P/00/008
Section 29(1)
Regulation 3.1(2)

AUSTRALIA
Patents Act 1990

NOTICE OF ENTITLEMENT

We RAYCHEM LIMITED

of Rolls House, 7 Rolls Building, Fetter Lane, LONDON EC4A 1NH, ENGLAND

being the Applicant and Nominated Person, in respect of Application No. 86642/91, entitled CIRCUIT PROTECTION ARRANGEMENT state the following:

Ian Paul Atkins is the actual inventor of the invention the subject of the Application.

The applicant and nominated person is the assignee of the invention from the actual inventor.

RAYCHEM LIMITED is the applicant of the applications listed in the declaration under Article 8 of the PCT.

Convention priority is claimed from the following basic applications referred to in the declaration under Article 8 of the PCT:

Basic Applicant	Application Number	Application Date	Country	Country Code
Raychem Limited	9022237.3	12 October 1990	Great Britain	GB
Raychem Limited	9022236.5	12 October 1990	Great Britain	GB

The basic applications referred to in the declaration under Article 8 of the PCT were the first applications made in a Convention country in respect of the invention the subject of the Application.

DATED this 16th day of August 1995

RAYCHEM LIMITED
By their Patent Attorney

GRIFFITH HACK & CO

OUR REF: P10137-JU:TJS:JM

AU9186642

(12) PATENT ABRIDGMENT (11) Document No. AU-B-86642/91
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 663473

(54) Title
CIRCUIT PROTECTION ARRANGEMENT

International Patent Classification(s)
(51)[5] H02H 003/02 H02H 009/02 H04M 001/74 H02H 003/087

(21) Application No. : 86642/91 (22) Application Date : 10.10.91

(87) PCT Publication Number : WO92/07402

(30) Priority Data

(31) Number	(32) Date	(33) Country
9022237	12.10.90	GB UNITED KINGDOM
9022236	12.10.90	GB UNITED KINGDOM

(43) Publication Date : 20.05.92

(44) Publication Date of Accepted Application : 12.10.95

(71) Applicant(s)
RAYCHEM LIMITED

(72) Inventor(s)
IAN PAUL ATKINS

(74) Attorney or Agent
GRIFFITH HACK & CO. , GPO Box 4164, SYDNEY NSW 2001

(56) Prior Art Documents
US 4110809
EP 0147818
GB 976862

(57) Claim

1. A circuit protection arrangement, which comprises a series switching circuit that is intended to be connected in a line of the circuit, and will switch to an open state when subjected to an overcurrent, and a shunt switching circuit arranged to be triggered by the series switching circuit, the shunt switching circuit being open under normal operating conditions but will shunt the overcurrent across the load of the circuit or to ground when triggered by the series switching circuit.

OPI DATE 20/05/92 APPLN. ID 86642 / 91
AOJP DATE 25/06/92 PCT NUMBER PCT/GB91/01760

PCT

INTERNATIONA ... ... Y (PCT)

(51) International Patent Classification 5 : H02H 3/02, 3/087

A1

(11) International Publication Number: WO 92/07402

(43) International Publication Date: 30 April 1992 (30.04.92)

(21) International Application Number: PCT/GB91/01760

(22) International Filing Date: 10 October 1991 (10.10.91)

(30) Priority data:
9022237.3 12 October 1990 (12.10.90) GB
9022236.5 12 October 1990 (12.10.90) GB

(71) Applicant *(for all designated States except US)*: RAYCHEM LIMITED [GB/GB]; Rolls House, 7 Rolls Buildings, Fetter Lane, London EC4A 1NH (GB).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)* : ATKINS, Ian, Paul [GB/GB]; 6 Cayenne Park, Swindon, Wiltshire SN2 2SF (GB).

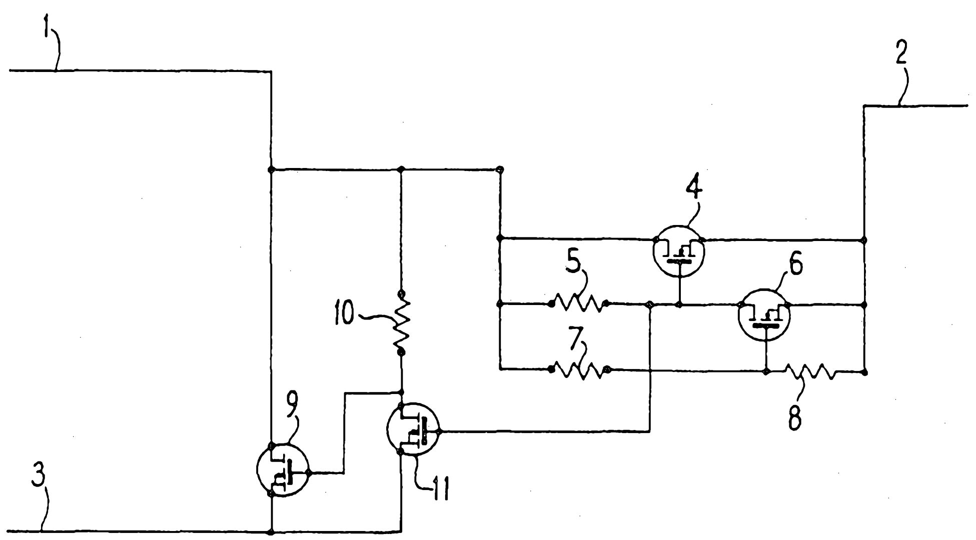
(74) Agents: DLUGOSZ, A., C. et al.; Raychem Limited, Faraday Road, Dorcan, Swindon, Wiltshire SN3 5HH (GB).

(81) Designated States: AT (European patent), AU, BE (European patent), BR, CA, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, KR, LU (European patent), NL (European patent), NO, SE (European patent), US.

Published
With international search report.

663473

(54) Title: CIRCUIT PROTECTION ARRANGEMENT



(57) Abstract

A circuit protection arrangement comprises a series switching circuit that is intended to be connected in a line of the circuit and will switch to an open state when subjected to an overcurrent, and a shunt switching circuit that is open under normal operating conditions but will shunt the overcurrent across the load of the circuit or to ground when triggered by the series switching circuit. Preferably the series switching circuit comprises a switching transistor (4) that is controlled by a control transistor (6), and the shunt switching circuit comprises a shunt switching transistor (9) that is controlled by a shunt control transistor (11) which is itself controlled by the series switching circuit. The shunt switching circuit may be connected to ground or it may be connected to a back-up load or voltage foldback device such as a triac.

Circuit Protection Arrangement

This invention relates to arrangements and devices for protecting electrical circuits from overcurrents, for example from overcurrents caused by equipment faults or transient overcurrents caused by lightning, electrostatic discharge, equipment induced transients or other threats.

Many circuit protection devices have been proposed for the protection of electronic circuits from overcurrents and overvoltages. For example voltage controlled triacs are employed for protecting certain systems such as telephone circuits from overvoltages. The devices are connected between the lines and ground and will fire in order to shunt any voltage transient when the transient voltage on the line reaches a predetermined value (typically 200 V) and will remain in their on state until the current passing through them is reduced to below a certain value, the holding current. Such devices have the disadvantage that once they have fired they can be latched in their on state by the dc power source of the telephone line which is quite capable of delivering short circuit currents in the order of 200 mA. While conventional triacs normally have a holding current of up to 50 mA, triacs having higher holding currents, for example 300 mA need to be employed in order to overcome the latching problem. However, these traics have the disadvantage that, when subject to certain transients, they may switch incompletely and remain at a high voltage of 200 V or thereabouts while passing a current of 200 mA with the result that the device and possibly other equipment may be violently damaged. One circuit that has been proposed for use with telephone systems is described in French patent application No. 2,619,262. This circuit comprises a combined overvoltage and overcurrent protection device in which a comparison circuit compares the voltage on one of the lines with a reference voltage and, if it is greater, the transient is shunted across the load and a series electronic switch is opened. This device, however, suffers from the disadvantage that it will not be triggered by a system failure leading, for example, to a short circuit and damage to the series switch may occur due to the currents experienced. In addition, a significant amount of the overcurrent transient may pass through the device before the series switch is opened. The device has the further disadvantage that the voltage protection circuit merely limits the transient voltage to a maximum value. Since significant transient current flows through this part of the circuit, unacceptable heating can occur.

According to one aspect the present invention provides a circuit protection arrangement, which comprises a series switching circuit that is intended to be connected in a line of the circuit, and will switch to an open state when subjected to an overcurrent, and a shunt switching circuit arranged to be triggered by the series switching circuit, the shunt switching circuit being open under normal operating conditions but will shunt the overcurrent across the load of the circuit or to ground when triggered by the series switching circuit.

The arrangement according to at least preferred embodiments of the invention has the advantage that it is possible to protect the load circuits not only from threats that cause an overvoltage to be generated, but also from those that cause an overcurrent, e.g., systems failures as mentioned above. In addition, the fact that the series switching circuit is actuated directly by the pulse rather than by a shunt switching circuit can reduce the delay in isolating the load circuit from the threat.

In one embodiment, in a telephone system the shunt switching circuit will be connected directly between one incoming wire and ground and the series switching circuit will be connected in the wire between the shunt switching circuit and the exchange equipment. The second wire will be connected in a corresponding manner. When the system is subjected to a transient the series switching circuit will open and at the same time will cause the shunt switching circuit to close so that the transient is shunted to ground. System current cannot flow from the exchange equipment and cause the shunt switching circuit to latch because the series switching circuit is open. After the transient has passed the system voltage will be dropped across the series switching circuit. This circuit will reset to its normal state as soon as the line to the subscriber is made open circuit, ie. by the subscriber replacing the handset.

In a preferred form of arrangement the series switching circuit includes a series switching transistor that controls the current flow through the series switching circuit. The series switching transistor is preferably controlled by a series control transistor that forms one arm of a voltage divider connected to the base or gate of the series control transistor. The base or gate voltage of the series control transistor is dependent on the voltage drop across the series switching transistor so that, as the voltage drop across the series switching transistor increases, the forward biasing of the series control transistor increases. As the series control transistor becomes more conductive the reverse biasing of the series switching transistor increases causing the switching transistor to switch to its blocking state. As soon as this has occured the voltage drop across the switching transistor will increase substantially causing the control transistor to remain in its "ON" or low resistance state and hence the series switching transistor to remain in its blocking state until the arrangement is reset.

Thus, it is possible for the arrangement to include no resistive components in series with the series switching transistor, so that any voltage drop across the series switching circuit is solely due to the collector-emitter or drain-source voltage drop of the series switching transistor (and any rectifying diodes). The absence of a series resistor reduces the number of load current carrying components which allow easier integration of the device.

The shunt switching circuit preferably comprises a voltage foldback device that is connected between the line of the circuit and a return line or ground. The foldback device should be capable of being triggered by a pulse supplied by the remainder of the shunt switching circuit, and so thyristors or triacs are preferred. The shunt switching circuit preferably has no resistive components in series with the foldback device so that the voltage drop between the line and the return line or ground is solely due to the voltage drop across the foldback device. In this way the energy dissipation in the shunt switching circuit when the transient is shunted is minimized.

The shunt switching circuit may include a shunt switching transistor that is arranged to switch current from the line to the foldback device. In this case the base or gate bias of the shunt switching transistor may be controlled by a shunt control transistor whose base or gate voltage depends on the voltage drop across the series switching circuit. For example, the base or gate of the shunt switching transistor may be connected to a voltage divider that spans the switching circuit, one arm of which comprises the shunt control transistor. The base or gate voltage of the shunt control transistor may, in this case, be determined by the series shunt switching circuit so that, for example, switching of the series switching circuit reverse biases the shunt control transistor which causes the shunt switching transistor to become forward biased.

This form of three terminal protection device whether or not it includes the voltage foldback device is novel and so, according to a second aspect the invention provides a circuit protection arrangement, which comprises a switching circuit that is intended to be series connected in a line of the circuit to be protected and which will allow normal circuit currents to pass but will switch to a blocking state when subjected to an overcurrent, the arrangement including a shunt terminal connected to a switching circuit which includes a shunt switching transistor and a shunt control transistor which controls the base or gate bias of the shunt switching transistor and whose base or gate voltage depends on the voltage drop across the series switching circuit so that, under normal circuit conditions the shunt switching transistor is in a blocking state, but when the switching circuit switches to a blocking state the shunt switching transistor is biased to a conducting state.

The arrangement according to the second aspect of the invention preferably comprises series and shunt switching circuits as described above.

In operation the shunt terminal may be connected directly to the return line of the electrical circuit in order to shunt any overcurrent across the load. In this arrangement the transient current is able to be shunted across the load passing only through a transistor switch, so that the temperature rise in the arrangement can be held to a relatively low value. In some instances it may be left unconnected so that the arrangement is employed as a two-terminal device. Often it will be appropriate to connect the shunt terminal to other components, for example, it may be connected to the return line via a load having substantially the same impedance as that of the line and/or of the electrical circuit, in order to prevent or reduce the occurance of reflections in the line. Such an arrangement may, for instance, be employed in a local area network (LAN) in which a number of stubs extend from a main bus. If any of the equipment associated with the stubs fails this will alter the load on the bus, with the result that only a limited number of equipment failures can be accommodated before the whole LAN stops functioning. If instead the arrangement switches a matched load into the circuit, the LAN will continue functioning even with a large number of equipment failures.

Alternatively, the shunt terminal may be connected to a transient absorbing load. Where it is likely that the overcurrent will be caused by a fault in the electrical circuit, it may be appropriate for the signal transmitted by the third terminal to switch in a backup system. It may not be necessary for the shunt switching transistor to pass the entire overcurrent. Instead it may be connected to an additional circuit protection device that is capable of passing larger currents than the shunt switching transistor, preferahly a foldback or crowbar device such as a thyristor or a triac, in order to trigger the additional device as described above.

Each of the series transistors' parameters will vary with temperature, the characteristic of the control transistor dominating that of the switching transistor since the control transistor is in its high resistance state during normal operation. The changing parameters of the series control transistor causes it to turn ON at lower voltages, thereby reducing the trip current of the arrangement with increasing temperature. This effect can be compensated either by making the resistor in parallel with the control transistor gate and source have a positive temperature coefficient of resistance (PTC) or by making the resistor connected to the switching transistor base or gate have a negative temperature coefficient or resistance (NTC). This latter option is preferred for arrangements that are formed as monolithic devices.

In operation the shunt terminal may be connected directly to the return line of the electrical circuit in order to shunt any overcurrent across the load or, for example in the case of a balanced pair in a telephone system, may be connected to ground. In this arrangement the transient current is able to be shunted across the load or to ground passing only through a foldback device, so that the power dissipated in the arrangement can be held to a relatively low value.

Where the arrangement is intended to be employed with a.c. circuits, the series switching arrangement will be connected to the line via a rectifying bridge circuit. It is preferred for the shunt switching transistor to be connected between the line and the third terminal via a separate rectifying bridge circuit. Alternatively a pair of equivalent circuit protection arrangements according to the invention may be employed, the two arrangements handling different cycles of the a.c. signal. This arrangement has the advantage that the voltage drop across the bridge diodes is removed or reduced.

The overcurrent protection arrangement according to the invention may employ bipolar transistors and/or field effect transistors. Where bipolar transistors are used they are preferably used in a Darlington configuration as the switching transistor in order to reduce the base current required when the transistor is switched ON. This base current must be supplied via a resistor connected between the base and collector of the switching transistor. When the circuit switches to its blocking state the switching transistor base current is diverted through the control transistor (which is now ON) and becomes a leakage current. However, since the voltage drop across the resistor is much higher when the arrangement is in is blocking state, the leakage current is larger than the switching transistor base current. If a Darlington pair or triplet is employed as the switching transistor, the effective d.c. current gain will be increased considerably so that a much higher resistance can be used.

Where field effect transistors are employed, enhancement mode MOSFETS are preferred. The arrangement may be produced as an integrated circuit, in which case the resistors employed in the switching circuit (and in the pulse generator circuit) may be provided by MOSFETs, for example with their gates and drains connected as in NMOS logic. Alternatively, the control transistor and the resistor which together form the voltage divider for the base or gate of the switching transistor may be provided by a complementary n-channel and p-channel pair of FETS connected in the manner of CMOS logic.

The arrangement may be employed as a three terminal arrangement where a single pair of lines incorporates the arrangement. However, five terminal devices may be formed, in which a pair of three terminal arrangements have a common third terminal or even a common shunt switching arrangement. In addition, a four terminal device may be formed, for example for protecting a balanced pair of lines, in which the shunt switching circuit will shunt the threat across the pair.

The arrangement according to the invention may be formed using discrete components or it may be formed monolithically using known techniques.

Several circuits in accordance with the present invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 shows one form of arrangement according to the invention;

Figure 2 shows a modification of the arrangement of figure 1; and

Figure 3 shows a modification of the arrangement according to the invention.

Figure 1 shows a circuit protection device according to the invention suitable for use with a d.c. circuit, and having three terminals 1, 2 and 3. The device is intended to be series connected in a line of the circuit with terminals 1 and 2 connected to the line and terminal 3 connected to the return line, secondary load or backup system. Alternatively, terminal 3 may be connected to a separate or ground point, optionally via a secondary load.

The arrangement has a series switching circuit which comprises a switching transistor 4 connected in series with the line with its gate connected to a voltage divider which spans the switching transistor 4 and which is formed from a 1 Mohm resistance 5 and a control transistor 6. The gate of the control transistor is connected to a further potential divider formed from two 1 Mohm resistances 7 and 8 which span the switching transistor 4 so that the gate voltage of the control transistor 6 is held at half the voltage drop across switching transistor 4.

The arrangement also has a shunt switching circuit connected to terminal 3 which comprises a shunt switching transistor 9 that controls the flow of current between terminals 1 and 3. The gate of the shunt switching transistor 9 is connected to a voltage divider which spans the switching transistor 9 and which is formed from a 1 Mohm resistance 10 and a shunt control transistor 11. The gate of the shunt control transistor 11 is connected to the same potential divider as is the gate of transistor 4. All the transistors employed in this arrangement are enhancement mode MOSFETs.

In operation terminals 1 and 2 will be connected in a line of the circuit. When no current flows through the circuit all the transistors are in their high resistance or "OFF" state so that the series resistance of the arrangement is about 2 Mohms due to resistances 7 and 8. As the voltage is increased no current will flow until the voltage at the supply terminal 1 reaches the switch on threshold of transistor 4 since transistor 6 is OFF with a resistance in the order of 10^{12} ohms and the gate of transistor 4 is therefore held at the input voltage. Once this voltage is exceeded transistor 1 goes into its conductive state and the V/I characteristic follows a line of resistance equivalent to that of the ON state resistance of transistor 4 but offset by the switch on threshold of transistor 4 (about 2V). At such levels of applied voltage transistor

11, whose gate is maintained at the same voltage as that of transistor 4, is in its ON state which causes the shunt switching transistor to be zero biased and therefore in its OFF state. The arrangement typically has a series resistance of 200m ohms with a voltage drop of 2V, and a shunt resistance of 1M ohm in its normal operating condition.

If the voltage drop across switch transistor 4 increases due to an overcurrent transient or circuit fault the gate voltage of control transistor 6 will rise until it reaches the switch ON threshold of control transistor 6 whereupon the gate voltage of switch transistor 4 will fall to the value of its source voltage and the transistor will turn OFF. At the same time the gate voltage of shunt control transistor 11 will fall to approximately its source voltage and transistor 11 will turn OFF causing the gate of shunt switching transistor 9 to become forward biased and so turning it ON. Since the voltage drop across series switching transistor 4 in is OFF state is greater than in its ON state, series control transistor 6 will remain forward biased causing the arrangement to stay permanently in its tripped state with series switching transistor 4 in its OFF state and shunt switching transistor 9 in its ON state.

Figure 2 shows a modification of the circuit of figure 1 in which the field effect transistors have been replaced by bipolar junction transistors, and, in the case of series switching transistor 4 and shunt switching transistor 9, by a Darlington pair. In addition a 1 microfarad capacitor 12 is included in parallel with resistance 8. The capacitor 12 prevents tripping of the arrangement by short current transients. If desired the value of the capacitor can be less than 1 microfarad, such an arrangement giving a sufficient time constant for use with, for example, tungsten filament lamps.

Figure 3 shows a modification of the arrangement which may, for example, be used in telephone equipment. in this arrangement the shunt line 15 is connected to the base of a triac 17 formed from two thyristors.

In this circuit the base of the shunt control transistor 11 is not connected to the base of the series switching transistors 4 as in Figure 2, but instead is held in a further voltage divider formed from transtor 6' and 5'. The base of transistor 6' is held in another voltage divider formed by resistors 7' and 8'.

When the arrangement is subjected to a transient the series switching transistor 4 will switch OFF as described above, and the shunt switching transistor 9 will turn ON, thereby causing part of the overcurrent to be injected into the base of the triac 17 and switching the triac ON.

The purpose of using a second voltage divider circuit 5', 6', 7' and 8' is to control the shunt switching circuit and remove any dependence of the switching current on the load of the circuit.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A circuit protection arrangement, which comprises a series switching circuit that is intended to be connected in a line of the circuit, and will switch to an open state when subjected to an overcurrent, and a shunt switching circuit arranged to be triggered by the series switching circuit, the shunt switching circuit being open under normal operating conditions but will shunt the overcurrent across the load of the circuit or to ground when triggered by the series switching circuit.

2. An arrangement as claimed in claim 1, wherein the series switching circuit includes a series switching transistor, the arrangement having no resistive components in series with the series switching transistor so that any voltage drop across the series switching circuit is solely due to the collector-emitter or drain-source voltage drop of the series switching transistor and any rectifying diodes where present.

3. An arrangement as claimed in claim 2, wherein the series switching circuit includes a series control transistor that determines the base or gate voltage of the series switching transistor.

4. An arrangement as claimed in claim 3, wherein the base or gate of the series control transistor is held in a voltage divider that spans the series switching transistor.

5. An arrangement as claimed in any one of claims 1 to 4, wherein the shunt switching circuit comprises a voltage foldback device that is connected between the line of the circuit and a return line or ground.

6. An arrangement as claimed in claim 5, wherein the foldback device is a thyristor or a triac.

7. An arrangement as claimed in claim 5 or claim 6, wherein the shunt switching circuit has no resistive components in series with the

foldback device so that the voltage drop between the line and the return line or ground is solely due to the voltage drop across the foldback device.

8. An arrangement as claimed in any one of claims 5 to 7, wherein the shunt switching circuit includes a shunt switching transistor that is arranged to switch current from the line to the foldback device to trigger the foldback device.

9. An arrangement as claimed in claim 8, wherein the shunt switching circuit includes a shunt control transistor which controls the base or gate bias of the shunt switching transistor and whose base or gate voltage depends on the voltage drop across the series switching circuit.

10. An arrangement as claimed in claim 9, wherein the base or gate of the shunt switching transistor is connected to a voltage divider that spans the series switching circuit, one arm of the voltage divider comprising the series control transistor.

11. A circuit protection arrangement, which comprises a switching circuit that is intended to be series connected in a line of the circuit to be protected and which will allow normal circuit currents to pass but will switch to a blocking state when subjected to an overcurrent, the arrangement including a shunt terminal connected to a shunt switching circuit which includes a shunt switching transistor and a shunt control transistor which controls the base or gate bias of the shunt switching transistor and whose base or gate voltage depends on the voltage drop across the series switching circuit, so that, under normal circuit conditions the shunt switching transistor is in a blocking state, but when the switching circuit switches to a blocking state the shunt switching transistor is biased to a conducting state.

12. An arrangement as claimed in claim 11, wherein the series switching circuit includes a series switching transistor that controls the current flow through the series switching circuit.

13. An arrangement as claimed in claim 12, wherein the series switching transistor is controlled by a series control transistor whose base or gate voltage is dependent on the voltage drop across the series switching transistor, so that as the voltage drop across the series switching transistor increases, the forward biasing of the series control transistor increases, causing the series control transistor to go to a low resistance state which causes the series switching transistor to switch to a high resistance state.

14. An arrangement as claimed in claim 13, wherein the base or gate of the shunt switching transistor is connected to a voltage divider that spans the series switching circuit, one arm of the voltage divider comprising the series control transistor.

15. An arrangement as claimed in claim 13 or claim 14, which includes no resistive components in series with the series switching transistor.

16. An arrangement as claimed in any one of claims 11 to 15, wherein the shunt terminal is connected directly to the return line.

17. An arrangement as claimed in any one of claims 11 to 15, wherein the shunt terminal is connected to the return line via a load having substantially the same impedance as that of the line.

18. An arrangement as claimed in any one of claims 11 to 15, wherein the shunt terminal is connected to a backup circuit which is brought into operation when the overcurrent is experienced.

19. An arrangement as claimed in any one of claims 11 to 16, wherein the shunt terminal is connected to a transient absorbing load.

20. An arrangement as claimed in any one of claims 1 to 19, which is connected to the line via a rectifying bridge circuit.

21. A circuit protection unit which comprises a pair of arrangements as claimed in any one of claims 1 to 20 arranged to be series connected in a pair of current-carrying lines so that an overcurrent in either line will be shunted across the load of the circuit or to a common ground.

22. A circuit protection arrangement, substantially as herein described, with reference to Figure 1 or Figure 2 or Figure 3 of the drawings.

Dated this 16th day of August, 1995

RAYCHEM LIMITED
By their Patent Attorney
GRIFFITH HACK & CO.

411/S:10137JU

1/2

86642/91

FIG. 1

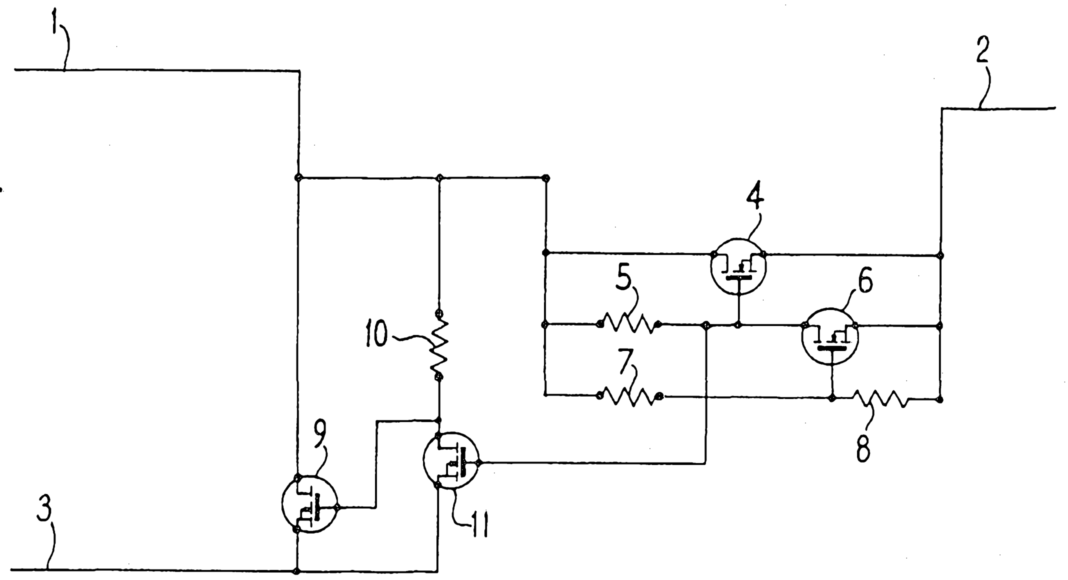
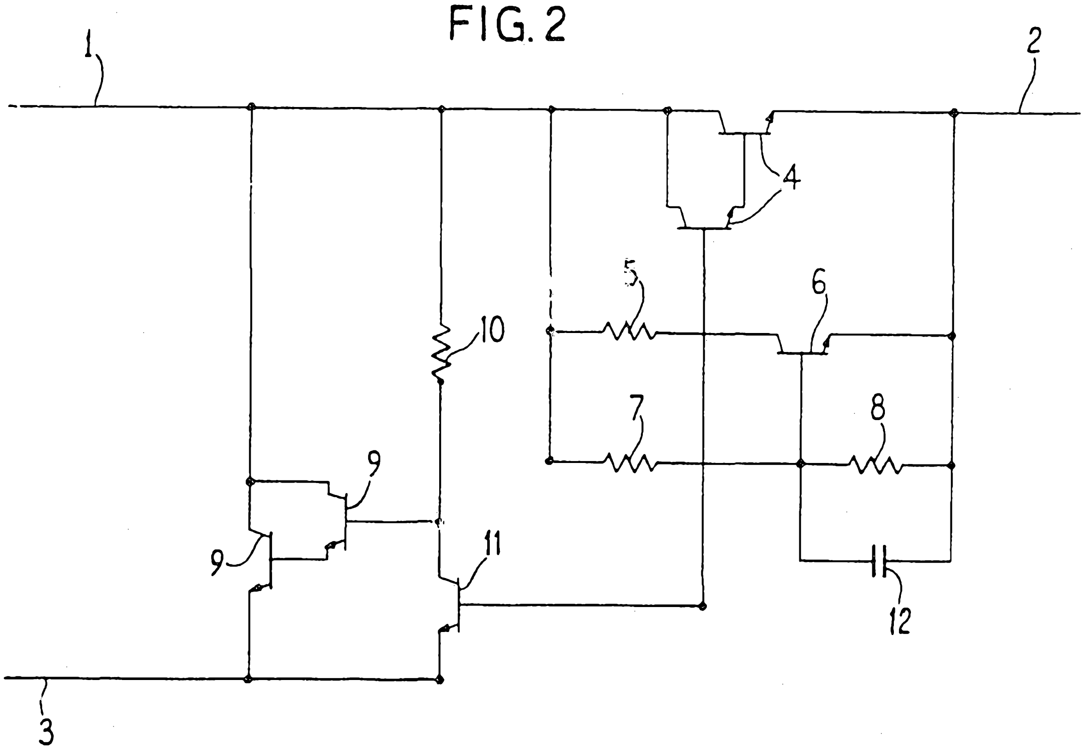
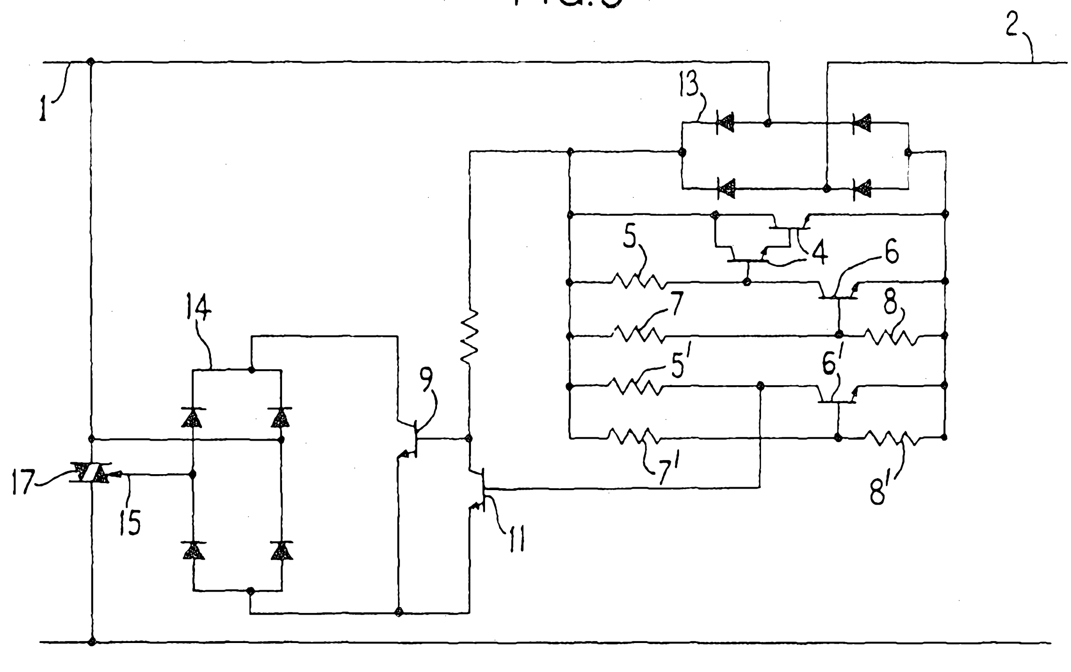


FIG. 2



PCT/GB 91/00760
13 May 1991
13 05 92

FIG.3



SUBSTITUTE SHEET

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 91/01760

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 H02H3/02; H02H3/087

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	H02H

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category°	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
Y	US,A,4 110 809 (LOCKHEED AIRCRAFT CORPORATION) 29 August 1978 see column 4, line 67 - column 5, line 17	1-9, 11-16, 18,22
Y	DE,A,2 147 471 (NORDDEUTSCHE MENDE RUNDFUNK) 26 July 1973 see page 4, paragraph 3-5	1,5-9, 11,18
Y	DE,A,3 725 390 (WICKMANN-WERKE) 9 February 1989 see column 5, line 55 - column 7, line 58	2-4, 12-16,22
A	EP,A,0 147 818 (FASE) 10 July 1985 see abstract	1
A	GB,A,976 862 (THE GENERAL ELECTRIC COMPANY) 2 December 1964 see page 4, line 37 - line 129	1

-/--

° Special categories of cited documents :[10]

"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

"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

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
06 JANUARY 1992	21. 01. 92
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	LIBBERECHT L.A.

1

International Application No PCT/GB 91/01760

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	FR,A,2 619 262 (CROUZET) 10 February 1989 cited in the application see abstract ---	1

ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. GB 9101760
SA 51896

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on 06/01/92
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A-4110809	29-08-78	None		
DE-A-2147471	26-07-73	None		
DE-A-3725390	09-02-89	None		
EP-A-0147818	10-07-85	DE-A-	3475148	15-12-88
GB-A-976862		FR-A-	1303330	
FR-A-2619262	10-02-89	None		