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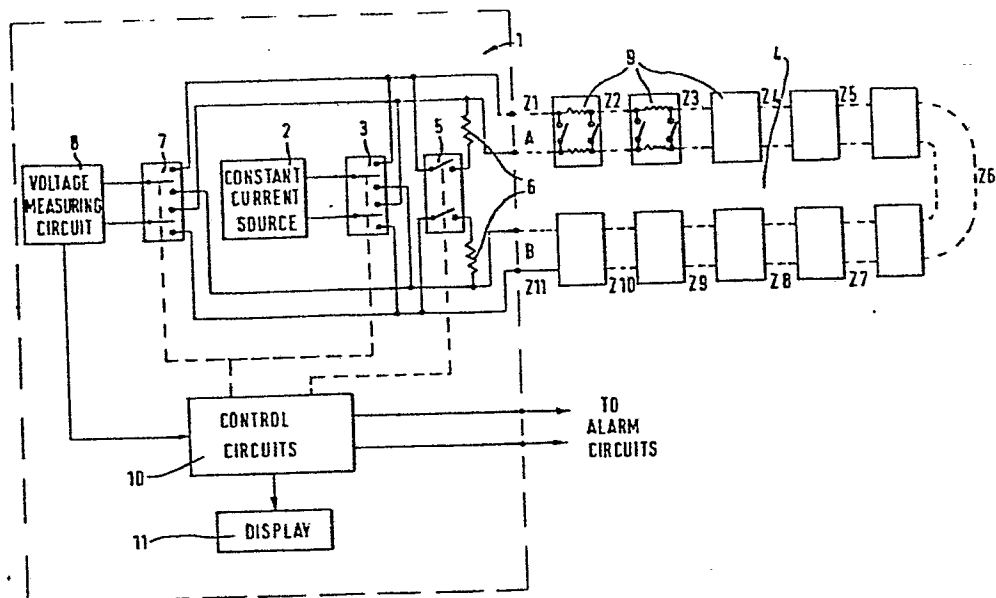
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(54) An improved fire detection system.

(57) A monitoring system for detecting fire or other elevated temperature conditions in a plurality of discrete zones Z_1, Z_2, Z_3 , etc. comprises a loop box 1 which has two pairs of terminals A and B to each of which is connected one end of a pair of conductors of a linear temperature detector cable passing through each of the discrete zones. Adjacent zones are sectionalised by zone boxes 9, each of which comprises a pair of balanced resistors, one resistor connected in series in one conductor of the loop and the other resistor being connected in series in the other conductor. The loop box 1 has a constant current generator 2 which can be connected via an electronic switch 3 to either the A or B end of the loop 4; an electronic switch 5 which connects one of two fixed resistors 6 directly across the two conductors of the loop at the opposite end to that to which the generator 2 is connected; and an electronic switch 7 which connects a voltage measuring circuit 8 onto the terminals of the loop to which the generator 2 is connected. Electronic switches 3, 5 and 7 are operated by control circuits 10 whose output signals are fed to a display device 11, which shows if the system is operating normally, identifies the nature of any abnormalities and indicates any discrete zone in which there is a short circuit caused by a fire, and to external alarms.

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AN IMPROVED FIRE DETECTION SYSTEM

This invention relates to a monitoring system for detecting fire or other elevated temperature conditions.

In an electric power station, factory or other establishment which comprises a plurality of separate buildings or at least one building which, for the purposes of fire prevention, is divided into a plurality of discrete zones by fire walls, fire doors or other means, it is the general practice to employ a system of fire detection known as a 'zoned' system. In a 'zoned' system, each discrete zone or each building constituting a discrete zone has its own associated fire detector comprising a length of temperature sensitive cable which is connected to a terminal box circuitry for the detection of a change in a characteristic of the cable when the cable is exposed to localised heating such as may occur in the event of a fire. Each terminal box is located close to its associated temperature sensitive cable and must be of such a form that it will withstand exposure to fire. Since the circuitry of each terminal box must remain active under fire conditions, the box must be supplied with power through fire-resistant cable and if, as is customary, the circuitry of

each termination box is connected to a central audible and/or visual alarm system, fire resistant cables are also required for this purpose. Usually the central alarm system is installed in a central control room in which is also installed a central display or annunciator providing visual identification of any discrete zone or building constituting a discrete zone in which a fire has been detected.

Since each discrete zone or building constituting a discrete zone has its own terminal box and associated fire resistant cables for the supply of power to and for the transmission of an alarm signal from its circuitry, such a 'zoned' system of fire detection is expensive both in equipment and installation. The number of terminal boxes employed however, inevitably reduces the overall reliability of the system because the chances that the circuitry of at least one of the terminal boxes may become faulty, so that the zone or building that it serves is unprotected, are greatly increased. Moreover, having each discrete zone or building constituting a discrete zone completely independent of each of the other zones or buildings in respect of temperature sensing circuitry and power supply and signal transmitting cables takes no account of the very low probability that fires in two or more discrete zones or buildings may occur at one and the same time.

It is an object of the present invention to provide an improved monitoring system for detecting fire or other elevated temperature conditions in a plurality of discrete zones, which system is less expensive and substantially more reliable than 'zoned' fire detection systems hitherto proposed

and used.

According to the invention, the monitoring system comprises a pair of elongate electric conductors passing through each of said plurality of discrete zones and, over at least that part of the length of the pair passing through each zone, being of such a construction that the pair of conductors form part of a linear sensor extending along said part of the length of the pair; means, interconnected in the length of the pair of conductors between each adjacent pair of discrete zones, for sectionalising the length of the pair into a plurality of discrete linear sensors connected in series; means, connected to each end of the length of the pair to form a loop, for injecting a signal into the pair of conductors and for measuring the terminal voltage of the loop in order to identify that one of the linear sensors which has detected an unacceptable rise in temperature in the discrete zone in which it is located; and, connected to the signal injecting and voltage measuring means, an audible and/or visual alarm for signifying the existence of a fire or an unacceptable elevated temperature condition and/or a device for indicating the discrete zone in which the fire or elevated temperature condition has been detected.

By a linear sensor is meant an elongate temperature detector of the kind comprising two elongate electric conductors which are electrically insulated from one another throughout their lengths by an electrically insulating material that will melt under the temperature conditions to be detected and which are so arranged that, when said insulating material melts at any position along the lengths of the elongate

conductors, one or each of the conductors will move into electrical contact with the other conductor to produce a short circuit.

Preferably, in the event of a temperature rise sufficient to cause the insulating material separating the elongate conductors of the linear sensor to melt at a position along their lengths and produce a short circuit, the or each elongate electric conductor of the loop of the monitoring system is so urged towards the other conductor and/or at least the outer surface of each conductor is of such a metal or metal alloy that the electrical resistance of the electrical contact at the short circuit between the two conductors will be substantially zero.

Preferably, also, the pair of elongate electric
.5 conductors of the loop of the monitoring system is a component part of an electric cable, a preferred cable being the linear temperature detector described and claimed in the Complete Specification of our Patent No. 1461769.

One or each end of the pair of elongate conductors
20 constituting the loop may be directly connected to the means for injecting a signal into the pair of conductors of, and for measuring the terminal voltage of, the loop or said means may be indirectly connected to one or each end of the pair, or to sectionalising means at said end of the pair, by fire-resistant
25 cable or other non-sensing cable. In some circumstances, adjacent discrete zones of the loop, for example where the zones are physically spaced a long distance apart, may be interconnected by fire-resistant cable or other non-sensing

cable connected in series in the loop. Such interconnecting non-sensing cables may themselves be regarded as separate zones or they may be included in a discrete zone. As non-sensing cable, it is preferred to employ mineral insulated fire-resistant cable.

Preferably, but not necessarily, the means for injecting a signal into the pair of conductors of, and for measuring the terminal voltage of, the loop are housed at a central station that is remote from the discrete zones so that no active circuitry is within the discrete zones.

Each means for sectionalising the length of the pair of elongate conductors into a plurality of discrete linear sensors connected in series preferably comprises a pair of balanced resistors, one resistor of the pair of resistors being connected in series in one of said pair of conductors and the other resistor of the pair being connected in series in the other conductor of said pair of conductors.

The means for injecting a signal into the pair of conductors is preferably a constant current source. A constant direct current source may be employed but preferably a constant alternating current source is used. In the preferred embodiment, a constant low frequency alternating current source is employed, e.g. a source having a frequency in the range 30 to 70 c/s, because transmission line effects are substantially reduced and standard low frequency type transformers can be used as isolating elements.

Where a monitoring system is to be employed in an establishment that, on account of its size and/or distribution, is conveniently divided into a multiplicity of discrete zones,

preferably the monitoring system comprises two or more than two separate loops each comprising a plurality of discrete linear sensors connected in series, each loop having its own means for injecting a signal into the pair of conductors of the loop and for measuring the terminal voltage of the loop, and a master controller which controls each of said means and which is connected to an audible and/or visual alarm for signifying the existence of a fire or an unacceptable elevated temperature condition and/or a device for indicating the discrete zone in which the fire or elevated temperature condition has been detected, the alarm and/or device being connected to all of said loops.

As in the monitoring system comprising a single loop, the means for injecting signals into the pairs of conductors of, and for measuring the terminal voltages of, the loops and the master controller may be housed at a central station that is remote from the discrete zones so that no active circuitry is within the discrete zones.

The invention is further illustrated, by a description, by way of example, of a preferred form of monitoring system for detecting fire or other elevated temperature conditions with reference to the accompanying drawing which shows a schematic lay-out of the monitoring system.

Referring to the drawing, the monitoring system comprises a loop box 1 which constitutes signal injecting and voltage measuring means and which comprises a constant current generator 2, electronic switches 3, 5 and 7, fixed resistors 6, and a voltage measuring circuit 8. The constant current

generator 2 is set to give 1 mA for any load resistance from 0 to 12 kilo-ohms; the open circuit output voltage of the generator is 15 volts. The loop box 1 has two pairs of terminals A and B to each of which is connected one end of the pair of conductors of a linear temperature detector cable as described and claimed in our Patent No. 1461769 to form a loop 4. The generator 2 can be connected via the electronic switch 3 to either the A or B end of the loop 4. The electronic switch 5 connects one of the fixed resistances 6 directly across the two conductors of the loop at the opposite end of the loop to that to which the generator 2 is connected. The electronic switch 7 connects the voltage measuring circuit 8 onto the terminals of the loop to which the generator 2 is connected.

The loop 4 passes through eleven discrete zones Z_1 , Z_2 , Z_3 , etc. adjacent zones being sectionalised by means of zone boxes 9, each of which comprises a pair of balanced resistors, one resistor of the pair being connected in series on one conductor of the loop and the other resistor of the pair being connected in series in the other conductor of the loop.

In order to provide for routine checking of the operation of the monitoring system, in each zone box 9 two test switches are interconnected between the pair of balanced resistors which can be short circuited when effecting a routine check by actuation, in turn, of each of the test switches.

Electronic switches 3, 5 and 7 are operated by control circuits 10 whose output signals are fed to a display

device 11, which shows if the system is operating normally, identifies the nature of any abnormalities and indicates the location of any short circuit, and to external audible and visual alarm devices.

The status of the loop 4 is determined by the voltages appearing at the loop terminals A and B under the various modes of operation. When the system is normal the terminal voltage will be the product of the current source output multiplied by the known total resistance of the loop.

(i) Insulation Resistance Check

For the purposes of an insulation resistance check, detection of a voltage lower than the normal circuit terminal voltage, but not as low as would occur if a zone was short circuited, will actuate an "INSULATION FAULT" indicator in the display device 11.

(ii) Continuity Check

For the purposes of a continuity check, voltages above the level of the normal circuit terminal voltage will actuate an "OPEN CIRCUIT" indicator in the display device 11.

(iii) Identification of a Short Circuited Zone

If the voltage level falls below the voltage level indicating the existence of an insulation fault, then the existence of a short circuit is suspected. The zone in which the short circuit is located is determined by calculating the number of zone boxes 9 through which the current would have to pass to produce the measured terminal voltage. For example, if a current of 1 mA is injected at terminal A and each zone box 9 has a total resistance of 1 k Ω , then a short circuit in

zone Z_4 will produce a terminal voltage at A, in the range 3-4 volts - depending on the cable resistances in zones Z_1 , Z_2 , and Z_3 . An indicator on the display device 11 shows in which zone the short circuit is located.

For the purposes of:-

- (iv) confirmation of a short circuited discrete zone, and
- (v) operation when the loop is broken or when a discrete zone is short circuited,

the control circuits 10 are arranged to operate the electronic switches 3, 5 and 7.

(iv). Confirmation of a short circuited zone

Confirmation of the location of a short circuited zone can be easily effected by switching the current generator 2 and voltage measuring circuit 8 to the opposite end of the loop 4 (provided the loop is unbroken). Referring to the example quoted above, the short circuit in zone Z_4 will produce a terminal voltage at B in the range of 7-8 volts. The control circuit 10 is designed so that 7-8 volts measured at terminal B operates the same indicator as 3-4 volts measured at terminal A.

In the unlikely event of the simultaneous occurrence of short circuits in different zones the confirmatory test cannot be applied and the indications obtained at terminals A and B will be different - each terminal only "seeing" the short circuit nearest to it.

- (v) Operation when the loop is broken, or after the occurrence of a short circuit

Since both ends of the loop 4 are brought into the

loop box 1, it is possible to provide limited operation of the alarm system after a short circuit has occurred, or when the loop continuity is broken. In the case of a short circuit it is possible to check continuity (through the short circuit) from both ends of the loop, and to detect if further short circuits develop, but it is not possible to monitor insulation resistance. In the event of an open circuit developing it is possible to monitor the insulation and detect if short circuits occur on either side of the break, but the loop continuity up to the break point cannot be checked.

In addition to the continuous monitoring of the system integrity provided by the control sequence within the loop box 1, routine checks of the operation of the total system can be achieved by operating the test switches in the zone boxes 9.

What we claim is:-

1. A monitoring system for detecting fire or other elevated temperature conditions in a plurality of discrete zones, characterised in that the system comprises a pair of elongate electric conductors passing through each of said plurality of discrete zones and, over at least that part of the length of the pair passing through each zone, being of such a construction that the pair of conductors form part of a linear sensor extending along said part of the length of the pair; means, interconnected in the length of the pair of conductors between each adjacent pair of discrete zones, for sectionalising the length of the pair into a plurality of discrete linear sensors connected in series; means, connected to each end of the length of the pair to form a loop, for injecting a signal into the pair of conductors and for measuring the terminal voltage of the loop in order to identify that one of the linear sensors which has detected an unacceptable rise in temperature in the discrete zone in which it is located; and, connected to the signal injecting and voltage measuring means, an audible and/or visual alarm for signifying the existence of a fire or an unacceptable elevated temperature condition and/or a device for indicating the discrete zone in which the fire or elevated temperature condition has been detected.

2. A monitoring system is claimed in Claim 1, characterised in that the means for injecting a signal into the pair of conductors of, and for measuring the terminal voltage of, the loop are housed at a central station that is remote from the discrete zones.

3. A monitoring system is claimed in Claim 1 or 2, characterised in that one or each end of the pair of elongate

electric conductors constituting the loop, or sectionalising means at said end of the pair, is indirectly connected to the means for injecting a signal into the pair of conductors of, and for measuring the terminal voltage of, the loop by fire-resistant cable or other non-sensing cable.

4. A monitoring system as claimed in any one of the preceding Claims, characterised in that adjacent discrete zones of the loop are interconnected by fire-resistant cable or other non-sensing cable connected in series in the loop.

5. A monitoring system as claimed in Claim 4, characterised in that interconnecting non-sensing cables are regarded as separate zones.

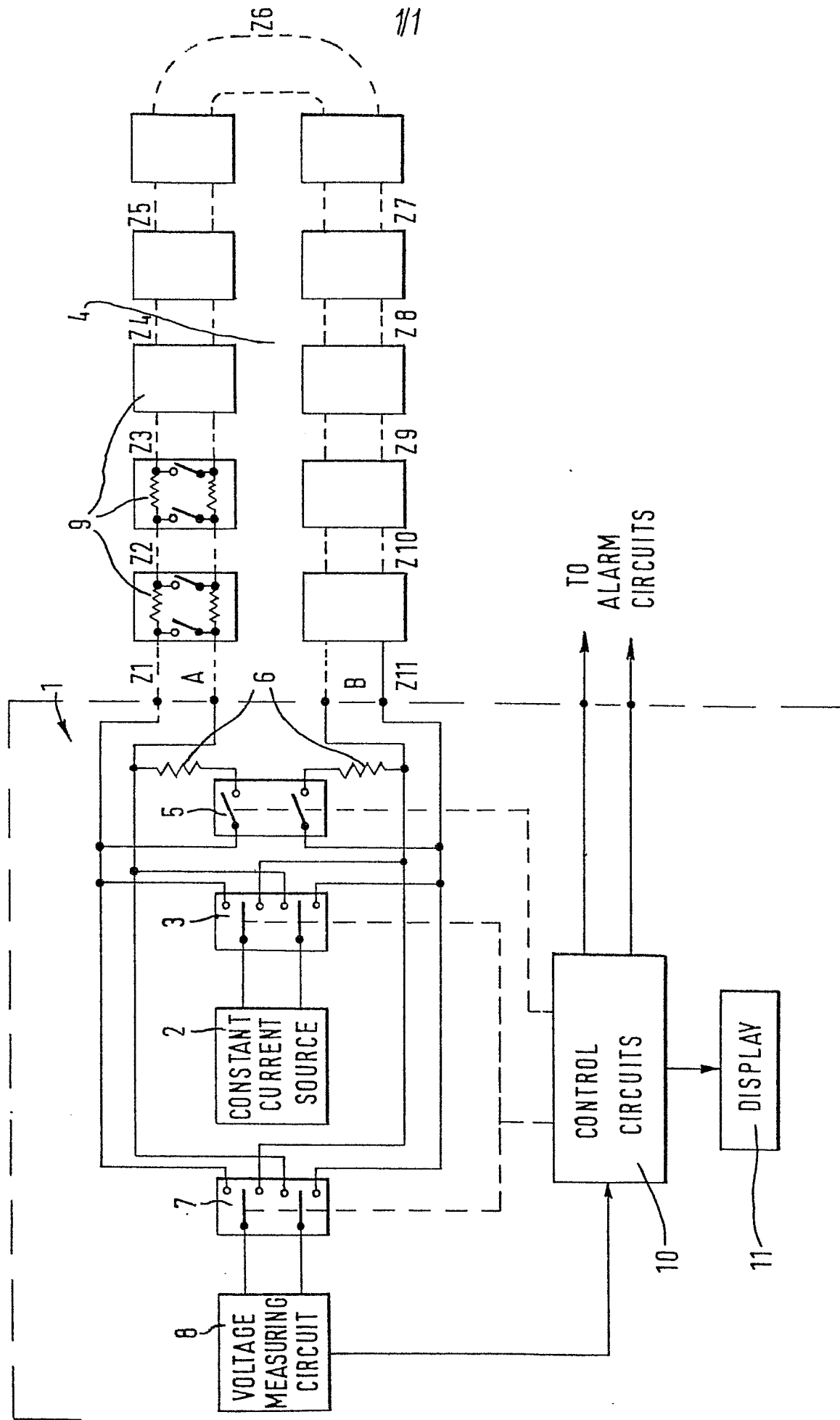
6. A monitoring system as claimed in any one of the preceding Claims, characterised in that each means for sectionalising the length of the pair into a plurality of discrete linear sensors connected in series comprises a pair of balanced resistors, one resistor of the pair of resistors being connected in series in one of said pair of conductors and the other resistor of the pair being connected in series in the other conductor of said pair of conductors.

7. A monitoring system as claimed in any one of the preceding Claims, characterised in that the pair of elongate conductors of the loop is a component part of an electric cable.

8. A monitoring system as claimed in any one of the preceding Claims, characterised in that the means for injecting a signal into the pair of conductors is a constant current source.

9. A monitoring system as claimed in any one of Claims 1 to 7, characterised in that the means for injecting a signal into the pair of conductors is a constant alternating current source having a frequency in the range 30 to 70 c/s.

10. A monitoring system as claimed in any one of the preceding Claims, characterised in that the system includes two or more than two separate loops, each loop comprising a plurality of discrete linear sensors connected in series and having its own means for injecting a signal into the pair of conductors of the loop and for measuring the terminal voltage of the loop, and a master controller which controls each of said means and which is connected to an audible and/or visual alarm for signifying the existence of a fire or other unacceptable elevated temperature condition and/or a device for indicating the discrete zone in which the fire or other elevated temperature condition has been detected, the alarm and/or device being connected to all of said loops.





DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
	<u>US - A - 3 277 457</u> (HERMAN) * Column 1, line 66 - column 3, line 36 * -- <u>GB - A - 811 169</u> (EKMAN) * Page 1, lines 8-50; page 1, line 67 - page 2, line 41; page 3, lines 12-68; page 4, lines 25-34 * -- <u>US - A - 2 452 942</u> (LORD) * Column 1, lines 1-10; column 5, line 3 - column 6, line 31 * -- <u>GB - A - 1 266 424</u> (GENERAL ELECTRIC CO.) * The whole document * -- <u>FR - A - 2 205 664</u> (EURATOM) * Page 1, lines 1-8, 29-34; page 2, line 15 - page 3, line 3. * ----	1-4 1-4,6 1-4 1,6 1,3,4,7	G 08 B 17/06 G 08 B 25/00 TECHNICAL FIELDS SEARCHED (Int.Cl. ³) G 08 B 17/06 G 08 B 25/00 CATEGORY OF CITED DOCUMENTS X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons &: member of the same patent family, corresponding document
The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
The Hague	22-02-1980	ORNELIS	