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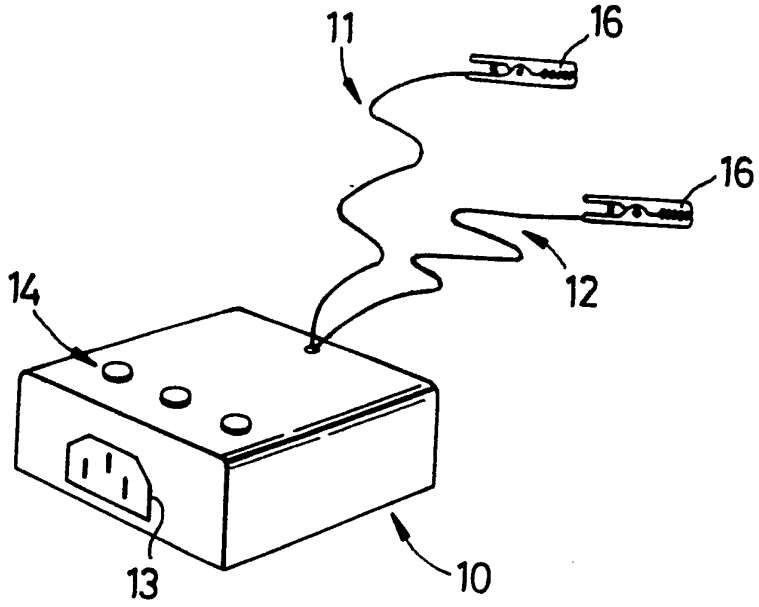

(57) Abstract

An anti-static and safety apparatus comprises a standard 3-lead equipment socket (13), means (10) for detecting and indicating (lights 14) any voltage faults on the socket, and a pair of flying leads (11 and 12) connected to the earth of the connector and each having a crocodile clip (16) or the like at its free end. This is used for servicing electronic equipment which is sensitive to "static". The apparatus is first connected to the power cord of the equipment to be serviced. Then, if the apparatus does not indicate any main faults, the engineer puts on the standard anti-static wristband, puts the equipment to be serviced on an anti-static mat, removes the covers of the equipment, and ensures that the wristband, the mat, the equipment, and the flying lead of the present apparatus are all connected together. In a modified form, the apparatus includes a 3-pin mains plug so that it can be connected directly to the main.

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ANTI-STATIC SAFETY APPARATUS

This invention relates to apparatus for use in servicing sensitive electronic equipment.

Modern electronic equipment generally utilizes some form of integrated circuit devices. These have high reliability in normal use. However, they normally operate at voltages of less than 10 V, and are liable to destruction or damage (which is worse, because it leads to early failure and the need for servicing and repair) if exposed to high voltages. Obviously, this is unlikely in normal use, but it is unfortunately not unlikely during the distribution, installation, servicing, or other handling of these devices, when voltages high enough to cause such damage or destruction can readily arise as "static".

Various techniques have therefore been developed for minimizing the chance of damage to such components by static. These include such measures as, for example, packing items such as chips and circuit boards in conductive packaging.

The servicing of equipment is a major area where the prevention of damage to components by static is required. Much servicing necessarily occurs in the field, where the ambient conditions cannot be readily controlled. A system has been developed for such conditions in which a wrist strap is worn by the service engineer with a lead which can be attached to a

suitable earth. A conductive work mat is provided, for parts, tools, etc. to be placed on, and the lead has a connector part way along it for connection to the mat. The lead includes resistors giving resistance of about 1 Mohm and has crocodile or bulldog type clip ends which are insulated, so that if the engineer should accidentally touch something live (at mains voltage), the resulting shock will not be dangerous.

This system is satisfactory as long as a satisfactory earth is available. The instructions provided with one widely used example of this system state:

> "Connect the shorter section of the ground cord assemnly to a reliable ground, either by the banana plug or by the bulldog clip. Note: Water pipes, unpainted equipment frames, electrical conduit, and building frame members are generally good ground locations."

However, there are many situations in which none of these grounds are available. Many buildings have heating systems which do not involve exposed water pipes; with the advent of plastic piping, water pipes cannot reliably be assumed to be good earths; many items of equipment, such as personal computers and work stations, do not have metal frames which can be taken

as earthed; many buildings, particularly office accommodation, do not have exposed electrical conduit; and few buildings have accessible building frame members.

The one component which is almost invariably present and which provides an earth is the mains electrical supply, and this is therefore often the only practicable earth. However, although the earth of a 3-wire mains electrical supply ought to be a good earth, we have found that in practice, this is not always so. We have found instances where, due to a fault in the wiring of a building, the nominal earth of the mains supply is in fact at a voltage of roughly a third of the mains voltage. Also, even if the earth of the supply is good, a particular socket may be wired up incorrectly, with the earth either not connected or even connected to the live line; and although incorrect wiring of a mains socket may be relatively rare, the supply near the equipment to be serviced (or the location where it is convenient to service the equipment) may not be a mains socket but provided by one or more extension leads (such as a multi-way extension socket block), which multiplies the possibilities for incorrect wiring.

Faced with the absence of any convenient earth of a type described in the above-quoted instructions, a service engineer may choose to use the mains supply earth, thereby being exposed to the risk that that earth may be either defective or even actually live.

The use of a mains earth also presents a minor but irritating problem, in that it is not directly accessible. If a spare socket is available, then it may be possible to insert a small screwdriver into its earth and connect to that by a crocodile clip. However, that has obvious disadvantages, and is not to be recommended. Another possibility is to leave the mains connected to the equipment being worked on (or reconnect the mains once the covers have been removed), leaving the equipment switched off, and using the frame of the equipment as earth. This assumes that the frame of the equipment is connected either to earth or to neutral. However, even if this is the case, this method has the danger that in some equipment, the mains switch is a two-pole switch (switched live and neutral) and the live pole may be faulty, leaving the equipment live even though its mains switch is off.

Instead of using a mains earth, the engineer may choose to use a so-called "soft" or "floating" earth. In this, the equipment and the engineer are connected to a floor and/or bench mat, but there is no connection to true earth. This technique

ensures that the engineer, the equipment, and any components being used are all at the same voltage. However, it involves dangers if any casual contact with true earth should occur. If that happens, a large voltage spike may result because the "floating earth" system may in fact be at a high (static) voltage relative to true earth. Similar dangerous spikes can also occur simply as the result of someone else touching the engineer or even merely passing close by.

There is therefore a need for a safe anti-static system which overcomes the various disadvantages discussed above.

According to one aspect, the present invention provides an anti-static and safety apparatus comprising a standard 3-lead equipment connector, means for detecting and indicating any voltage faults on the connector, and at least one flying lead connected to the earth of the socket and having a crocodile clip or the like at its free end. In one preferred form, the present apparatus thus consists essentially of a socket which matches the standard socket used on electronic equipment, means for signalling any mains fault and at least one flying earth lead.

There are two types or standards of mains power "connectors" used for power at "domestic" levels (up to the region of 10 A). One type is the socket generally provided as

a fixed building installation; in the UK, this is now the standard 13 A "square pin" socket (with corresponding plug). The other type is the socket which is often provided on a piece of electrical or electronic equipment; this is currently an international standard (IEC 320) socket (with corresponding plug). Very many types of electronic equipment are fitted with built-in IEC plugs, and such equipment is connected to the mains supply by means of a cable having (for UK use) a 13 A square pin plug at one end and an IEC plug at the other end.

The preferred embodiment of the present apparatus is primarily intended for use with such equipment; and thus cannot be used with equipment which has a built-in mains lead with a 13 A square pin plug on the end. This preferred embodiment functions as a substitute for the equipment, in the sense that the mains connection is transferred from the equipment to the present apparatus. We can term this the IEC-socket embodiment.

However, an alternative type of embodiment is also feasible, in which the present apparatus in effect replaces the mains-plug-and-IEC-plug connector between the mains and the equipment. This type of embodiment thus has a 13 A square pin plug. It may also optionally have an IEC plug, so that it can also be connected to the equipment and thus allow the equipment to be powered up for certain types of testing and servicing. (Alternatively, it may have a 13 A square pin socket, so that

the equipment can be connected using the existing mains-plug-and-IEC-plug connector.) We can term this the mains-plug embodiment.

Obviously, in countries other than the U.K., the appropriate type of mains plug would be used instead of the U.K. 13 A square pin plug.

According to another aspect, the present invention provides a method of servicing electronic equipment which is sensitive to "static", comprising an initial step of connecting the apparatus just defined to the mains supply, and then, if the apparatus does not indicate any mains faults, the subsequent steps of the engineer ensuring that the standard anti-static wristband, the standard anti-static mat, the equipment, and the flying lead of the present apparatus are all connected together.

An IEC-socket embodiment of the invention will now be described, by way of example, with reference to the drawings, in which:

Fig. 1 is a perspective view of the apparatus, and

Fig. 2 is a block diagram of the circuitry of the apparatus.

Fig. 3 shows the manner in which the apparatus is used.

As seen in Fig. 1, the apparatus consists of a unit 10 having two insulated flying leads 11 and 12 coming from it. The unit 10 has a standard IEC socket 13 and a set of indicator lights 14.

As shown in Fig. 2, the two flying leads 11 and 12 are connected to the earth line of the plug 13. All three leads of the plug 13 are also connected to a sensing circuit 15 which includes the indicator lights 14.

The socket 13 of the apparatus is identical to the socket of the electronic equipment which the present apparatus is intended to be used in conjunction with. That equipment will normally be powered by a cable having a 13 A plug on one end and an IEC plug on the other end, connecting the equipment to a 13 A mains socket. To service the equipment, the cable is unplugged from the equipment (while being left plugged into the mains) and plugged into the present apparatus.

The sensing circuit 15 senses the voltages between the live, neutral, and earth lines at the socket 13, and energises the indicator lights 14 in a manner which indicates whether the N and E lines are at the same voltage and the L line at a

different voltage (correct), or whether there is some fault condition. GB patent 1 261 518 shows suitable circuitry for this.

The indicator lights 14 will therefore indicate whether the mains supply at the plug of the power supply cable to the equipment is sound. If it is, then the flying leads 11 and 12 are known to be at true earth, and can be connected with confidence to the equipment and the engineer. If, however, the indicator lights 14 indicate that there is a fault, then it is not safe to use the E line of the plug of the power cable as an earth. The power supply must then be checked and corrected before servicing of the electronic equipment can start.

The procedure for using the present apparatus is therefore as follows. The equipment being serviced is logged off, switched off, and disconnected from the mains power supply (if it is not already in this state). The present apparatus is connected to the IEC plug on the equipment end of the power supply cable to the equipment. Assuming that the mains supply is indicated as being correct, the engineer puts on the standard anti-static wristband, and attaches the intermediate connector of the attached earthing lead to the standard anti-static mat. The covers of the equipment are then removed, and the flying

lead of the present apparatus and the end of the standard anti-static earthing lead are both connected to the chassis of the equipment.

The wristband may be permanently connected to its flying lead if desired.

Provided that the equipment is powered through an IEC plug, the present apparatus can always be used; there is no need for any additional connection to the building power supply or any other earth, because the present apparatus uses the earth which is automatically available at and normally used by the equipment itself. It will be realized that the present apparatus actually performs a check of the power supply all the way to the equipment, including any extension leads, multi-way distributors, and the like which may be used.

The physical form of the apparatus can obviously be varied widely. For example, the socket 13 may be connected to the main body 10 of the apparatus by a flexible cable, and the sensing circuit 15 may be detachable from the rest of the apparatus (e.g. by means of a 13 A plug and socket). In the mains-plug embodiment in which the apparatus includes a standard mains plug (13 A square pin in the U.K.), the sensing circuit 15 and indicatior lights 14 may be built into the plug body.

Also, there may be only one flying earth lead. The flying lead or leads may be made disconnectable, though this has the disadvantage that they may be lost.

The IEC-socket apparatus preferably also includes an IEC plug, connected to the socket 13 via a flexible cable. This enables the equipment to be powered while it is being serviced, if that proves necessary, by inserting the plug of the present apparatus into the socket of the equipment, without interfering with the earthing of the engineer. The mains-plug embodiment may similarly include a mains socket, so that the equipment being serviced can be powered up by having its mains leads plugged into the present apparatus.

A flying lead connection is, as noted above, preferably made to the chassis of the equipment being serviced. As noted above, the equipment may have a two-pole mains switch and the live pole may be faulty, in which case the equipment will be live when its mains switch is off. If the present apparatus includes an IEC plug, so that the equipment being serviced can be powered through the apparatus, the sensing circuitry may also include means for detecting an earth leakage current through the (or either) flying lead. Such a mains switch fault will then be immediately indicated. The apparatus may also incorporate a

circuit breaker which breaks the power to the IEC plug in response to signals on the flying leads; such circuit breaker may be either voltage or current sensitive.

The or each flying earth lead may include a suitable resistor (of the order of 1 Mohm). It is preferred, however, not to do this, because the leads would then not be true earth leads. To avoid the danger of the engineer receiving a shock while connecting the flying leads, the crocodile clips at their ends are preferably insulated, so that the engineer will not come into contact with any part of the lead while making the connections. The insulation of the or each flying lead is preferably of standard earth lead colouring (green and yellow in the UK).

It will of course be realized that different or more elaborate electronic circuitry can be used for the sensing circuitry. For example, the state of the supply may be indicated in various ways and by various means, such as neon lights, LCDs, or LEDs (in which case red can be used for fault conditions and green for safe conditions). The sensing circuitry may be arranged to monitor the mains voltage and indicate a fault if that voltage is substantially different from the proper value. The apparatus may also be arranged to monitor the mains and flying lead conditions continuously, and give a warning if any significant change should occur while

equipment servicing is proceeding. The apparatus may use flashing and/or audible signals to signal fault conditions, particularly faults which occur after the initial connection of the apparatus.

The apparatus may be combined with meter means which indicate voltage, current, resistance, and/or power. (Resistance and power measurement are broadly equivalent to current measurement, since the voltage is fixed at the main voltage.) For example, the voltages L-N, L-E, and N-E of the power supply may be automatically indicated in succession, with the apparatus then changing automatically to a current metering mode (assuming that the voltages are within acceptable limits). The provision of current measurement is advantageous for servicing some types of equipment, since current levels and variations can give useful indications of, e.g., the behaviour of drive motors and the mechanisms driven by them in some types of printer.

Such current measurement can be electromechanical (moving coil or moving iron) or electronic. If the measurement is electronic, a digital display may be used, and the apparatus may be programmed for a variety of functions, e.g. manual or automatic self-testing, range selection, and/or synthesized speech output for signalling fault conditions.

Fig. 3 shows one way of using the IEC-socket form of the apparatus 10. A service engineer 20 wants to service a piece of electronic equipment 21, which would normally be powered by a lead 22 (shown partly by a broken line) plugged into a mains wall socket 23. The normal procedure uses an anti-static mat 24 provided with two leads 25 and 26 from a connection point 27. Lead 25 is attached to a wristband 28 on the engineer 20's wrist, and lead 26 is attached to the equipment 21. Although this ensures that the engineer, the mat (which is used for placing tools and spare components on), and the equipment are all at the same voltage, they are nevertheless floating. This is undesirable, as discussed above. This can be overcome by leaving the equipment plugged in to the socket 23, but this is also undesirable, as discussed above.

With the present apparatus, these disadvantages can be eliminated. For this, the engineer first unplugs the equipment 21 by disconnecting the lead 22 from it, and plugs the IEC plug on the free end of this lead into the IEC socket 13 (Fig. 1) of the present apparatus 10. He then looks at the lights 14 on the apparatus 10, to check that the three terminals L (live), N (neutral), and E (earth) of the IEC plug of the lead 22 are correctly connected. Having verified that, the engineer then connects the flying lead 11 of the apparatus 10 to the equipment

21. By this means, the presence of a sound earth is first verified and that earth is then used to earth the engineer, the mat, and the equipment.

It will be realised that the equipment, the engineer, and the mat can be connected together in various ways, and the flying lead 11 can be connected to any of them. As shown, the leads 25 and 26 contain high value resistors 29; however, the lead 11 can contain a high value resistor 29', as shown in broken lines. Further, the lead 26 can be absent, in which case the second flying lead 12 (not shown in Fig. 3) could be connected to the connection point 27 of the mat 24. Preferably, however, the high value resistor 29 of the lead 26 is retained, and the lead 12 is connected to that. The apparatus 10 may also be permanently connected to the wristband and/or the mat.

If the apparatus 10 has an IEC-plug lead (shown broken at 30), this can then be used to plug into the equipment 21 to power it up during servicing if that is necessary.

The mains-plug form of the present apparatus would be used similarly, except that the equipment lead 22 would be unplugged from the mains socket 23 instead of from the equipment 21 and the present apparatus would be plugged directly into the mains socket 23.

CLAIMS

1. An anti-static and safety apparatus comprising a standard 3-lead equipment connector, means for detecting and indicating any voltage faults on the connector, and at least one flying lead connected to the earth of the connector and having a crocodile clip or the like at its free end.

2. Apparatus according to claim 1 including also a standard 3-lead equipment plug.

3. Apparatus according to either previous claim including a second flying lead.

4. Apparatus according to any previous claim wherein the or each flying lead is insulated with standard earth lead colouring and the crocodile clip or the like at the end is insulated.

5. Apparatus according to any previous claim wherein the means for detecting and indicating voltage faults is responsive to (a) a live earth line, and (b) a live neutral line.

6. Apparatus according to any previous claim including also a second connector such that equipment being serviced or tested may be connected to the mains via the present apparatus.

7. A method of servicing electronic equipment which is sensitive to "static", comprising an initial step of connecting apparatus according to any previous claim to the mains supply, and then, if the apparatus does not indicate any mains faults, the subsequent steps of the engineer ensuring that the standard anti-static wristband, the standard anti-static mat, the equipment, and the flying lead of the present apparatus are all connected together.

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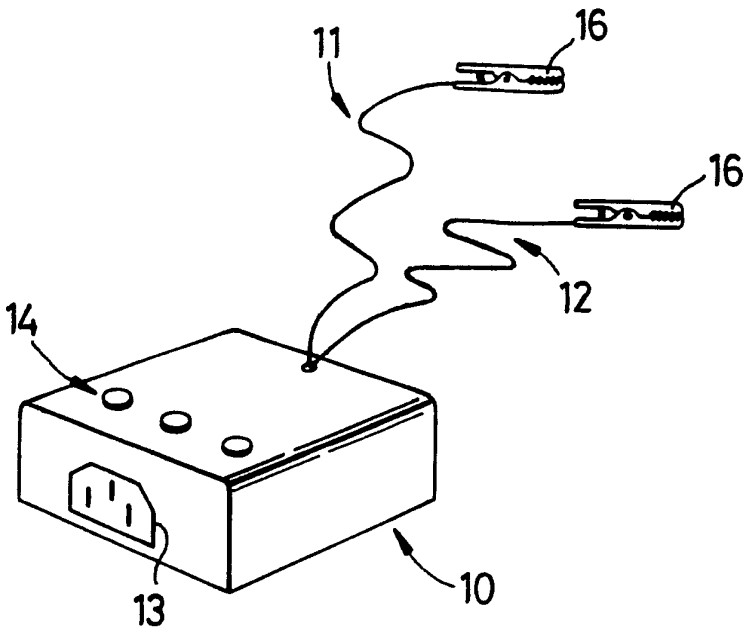

Fig. 1

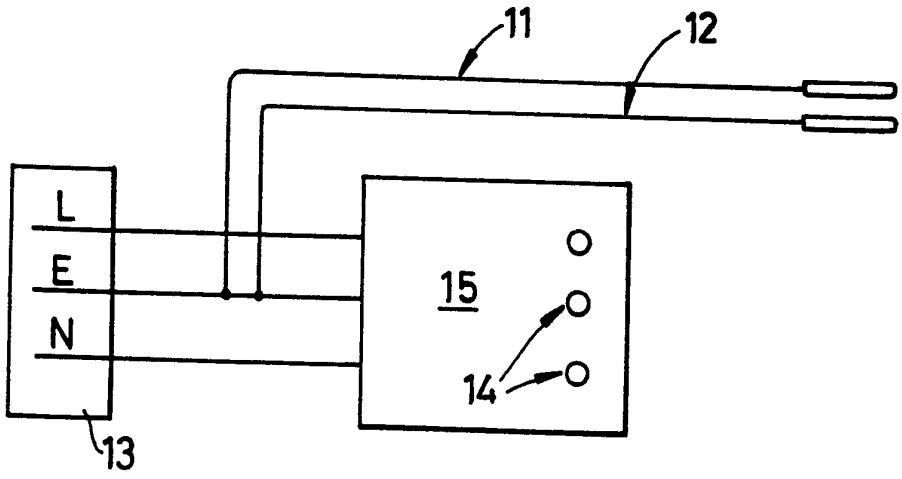

Fig. 2

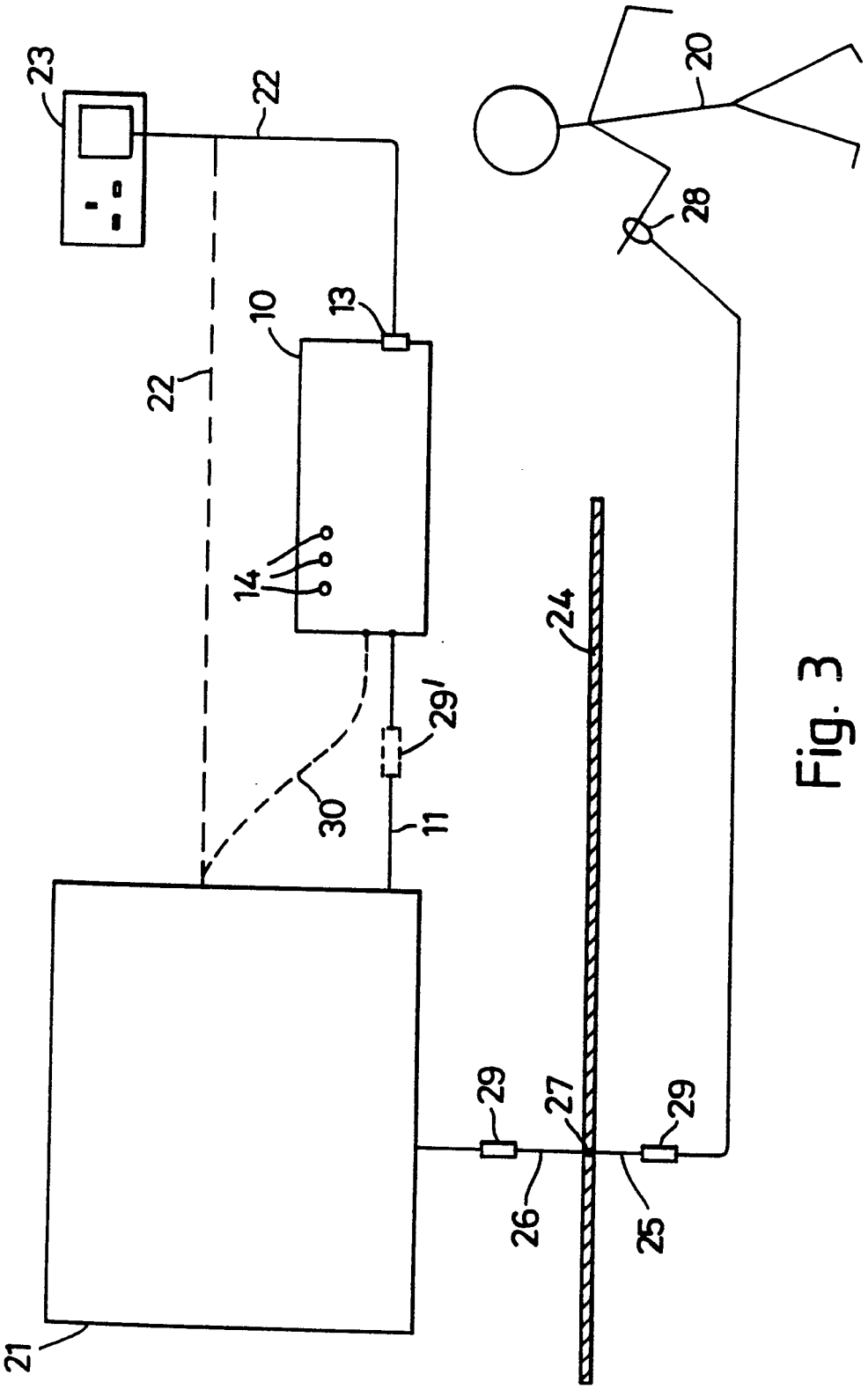

Fig. 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 91/00419

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 H05F3/02

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	H05F ; 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]
A	GB,A,2199707 (INDEPENDENT TELEVISION NEWS LTD) 13 July 1988 see page 1, line 1 - page 2, line 17; figure 1 ---	1, 5, 6
A	DE,U,8806250 (LOKOSANA AG) 17 November 1988 see page 6, paragraph 5 - page 7, last paragraph; figures 1, 2 ---	1, 2
A	US,A,4580188 (BROWN ET AL) 01 April 1986 see column 2, line 48 - column 3, line 52; figure 1 ---	1
A	FUNKSCHAU. vol. 58, no. 24, November 1986, MUNCHEN DE pages 74 - 75; Laudahn: "Erden ohne Gefahr" see the whole document ---	1

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
28 AUGUST 1991	12 SEP 1991
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	WOODALL C.G.

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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

GB 9100419

SA 48804

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
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB-A-2199707	13-07-88	GB-A,B 2167618	29-05-86
DE-U-8806250	06-10-88	CH-A- 677423	15-05-91
US-A-4580188	01-04-86	None	