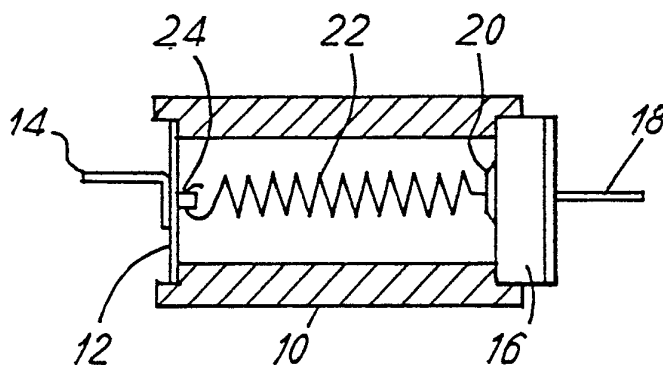




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(54) Title: DEVICE AND METHOD OF PROTECTING CIRCUITS AGAINST CHANGES IN OPERATING CONDITIONS

**(57) Abstract**

A device for protecting against excess current comprises a positive temperature coefficient (PTC) device and a tension spring connected by a solder joint adjacent the PTC device. Electrical current passes in series through the spring and the PTC device. Under normal operating conditions, the PTC device is in thermal equilibrium with its surroundings. If the current rises to a fault condition, the power dissipated in the PTC device increases rapidly and the temperature rises to cause melting of the solder joint. Because of the very rapid temperature rise, substantially immediate isolation is assured through the solder joint.

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DEVICE AND METHOD FOR PROTECTING CIRCUITS AGAINST CHANGES IN OPERATING
CONDITIONS

This invention relates to the protection of electrical circuit means against potentially damaging changes in operating conditions. These will usually be increases in current, but protection may also be required in certain cases against voltage changes or changes in temperature.

In household appliances, protection against excessive currents is conventionally provided by fuses. These have the advantages of relatively low cost. Moreover, a fuse has the advantage as a safety device that, when blown, it offers guaranteed and tamper proof isolation. These features can only be provided in mechanical or electromagnetic current isolators with special precautions. With normal fuses, however, there will be uncertainty as to the precise current value which will blow the fuse. This may not be a practical disadvantage when the aim is to protect against the effects of a short circuit. In these circumstances, the current through the fuse will rise rapidly to a level which is considerably in excess of the normal working current and the exact current level at which the fuse blows is therefore not critical. In certain applications, however, this uncertainty can be a substantial disadvantage. In cases where, for example, the current level in the fault condition is of the same order of magnitude as the normal working current, wide variations in the current level at which the fuse blows cannot be accepted. Either, there will be an unacceptable number of fuse failures at normal currents, or there will be a risk of the fuse failing to protect against the fault condition.



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Since the only practical method of accurately measuring the "blow current" of a fuse is destructive, it is not feasible to employ the technique used for certain other products of one hundred per cent testing, with rejection of components falling outside tolerance levels. The alternative is to manufacture every fuse to very close tolerances with destructive testing of a sufficiently high sample to give the required confidence. It will be appreciated that such techniques result in relatively high manufacturing costs as compared with the normal fuse. These problems are compounded where the fuse is required to operate at high voltages. Safety standards usually demand a minimum clearance gap which will increase with increases in the rated working voltage. Not only are higher voltage fuses intrinsically more expensive to manufacture; the difficulties of defining with confidence the "blow current" are also exacerbated. It will be understood that when a high voltage fuse blows, there is a risk that deposited condensation or combustion products may form an arc site.

It is one object of this invention to provide an improved method and device for protecting electrical circuit means against excessive currents which enable a current threshold to be accurately defined with a high confidence level.

This invention makes use of well known PTC devices having the property that the resistance of the device increases sharply at a threshold temperature.

According to one aspect of this invention there is provided a method for protecting electrical circuit means against currents in excess of a given current threshold by the connection in series of a

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normally conducting isolator having a fusible element and adapted to break electrical continuity on fusing thereof, the current being passed through a PTC device disposed in thermal communication with said element and being arranged so that above the current threshold, the power output of the PTC device exceeds the rate of heat dissipation therefrom and increases rapidly beyond the level required to fuse said element.

Advantageously, the cold resistance of the PTC device is very small compared with the resistance of the electrical circuit means to be protected so that, immediately above the current threshold, the power output of the PTC device is generally proportional to its resistance.

It will be understood that a PTC device can be selected to have a very rapid increase in resistance (typically several orders of magnitude) over a selected short temperature range. As will be explained in more detail hereafter, the power output of the PTC device can thus be arranged to increase very rapidly as the current exceeds the predetermined threshold, hence ensuring fusing of the element even if the melting point is significantly above the nominal figure.

In another aspect of this invention, there is provided a device for protecting electrical circuit means against currents in excess of a given current threshold comprising an isolator having a fusible element and adapted to break electrical continuity on fusing thereof and a PTC device arranged in electrical series connection and in thermal contact with the isolator and in thermal contact with a heat sink the PTC device being so arranged that as the current exceeds said threshold, the power output of the PTC device exceeds the rate of heat

loss to the sink and increases rapidly beyond the level normally required to fuse said element.

In other applications it is necessary to provide protection against changes in operating conditions other than current, for example, temperature.

Accordingly, in another aspect the present invention consists in a method for isolating electrical circuit means upon potentially damaging changes in operating conditions by the connection series of a normally conducting isolator having a fusable element and being adapted to break electrical continuity on fusing of that element, wherein a PTC device is arranged in thermal communication with the element and with a heat sink and adapted such that in normal operating conditions the rate of heat generation in the PTC device equals the rate of heat loss to the sink, it being further arranged that upon a potentially damaging change in operating conditions the rate of power generation exceeds the rate of heat loss and increases rapidly beyond the level required to fuse said element.

The invention will now be described by way of example with reference to the accompanying drawings in which:-

Figure 1 is a graph illustrating the variation of resistance with temperature for a typical PTC device,

Figure 2 is a circuit diagram of a typical PTC configuration,

Figure 3 is a graph illustrating the variation of power output with resistance,

Figure 4 is a graph illustrating the variation of power output with resistance and the power dissipation at different current levels.

Figure 5 is a sectional view of a device according to this invention,

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Figure 6 is a graph of working temperature of the device shown in Figure 5 against time,

Figures 7 and 8 are respectively plan and sectional views of a device according to a further embodiment of this invention,

Figures 9 and 10 are respectively plan and sectional views of a device according to a still further embodiment of this invention,

Figure 11 is a graph of power against temperature illustrating the effects of variations in ambient temperature,

Figure 12 is a diagram illustrating a further embodiment of this invention, and

Figure 13 is a sketch view of a still further embodiment.

A PTC or positive temperature coefficient device has the well known feature that the resistance increases rapidly over a short temperature range. The precise characteristics can be tailored to meet particular applications by controlling the manufacturing process. A typical plot of the resistance of a PTC against working temperature is shown in Figure 1. It will be seen that over a temperature range of around 5°C the resistance of the device increases by three orders of magnitude. PTCs have a wide variety of applications and one particular configuration is shown in Figure 2. Since the resistance R_p of the PTC device will vary with working temperature and will thus be dependent upon the power generated by self-heating in the PTC device, it is instructive to consider a plot of power P_p against PTC resistance R_p and this is shown in Figure 3. The power P_p generated in the PTC is shown as well as the power P_L dissipated in the load and the total power P_T dissipated in the circuit. The power P_p dissipated in the PTC has a maximum value and it can be

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shown that this will be reached if and when R_p becomes equal to R_L

In a case where the cold resistance of R_p^0 of the PTC device is very much smaller than the resistance of the load R_L it can be taken as a first approximation that the current I of Figure 1 will remain constant over the flat portion A and the knee B of the R/T curve shown in Figure 1. It is then possible to generate as shown in Figure 4 a family of power/temperature plots corresponding to different (and assumed constant) currents. In order to determine the operating point of the PTC device, it is necessary to consider the rate at which the heat generated within the device is lost to the surroundings. To a first approximation, the rate of heat dissipation will be proportional to the temperature of the device and - for a particular ambient temperature - a straight line plot of heat loss can be drawn as shown in Figure 4. The operating point of the PTC device carrying a constant current is then determined by the intersection of the heat dissipation plot with the P/T plot for that current.

If the current passing through the PTC device increases marginally, the operating point will shift to the intersection of the heat dissipation curve with a fresh P/T plot corresponding to the increased current. With a further increase in current however, a threshold value will be reached which the P/T curve for that current fails to intersect the heat dissipation curve. The rate at which power is generated within the PTC device will then always exceed the rate of heat dissipation. The temperature of the device will increase, the resistance will accordingly increase, leading in turn to increased power output. This positive feedback will continue until

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such time as the resistance R reaches the value of the load resistance R_L at the peak value shown in Figure 3 and the power generated in the PTC begins to fall. Depending upon the circumstances, either the power curve will intersect once more the heat dissipation curve with the device re-stabilising or the temperature of the PTC device will reach a level at which the resistance passes its maximum and begins to fall in a thermal runaway condition.

Against this background, one particular application of the device according to this invention can be described.

Referring to Figure 5, one device according to this invention comprises an insulating tube 10 closed at one end by a metal disc 12 carrying an external terminal 14. In the opposite end of the tube, there is disposed a PTC pill 16 carrying on its outer surface a terminal 18.

On the interior surface of the PTC pill 16 there is provided a soldered joint 20 which secures one end of a tension spring 22, the opposite end of which is secured at anchorage 24 to the plate 12.

In this example, the described device is to be used in the high voltage circuit of a microwave appliance. In a typical known circuit, a magnetron is powered from the secondary of a high voltage transformer with a diode voltage doubling circuit connected in series to produce the required voltage of around 2.3KV. The normal working current may be, for example, 500 milliamps, although failure of a diode may cause the current to rise to, say, 700 milliamps. In the absence hitherto of a reliable protective device, it has been necessary to ensure that the high voltage transformer is capable of carrying the fault current of 700 milliamps. This inevitably

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increases manufacturing costs. According to this invention, the described device is connected in series with the magnetron. The resistance of the voltage doubling circuit will typically be several kilohms whilst the resistance of the protective device may be, for example, only 5 ohms. Accordingly, the current is effected to a minimal extent by the cold resistance of the PTC pill and it is also the case that the PTC device is not required to withstand the operating voltage of around 2.3 kilovolts.

In normal operation, the described device is connected in series with the diode circuit and the magnetron, electrical continuity being established through the spring 22, the solder joint 20 and the PTC pill 16. The passage of current through the PTC pill will lead to self-heating and the temperature of the pill - and necessarily also that of the solder joint - will rise as before described to an equilibrium temperature at which the power generated through self-heating is balanced by heat dissipation.

For the particular PTC device whose characteristics are illustrated in Figure 4, a current of 500 milliamps and an ambient temperature of 20° will lead to the working point shown at X, that is to say a PTC temperature of 40°C . If the current rises to 700 milliamps, the PTC device will regain thermal equilibrium at working point Y with a temperature of 48°C .

In the described application, that is to say within the microwave appliance, ambient temperature is 60°C . At the normal working current of 500 milliamps, the PTC device will be in thermal equilibrium at working point Z. It can now be seen that if the current rises in a fault condition to 700 milliamps, the power

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generation curve fails to intersect the cooling curve and the PTC device will heat rapidly. Within a very short interval, the temperature attained by the PTC pill 16 will exceed the melting point of the solder joint 20. The tension spring 22 will therefore be released and electrical continuity through the device will be broken. This behaviour is illustrated in Figure 6 which is a plot of working temperature against time, on the assumption that an excess current condition arises at time t_x .

It will be understood that since the temperature of the PTC pill rises rapidly, it can by suitable design of electrical and thermal characteristics be ensured that the solder joint is broken within a given time interval of the fault condition occurring, irrespective of minor variations in the exact melting point of the solder. These variations are depicted as a temperature band T_A - T_B in Figure 6 and it will be seen that the temperature of the devices passes very rapidly through the band on the occurrence of a fault current. The behaviour of the PTC pill itself can be forecasted with considerably more accuracy than is the case with a fuse element. However, if a still further guarantee of correct operation of the protective device is required, it would be feasible to carry out 100% testing of the PTC pill 16 to ensure that on application of the fault current a thermal runaway condition is entered. Such a test performed before assembly of the solder joint would not of course be destructive. It would indeed be possible to test the device after final assembly by applying the fault current at a low test voltage. The resistance change in the PTC can be monitored without the power levels being sufficient to melt the solder joint.

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In certain applications, the protective device may be required to operate over a range of ambient temperatures. In such circumstances the characteristics of the PTC device will be selected so that within the anticipated band of ambient temperatures, there was always thermal stability at any point within the normal current range but that any current in excess of the stated fault current would lead to thermal runaway.

There is shown in more detail in Figures 7 and 8 a device according to this invention which is capable of providing isolation at high voltages. The device is formed with upper and lower ceramic housing parts 50 and 52. As seen best in Figure 7, the lower housing part 50 defines three internal cavities, being a first contact cavity 54, a spring cavity 56 and a second contact cavity 58. Along opposite sides of the spring cavity 56, there are formed recesses 60 which mate with corresponding lugs 62 provided on the upper housing part. There are also formed in the upper housing part 52 recesses 64 and 66 which overlie the first and second contact cavities respectively.

A first contact 68 has a mounting portion 70 positioned in the first contact cavity 54. The contact 68 has a neck 72 which is received in the housing aperture 74 and the protecting portion of the contact is formed (in this example) as a spade terminal 76. The mounting portion 70 has a tang 78 which provides an anchorage for one end of a tension spring 80. This tension spring extends between the first and second contact cavities through the spring cavity 56. There is disposed in the second contact cavity 58 a mounting plate 82 resting on blocks 84 formed integrally with the first housing part. A nose 86 projects integrally from the mounting plate and provides the

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site for a solder joint 88 between the mounting plate and the corresponding end of the tension spring 80. A PTC pill 89 is sandwiched between the mounting plate 82 and a second contact 90 of a configuration generally similar to that of the first contact. That is to say the second contact 90 has a neck 92 received within a housing aperture 94 and a projecting portion formed as a spade terminal 96. Good thermal and electrical contact between the mounting plate 82, the PTC pill 89 and the second contact 90 is ensured by means of a dished spring element 98 received within recess 66.

It will be understood that at the fault current level, heat generated within the PTC will melt the solder joint 88. The tension spring 80 is normally under considerable extension so that upon release of the solder joint, the now free end of the tension spring retracts through substantially the entire length of the spring cavity 56. There is accordingly defined an isolation gap of considerable extent. It should be noted that, in contrast to a fuse, the isolation gap is well defined and the amount of fusible material is relatively small. The risk of arcing across stray deposits of solder is therefore substantially removed.

With reference now to Figures 9 and 10, there is shown an alternative detailed embodiment of this invention. The device comprises a housing 100 and a cover 102 of a suitable plastics or ceramic material. A recess 104 in the housing accommodates a PTC pill 106 abutting on one circular face a heat collector plate 108 and on the opposite face a connection disc 110. A U-shaped spring clip 112 acts between the side of the recess 104 and the connection disc 110 to ensure that the PTC pill is correctly positioned and in proper thermal

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and electrical contact, notwithstanding minor variations in dimension. These may occur as a result of differential thermal expansion or because of manufacturing tolerances. A spade terminal 114 is rigidly secured to the connection disc 110 and extends outwardly of the housing through channel 116. This channel 116 is slightly oversized to accommodate variations in thickness of the PTC pill and the fact that the spade terminal 114 is disposed orthogonally minimises the surface opening.

A coiled torsion spring 118 is located within a spring cavity 120 in the housing and has opposed limbs 122 and 124 which are mutually inclined at an obtuse angle. Limb 122 has an end portion 126 folded in two directions which is received in a hook 128 pressed out of a spade terminal 130. The opposite torsion spring limb is soldered to a step 132 pressed out of the heat collector plate 108.

The described device is adapted to be plugged into a mounting having appropriate sockets for receiving the spade terminals 114 and 130. At currents within the predefined safe working range, electrical continuity between the terminals is provided by the spring 118, the heat collector plate 108, the PTC pill 106 and the connection disc 110. At currents in excess of the safe working range, the PTC pill is designed, as explained above, to increase power output and rise in temperature to effect melting of the solder joint enabling the torsion spring limb 124 to move to the position shown in dotted outline. It will be seen that in this way a well defined clearance gap is guaranteed.

The influence of ambient temperature has already been explained and in certain cases it may be desirable to form ventilation slots in

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the housing to control the temperature in the immediate vicinity of the PTC pill.

The examples so far described have illustrated the use of this invention to protect against increases in current. The invention is, however, capable of protecting against the potentially damaging effects of other changes in operating conditions. For example, there are applications in which it is necessary to isolate electrical equipment if ambient temperature or other surrounding temperature changes. Overheating of an appliance, equipment or installation may not necessarily be accompanied by fault current levels and the overheating may indeed be caused by an outside agency.

Referring to Figure 11, there is illustrated the power/temperature plot of a PTC device operating at constant current with the cooling plots for a range of ambient or surrounding temperatures T_1 to T_4 . It will be recognised that an initial increase in ambient temperature (to T_2 for example) merely causes the PTC device to shift to a new operating point. Beyond a threshold temperature T_3 , however, the cooling curve fails to intersect the power plot, resulting in the PTC device rapidly increasing in temperature. This effect is analogous with the previously described results of a current increase. If T_2 is the normal operating temperature and T_4 is a temperature associated with a fault condition, isolation is accordingly ensured wherever the fault condition arises.

Devices as previously described for use as current protection can accordingly also be used to protect against temperature increases. At lower voltages, the size of the device can of course be reduced. In

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certain applications, the parameters of a device may be selected so that it provides both temperature and current protection. That is to say either a current increase or an ambient temperature increase will cause the PTC device to heat rapidly and fuse the element.

One particular application of such a thermal cutout is to protect against the dangers of plugging a household appliance into house wiring which through deterioration or for other reasons is not capable of carrying the required current. In such circumstances, the appliance itself will operate normally and conventional fuses will not offer protection. It is likely, however, that overheating will occur at the socket and it is proposed to locate a thermal cutout according to this invention in the appliance plug in a position to respond to any overheating of the socket.

The fusible element may take forms other than the above described use of solder. Referring, for example, to Figure 12, a further embodiment is illustrated with the PTC pill being omitted for the sake of clarity. A heat collector plate 150 which abuts the PTC pill provides a central mounting point for a pawl 152 which can pivot with respect to the axis of the PTC pill. One arm of the pawl is formed as a tang 154 which opposes a block 156 secured optionally to the heat collector disc or to the body of the device. A thermal fuse pellet 158 is bonded between the tang 154 and the block 156. This pellet 158 takes the form of a spring compressed within a body of wax material.

The opposite arm of the pawl 152 is formed as a tooth 160 which engages beneath one limb of a torsion spring 140, the heat collector plate 150 having lugs 162 which restrain sideways movement of the torsion spring.

In the position shown in the Figure, electrical continuity is achieved through the collector plate 150, the pawl 152 and the torsion spring 140. If the temperature of the heat collector plate exceeds the melting point of the wax in the thermal fuse pellet 158, the compression spring trapped within the pellet is released to urge the tang 54 in the clockwise direction thus causing tooth 160 to move away from and in turn to release the torsion spring 140.

In other forms, the fusible element need not form part of the normally conducting path of the isolator. There is shown for example in Figure 13, (in a diagrammatic form) a device for protecting against earth current leakage. Contact pairs 100 and 102 in the live and return rails of a power supply are biased open and held closed by respective wax pellets 104, 105 mounted on a PTC pill 106 connected electrically in the earth rail. A current passing to earth will cause rapid heating in the PTC device melting the wax pellets and opening both live and return circuits.

The use of a fusible element in general provides the described devices with certain recognised advantages of conventional fuses, that is to say mechanical simplicity, reliability and tamper-proof isolation. The invention provides the further advantages of very accurate response and the ability to operate reliably at high voltages.

It should be understood that this invention has been described by way of example only and numerous modifications are possible without departing from the scope of this invention. Thus the fusible element could take a variety of forms, the choice being determined by such

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factors as the temperature at which fusing occurs and the available heat output. Solder has the advantage that the melting point can be controlled by variation of the solder composition with a comparatively low temperature limit. It will be possible, however, to use other fusible alloys. Similarly a variety of plastics materials will be suitable. The fusible element need not form part of the conducting path of the isolator and other mechanisms can be employed for ensuring that isolation takes place on fusing of the element. As with conventional switches, there is the option of having normally open contacts held closed by the fusible element or normally closed contacts forced open upon fusing of the element. The described usages of springs have the advantage of providing rapid opening to a comparatively large isolation gap and improving the operating characteristic by forcibly breaking the soldered joint once a defined degree of weakening or plasticity has been reached. Other alternatives are, however, possible. Whilst the invention has been described with reference to current and temperature protection, it will be understood that devices and methods according to this invention can also protect against over voltages which can be arranged to cause excess current flow in the PTC device.

CLAIMS

1. A method for isolating electrical circuit means upon potentially damaging changes in operating conditions by the connection in series of a normally conducting isolator having a fusible element and being adapted to break electrical continuity on fusing of that element, wherein a PTC device is arranged in thermal communication with the element and with a heat sink and adapted such that in normal operating conditions the rate of heat generation in the PTC device equals the rate of heat loss to the sink, it being further arranged that upon a potentially damaging change in operating conditions the rate of power generation in the PTC device exceeds the rate of heat loss and increases rapidly beyond the level required to fuse said element.
2. A method according to claim 1, wherein the rate of power generation of said PTC device is arranged to increase rapidly if the current through the PTC device exceeds a predetermined threshold.
3. A method according to claim 1, wherein the power generated in the PTC device is adapted to increase rapidly if the surrounding temperature exceeds a predetermined threshold level.
4. A method according to any one of the preceding claims, wherein the fusible element forms part of the normally conducting path of the isolator.
5. A method according to any one of the claims 1 to 3, wherein fusing of the element is arranged to open electrical contacts.

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6. A device for isolating electrical circuit means upon potentially damaging changes in operating conditions comprising a normally conducting isolator having a fusible element and being adapted to break electrical continuity on fusing of that element and a PTC device arranged in thermal communication with the element and so adapted that in normal operating conditions the rate of heat generation in the PTC device equals the rate of heat loss by the PTC device, it being further arranged that upon a potentially damaging change in operating conditions the rate of power generation in the PTC device exceeds the rate of heat loss and increases rapidly beyond the level required to fuse said element.

7. A device for protecting electrical circuit means against currents in excess of a given current threshold, comprising an isolator having a fusible element and adapted to break electrical continuity on fusing thereof and a PTC device arranged in electrical series connection and in thermal contact with the isolator and in thermal contact with a heat sink, the PTC device being so arranged that as the current exceeds said threshold, the power output of the PTC device exceeds the rate of heat loss to the sink and increases rapidly beyond the level normally required to fuse said element.

8. A device according to claim 7, wherein the isolator comprises a pair of contacts biased apart and held in electrical contact by said fusible element.

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9. A device according to claim 8, wherein one of said contacts takes the form of a tension spring.

10. A device according to any one of claims 7 to 9, wherein the fusible element comprises a solder joint.

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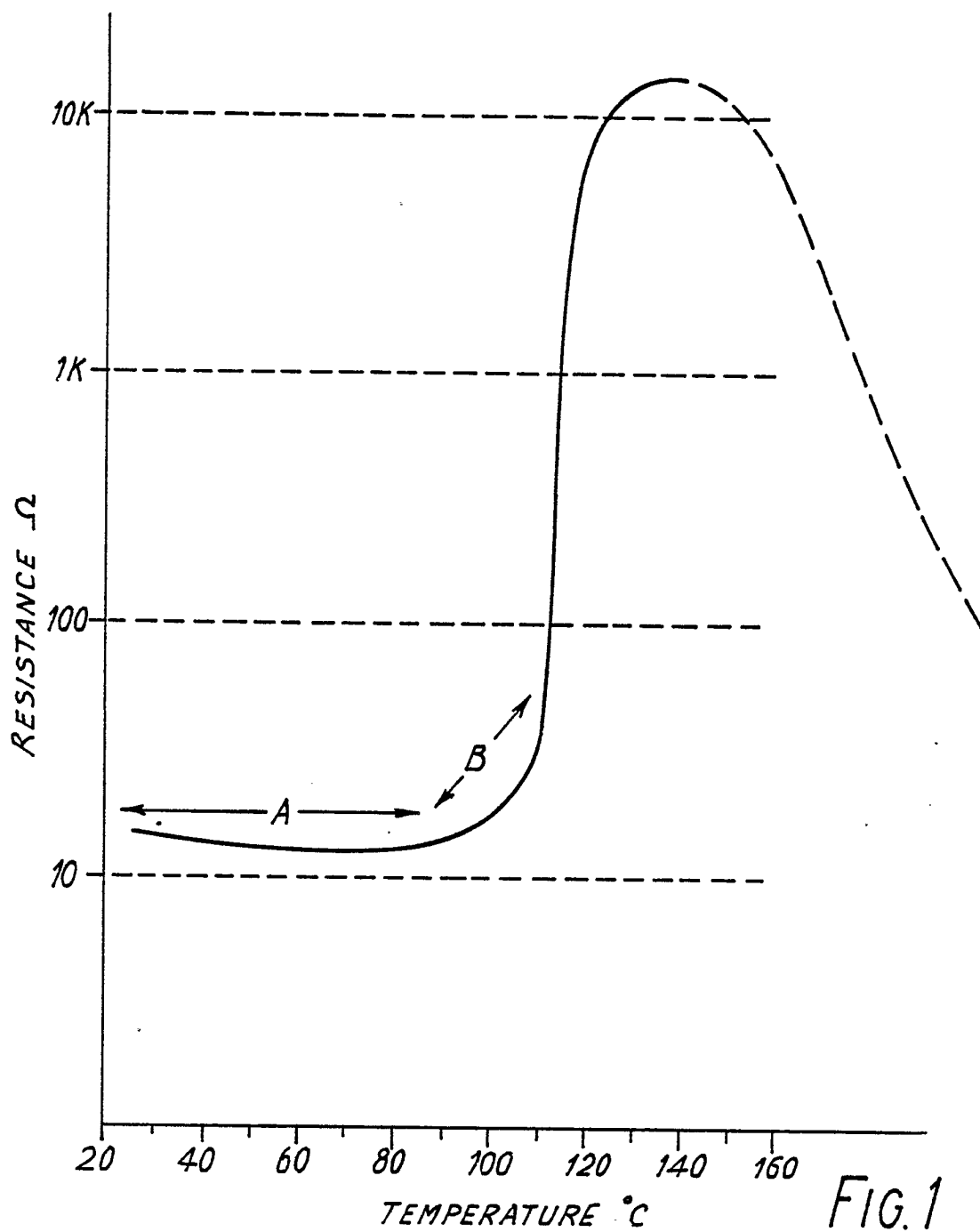


FIG. 1

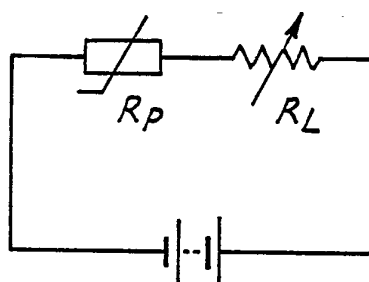


FIG. 2

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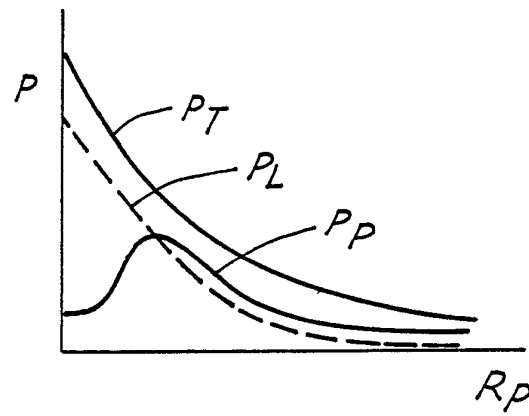


FIG. 3

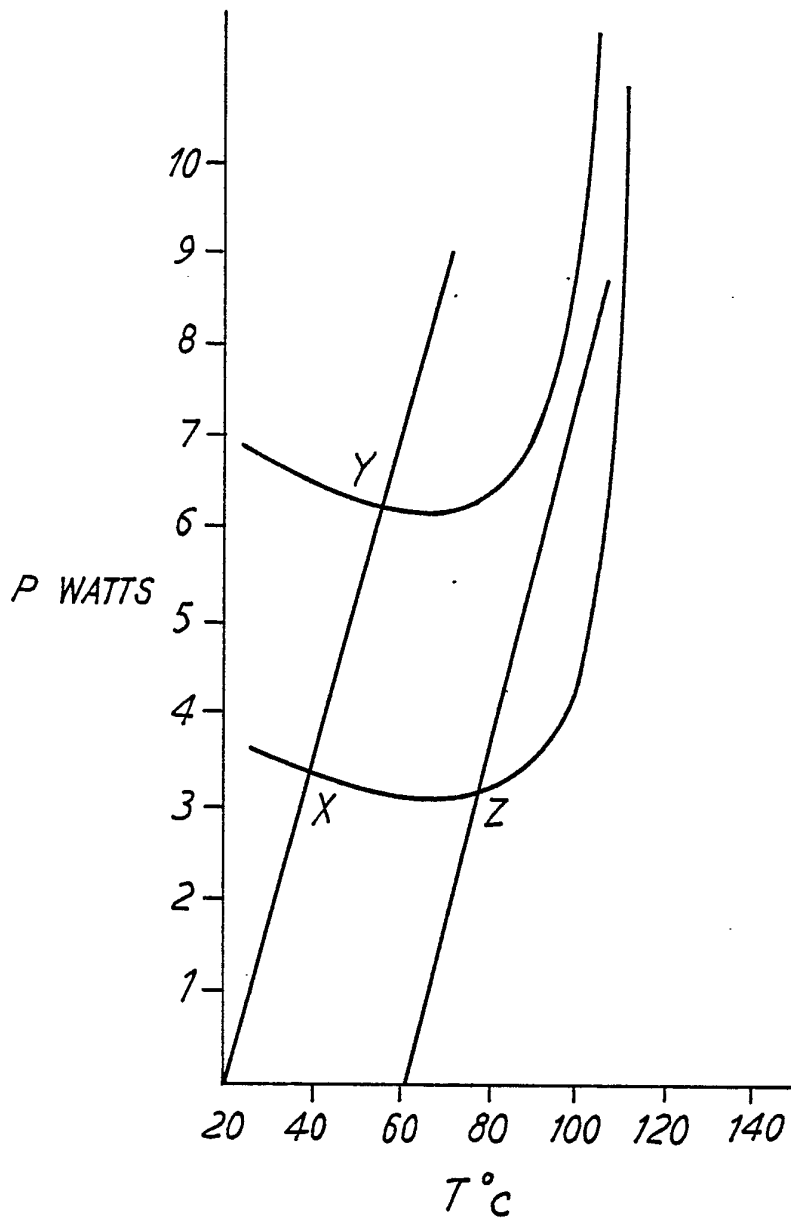


FIG. 4

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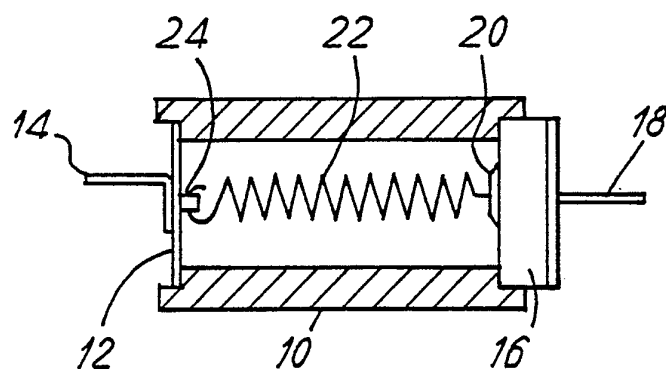


FIG. 5

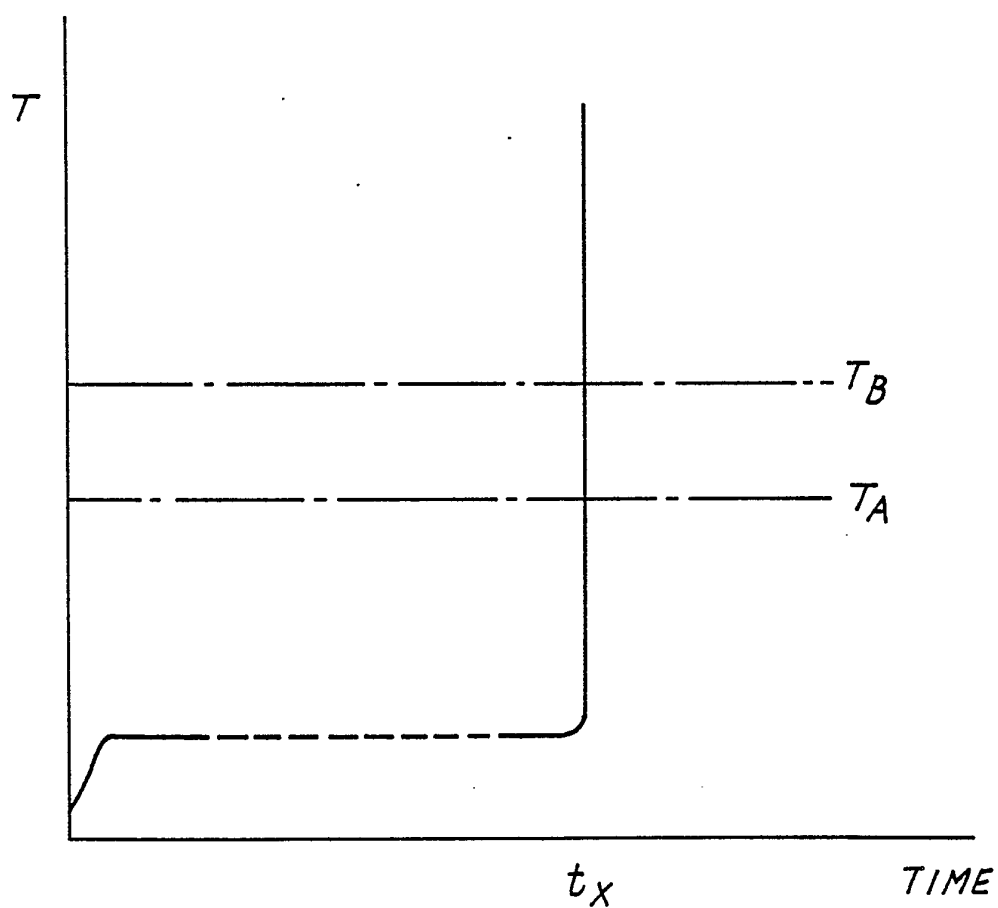


FIG. 6

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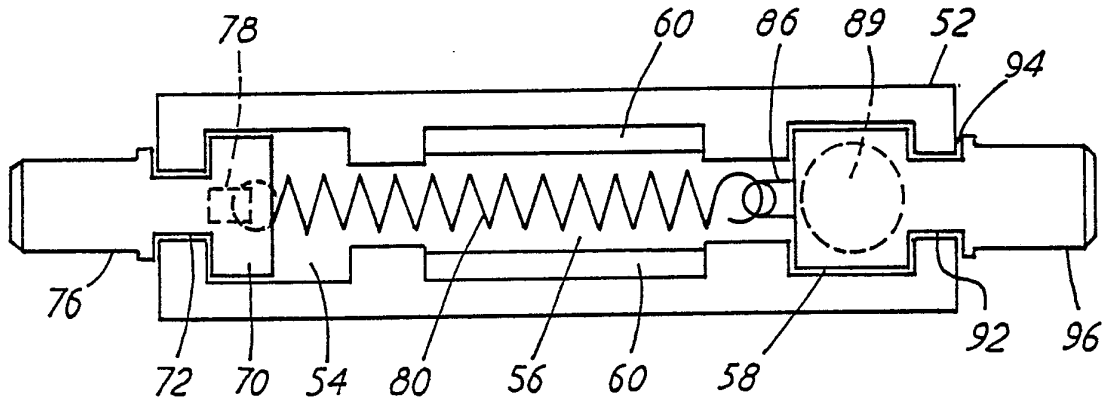


FIG. 7

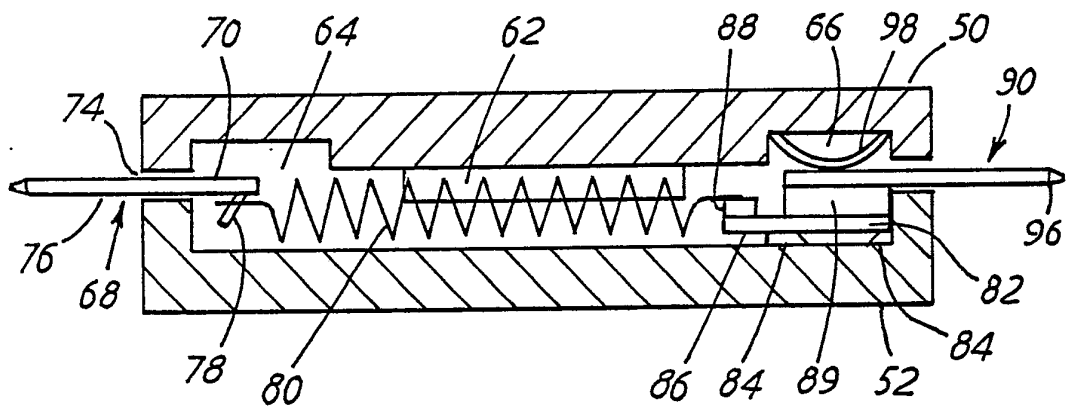


FIG. 8

SUBSTITUTE SHEET

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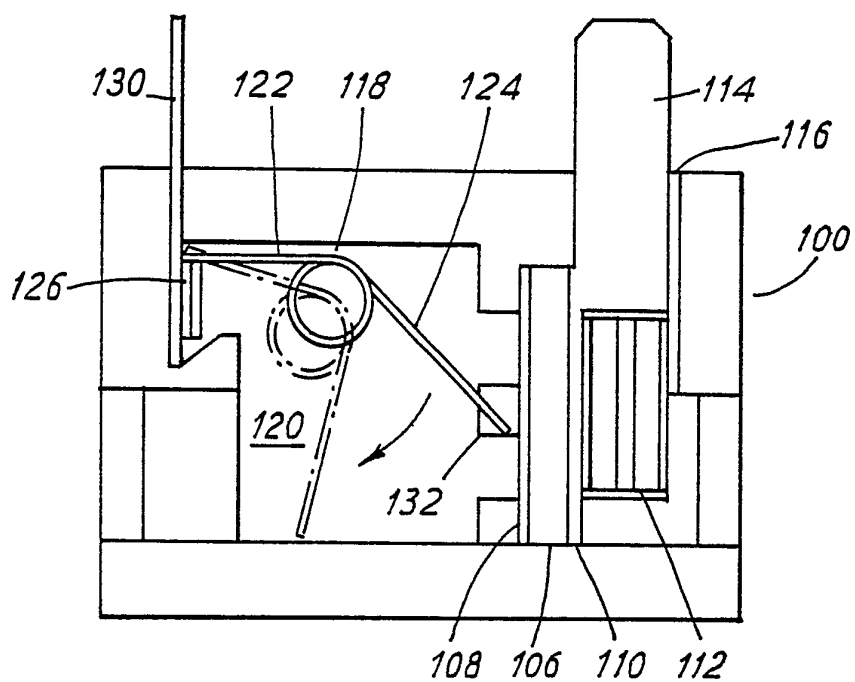


FIG 9

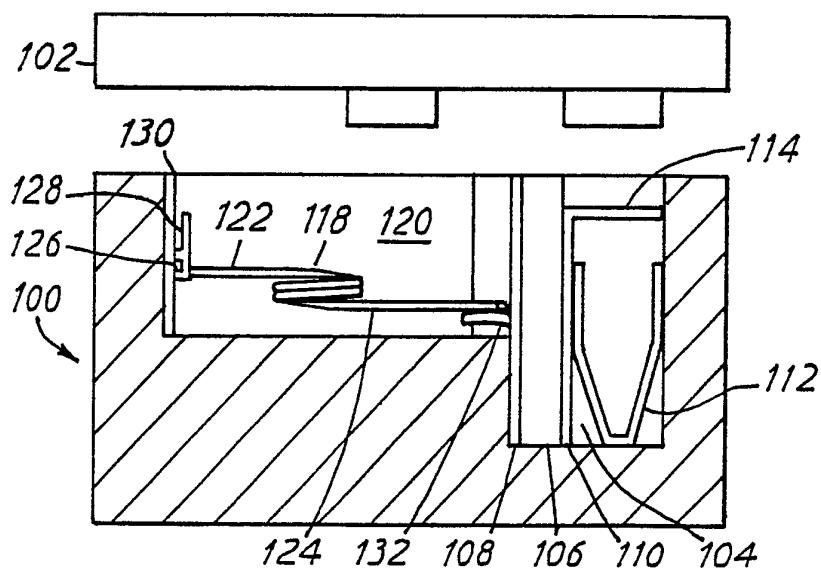


FIG. 10

SUBSTITUTE SHEET

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FIG. 11

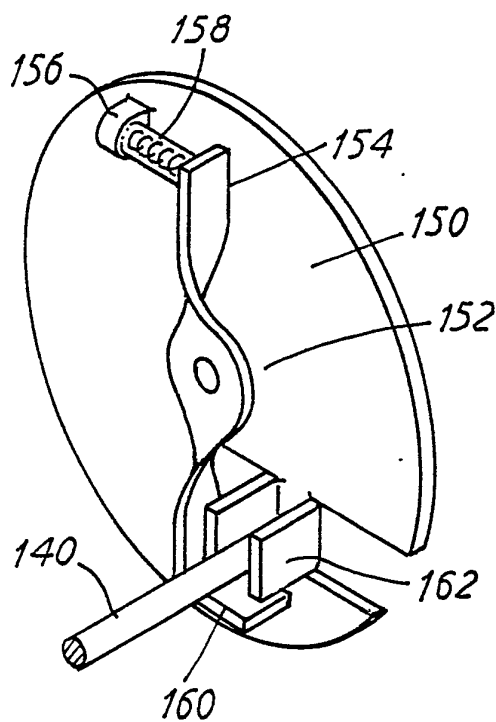
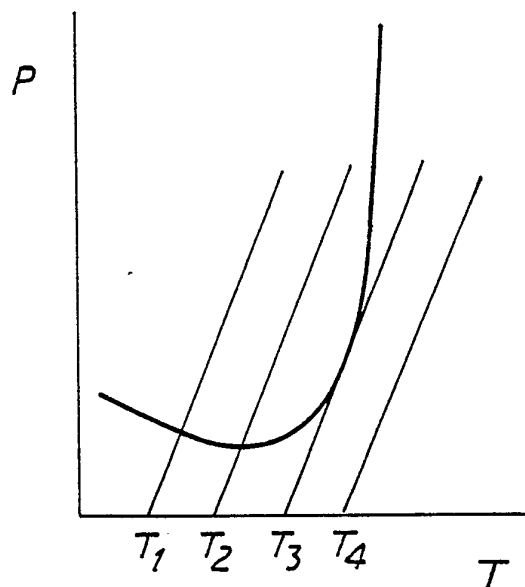
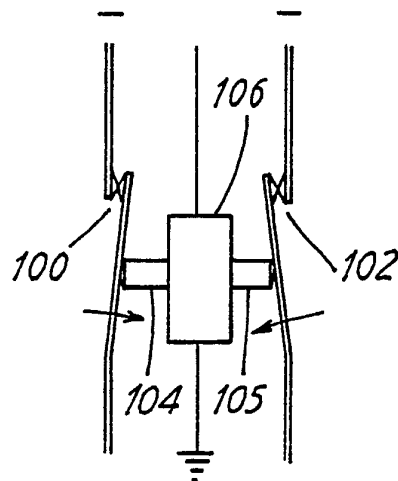


FIG. 12

FIG. 13



INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 86/00671

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC ⁴ : H 02 H 3/02 ; H 02 H 5/04; H 01 H 37/76		
II. FIELDS SEARCHED		
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III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category ⁹	Citation of Document, ¹¹ with Indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	DE, A, 2349445 (J. MORGAN) 10 April 1975, see page 7, line 14 - page 9, line 23; figures 1,2,6 --	1-10
X	DE, A, 2342015 (DANFOSS) 27 March 1975, see figures 1,2; claims 1-4 --	1-2,3-10
A	DE, A, 2604185 (BBC) 11 August 1977, see figures 1,3; claims 3,4 --	1-10
A	DE, A, 3030337 (SACHS) 18 March 1982, see figures 1,2; page 2, line 25 - page 3, line 30 -----	1-10
* 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. "A" 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
13th January 1987		13 FEV. 1987
International Searching Authority EUROPEAN PATENT OFFICE		Signature of Authorized Officer M. VAN MOL 

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/GB 86/00671 (SA 15039)

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 03/02/87

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-A- 2349445	10/04/75	None	
DE-A- 2342015	27/03/75	None	
DE-A- 2604185	11/08/77	None	
DE-A- 3030337	18/03/82	None	

For more details about this annex :
see Official Journal of the European Patent Office, No. 12/82