and an electrical load to form an operating circuit, the operating circuit having an on state and an off state and comprising a current carrying line and a return line, and which when so connected protects the circuit from overcurrents, the system having a normal operating condition and a fault condition, and comprising:

a. a set of relay contacts **16**, **17** and **18** which, when the system is so connected, is connected in series between the power supply **V+** and the load $\mathbf{R_L}$, and has:

i. a closed state which permits the flow of a normal current, I_{NORMAL}, when the system is in the normal operating condition, and

ii. an open state which permits the flow of at most a reduced current, substantially less than I_{NORMAL}, when the system is in the fault condition;

b. a resistive device $\mathbf{R_S}$ which, when the system is so connected, is connected in series with the set of relay contacts **16**, **17** and **18** and the load $\mathbf{R_L}$, and has

i. a normal state, when the current in the system does not exceed the normal current, I_{NORMAL}, by a predetermined current amount, and

ii. a fault state, when the current in the system exceeds the normal current, I_{NORMAL}, by the predetermined amount;

c. a control element **20** which comprises a series combination of

i. a PTC device **24** thermally coupled with the resistive device $\mathbf{R_S}$; and

ii. a relay coil **25** coupled with the relay contacts;

the series combination being connected across the power supply, between the current carrying line and the return line, with the PTC device connected to the current carrying line and the relay coil coupled to the return line;

the set of relay contacts changing from its closed state to its open state, thereby causing the system to change from its normal operating condition to its fault condition, when the resistance of the PTC device increases by a predetermined resistance amount in response to the resistive element changing from its normal state to its fault state;

d. a resistance-capacitance network **28** through which current can be supplied to the relay coil, so that if the relay contacts are open, the only way in which they can be closed is by supplying current to the relay coil through the resistance-capacitance network; and

e. a diode **42** or other electrical component which permits current to pass through the resistance-capacitance network to the relay coil but which prevents it from flowing in the opposite direction.

As shown in Figure 2, it is particularly preferred that this system should be in the form of a device **50** which comprises components (a), (b), (c), (d) and (e) set out above, and which also comprises five terminals which can be connected to a power source, a normally open side of the relay, a normally closed side of the relay, a load,

and a switching source (e.g. an electronic control module and associated FET as described in U.S. Patent Application Serial No. 09/019,767 and the corresponding PCT application). The device may also have a diagnostics pin out which provides logic level voltage when the PTC device has tripped. The logic level voltage is achieved by dividing the coil in appropriate proportions. Preferably the device is a pluggable device.

Various components can be packaged in the device **50** shown in Figure 2. For example, in Figure 2 PTC device **24**, diode **44**, RC network **28** and diode **42** are packaged in device **52**. Relay contacts **16**, **17**, **18**, relay coil **25** and resistor **45** are packaged in device **54**. Devices **52** and **54** are packaged in device **50**.

CLAIMS

1. An electrical protection system which can be connected between an electrical power supply and an electrical load to form an operating circuit, the operating circuit having an on state and an off state and comprising a current carrying line and a return line, and which when so connected protects the circuit from overcurrents, the system having a normal operating condition and a fault condition, and comprising:

a. a set of relay contacts which, when the system is so connected, is connected in series between the power supply and the load, and has:

i. a closed state which permits the flow of a normal current, I_{NORMAL}, when the system is in the normal operating condition, and

ii. an open state which permits the flow of at most a reduced current, substantially less than I_{NORMAL}, when the system is in the fault condition;

b. a resistive device which, when the system is so connected, is connected in series with the set of relay contacts and the load, and has

i. a normal state, when the current in the system does not exceed the normal current, I_{NORMAL}, by a predetermined current amount, and

ii. a fault state, when the current in the system exceeds the normal current, I_{NORMAL}, by the predetermined amount;

c. a control element which comprises a series combination of

i. a PTC device thermally coupled with the resistive device; and

ii. a relay coil coupled with the relay contacts;

the series combination being connected across the power supply, between the current carrying line and the return line, with the PTC device connected to the current carrying line and the relay coil coupled to the return line;

the set of relay contacts changing from its closed state to its open state, thereby causing the system to change from its normal operating condition to its fault condition, when the resistance of the PTC device increases by a predetermined resistance amount in response to the resistive element changing from its normal state to its fault state;

d. a resistance-capacitance network through which current can be supplied to the relay coil, so that if the relay contacts are open, the only way in which they can

be closed is by supplying current to the relay coil through the resistance-capacitance network; and

e. an electrical component which permits current to pass through the resistance-capacitance network to the relay coil but which prevents it from flowing in the opposite direction.

2. A system according to claim 1 wherein the electrical component (e) is a diode.

1/1

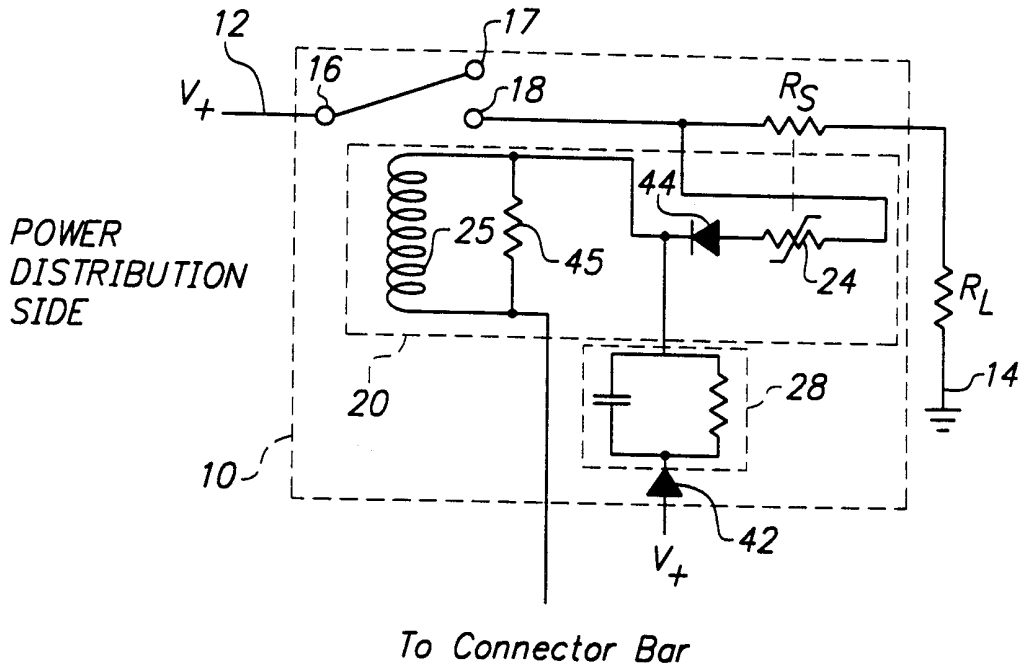

12
17
16
18
V_+
R_S
44
25
45
24
R_L
POWER
DISTRIBUTION
SIDE
20
28
14
10
42
V_+
To Connector Bar

FIG. 1

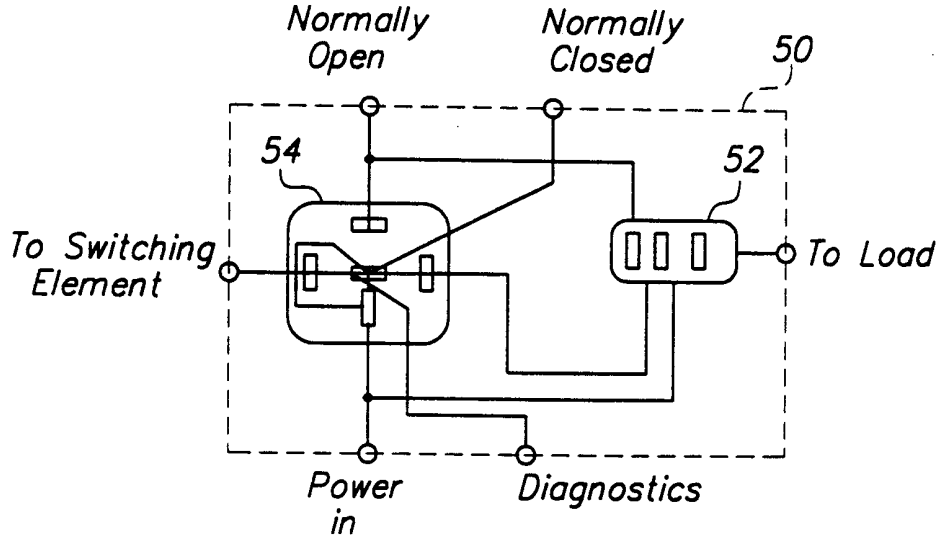

Normally
Open
Normally
Closed
50
54
52
To Switching
Element
To Load
Power
in
Diagnostics

FIG. 2

INTERNATIONAL SEARCH REPORT

Inter onal Application No
PCT/US 99/02261

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H02H3/087

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H02H G01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 095, no. 010, 30 November 1995 & JP 07 170727 A (U R D:KK), 4 July 1995 see abstract	1
A	WO 98 02946 A (RAYCHEM CORP ;EWD L L C (US)) 22 January 1998 cited in the application see abstract; figure 6	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 May 1999	28/05/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Salm, R

1

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte. ional Application No
PCT/US 99/02261

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9802946 A	22-01-1998	AU 3597997 A	09-02-1998