(12) PATENT (11) Application No. AU 199921446 B2
(19) AUSTRALIAN PATENT OFFICE (10) Patent No. 749079

(54) Title
Power converter

(51)^{6} International Patent Classification(s)
H02M 007/00

(21) Application No: 199921446 (22) Application Date: 1999 .01 .26

(87) WIPO No: WO99/39428

(30) Priority Data

(31) Number	(32) Date	(33) Country
98870015	1998 .01 .28	EP

(43) Publication Date : 1999 .08 .16
(43) Publication Journal Date : 1999 .10 .21
(44) Accepted Journal Date : 2002 .06 .20

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(56) Related Art
EP 119134
DE 4232763
DE 19603224

21446/99

PCT ORGANISATION MONDIALE DE LA PROPRIETE INTELLECTUELLE
Bureau international

DEMANDE INTERNATIONALE PUBLIEE EN VERTU DU TRAITE DE COOPERATION EN MATIERE DE BREVETS (PCT)

(51) Classification internationale des brevets ^{6} :
H02M 7/00
A1

(11) Numéro de publication internationale: **WO 99/39428**

(43) Date de publication internationale: 5 août 1999 (05.08.99)

(21) Numéro de la demande internationale: PCT/BE99/00011

(22) Date de dépôt international: 26 janvier 1999 (26.01.99)

(30) Données relatives à la priorité:
98870015.9 28 janvier 1998 (28.01.98) EP

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

Publiée
Avec rapport de recherche internationale.

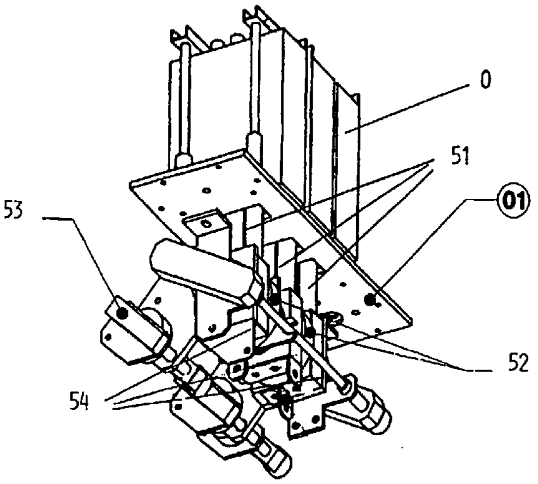
IP AUST
16 AUG 1999
RE

(54) Title: POWER CONVERTER

(54) Titre: CONVERTISSEUR DE PUISSANCE

(57) Abstract

The invention concerns a power converter powered by voltage successive feed (Ucat) consisting of insulated gate bipolar transistor (IGBT) static switches, in the form of at least an IGBT module (10) directly fixed on a cooling block (14) which is itself connected to fins (0) or the like. The invention is characterised in that an insulation (13) is provided between the cooling block (14) and the fins (0) and the cooling block (14) whereon the IGBT module(s) (10) is/are fixed is connected to a potential intermediate between the fins (0) potential and the peak of the power converter successive feed (+Ucat).



(57) Abrégé

La présente invention concerne un convertisseur de puissance alimenté par une tension d'alimentation continue (Ucat) composé d'interrupteurs statiques du type IGBT, se présentant sous la forme d'au moins un module IGBT (10) directement fixé sur un bloc refroidisseur (14) lui-même relié à des ailettes (0) ou similaires, caractérisé en ce qu'une isolation (13) entre le bloc refroidisseur (14) et les ailettes (0) est prévue et en ce que le bloc refroidisseur (14) sur lequel sont fixés le ou les modules IGBT (10) est relié à un potentiel intermédiaire entre le potentiel des ailettes (0) et le point haut de la tension d'alimentation (+Ucat) du convertisseur de puissance.

POWER CONVERTER

Subject of the invention

The present invention concerns a device such as a power converter or a converter module made up of static switches themselves comprising a set of semiconductors. Examples of power converters are choppers and inverters.

Technological background of the invention

Inverters, and more particularly voltage inverters, are intended to provide an AC voltage from a DC voltage.

A particularly important field of application is the variable-speed control of synchronous or asynchronous machines.

In this case, it is necessary for the load, which may be represented by each phase of a synchronous or asynchronous motor, to be provided with a three-phase voltage system which is as close as possible to a frequency-varying and amplitude-varying balanced sinusoidal three-phase system. The voltage inverter is a device which makes it possible to achieve this goal, and which generally uses arrangements of power components such as thyristors, GTOs, etc.

Recently, new types of static switches have been appearing which may be defined by the term "IGBT" (Insulated Gate Bipolar Transistor). These devices are controllable components, in the sense that one can at any moment prescribe the current required in the switch by adjusting the voltage on its control gate, whereas for the old generation of switches represented for example by GTOs or the like, it is only possible to decide the moment at which they turn on and the moment at which they turn off.

This implies, according to the prior art, that is to say in the case in which only GTO-type semiconductors are used to produce the inverters, that they cannot be used without an associated protection circuit (snubber circuit) which makes it possible to control the overvoltages across their terminals. Indeed, if such were not the case, they would be destroyed at the first switching owing to the overvoltages induced by the parasitic inductances of the wiring.

On the other hand, in the case of switches formed from IGBT semiconductors, it will be possible to dispense with a protection circuit. Indeed, by switching the current as rapidly as possible so as to reduce losses and by avoiding the creation of prohibitive overvoltages, it will not be necessary to add this protection circuit.

Nevertheless, to be able to reach these limits and make the most use of the IGBT component, it is necessary for the inductances of the wiring to be reduced to very low values, this again being difficult to achieve with conventional housings such as those used for GTO-type semiconductors.

IGBT semiconductors are usually arranged in module form. In practice, the IGBT semiconductors and their anti-parallel diode are placed in the same housing. The construction of the housing must be such that it also minimizes the internal parasitic inductances within the housing and allows internal connection by busbar, which will minimize the parasitic inductance of the wiring.

According to the prior art, these modules have a baseplate which serves for mechanical mounting onto a heat sink. The baseplate is electrically insulated from the semiconductors, and hence also from the power and control connecting terminals. Thus, the module can be fixed to a heat sink which is itself connected to earth.

The insulation of the modules should be designed to correspond to the voltage of the supply network for which it was designed. In a particular example, the 3300 V diodes and IGBT modules currently possess insulation adapted to the 1500 VDC networks.

Nevertheless, in the case of the use of a nominal power supply voltage of 3000 VDC, it is observed that this insulation as well as the voltage rating are insufficient. As far as the voltage rating is more particularly concerned, a proposal to place the semiconductors in series has already been envisaged for solving this problem.

However, placing the semiconductors in series solves only the problem of voltage rating and not the problem of the insulation of the IGBT modules. To be able to be used without particular precaution on a 3000 VDC network, it would be necessary to use IGBT modules with insulation provided for that purpose.

Objects of the invention

A first object of the present invention aims to solve this problem of insufficient insulation in the case of the use of insulated IGBT modules for a power supply voltage markedly lower than the real power supply voltage at which the converter operates. More particularly, the present invention aims to propose a converter which allows the use of insulated IGBTs for a voltage of 1500 VDC in the case of a nominal power supply voltage of 3000 VDC.

A second object of the present invention aims to propose a device which makes it possible to limit the damage to the converter in the event of an insulation defect either of the IGBT module, or of the insulated heat sink unit (cooling block) of the power converter.

A third object of the present invention aims to propose a process for detecting an insulation defect either of the IGBT module, or of the insulated heat sink unit of the power converter.

Other objects and advantages will become apparent in the description which follows.

Main characteristic elements of the invention

The present invention is related to a power converter such as a voltage inverter supplied with a DC power supply voltage (Ucat), this converter consisting of static switches of the IGBT type exhibiting the form of at least one IGBT module fixed directly to a heat sink unit itself connected to fins or the like, characterized in that insulation is provided between the heat sink unit and the fins and in that this heat sink unit to which the IGBT module or modules are fixed is connected to a potential intermediate between the potential of the fins and the top point of the power supply voltage (Ucat) of the power converter.

In a particularly simple way, it is possible to envisage arranging several IGBT modules on the same heat sink unit insulated from the fins.

According to a preferred embodiment, the setting to the intermediate potential is performed with the aid of a resistive divider.

According to a particularly preferred embodiment, a voltage peak-limiter which makes it possible to limit the voltage in the event of an overvoltage for example is associated with the IGBT modules.

The present invention also relates to a process for detecting a defect in the insulation either of the IGBT module or of the heat sink unit, characterized in that the intermediate potential is obtained via a voltage source in series with an impedance and is measured and compared with its theoretical value.

Description of the figures

Figure 1 represents a perspective view of an example of a module of a power converter like that used in the prior art.

Figures 2a and 2b represent a sectional diagrammatic view of an IGBT module as well as of a module of a power converter according to the present invention.

Figure 3 represents a perspective view of an exemplary embodiment of a power converter module according to the present invention.

Figure 4	represents a perspective view of a second embodiment of a power converter module comprising two times three (2x3) IGBTs.
Figure 5	represents the principle of operation and the application to modules with insulated heat pipes.
Figure 6	represents a device intended for the detection of an insulation breakdown.
Figure 7	represents a perspective view of a peak-limiter module which can be associated with the converter module as represented in Figures 3 and 4.

Description of several preferred embodiments of the invention

As already mentioned, the power converters customarily consisting of choppers and of inverters are devices which use static switches. These switches are themselves made up of a set of semiconductors such as thyristors, GTOs, IGBTs, etc.

Conventionally, these power converters require the use of a heat sink unit so as to remove the heat generated by the converter when operating. This heat sink unit is itself connected in a conventional manner, possibly by insulated tubes, to fins or to any other system having the same function. Examples of such heat sink units are described in Figures 4 and 5.

According to the prior art and as represented in Figure 1, a converter is made with the aid of several conventional switches 52, preferably of GTO type, cooled by insulated heat pipes. The insulated heat pipes consist of an evaporator unit 54 acting as a heat sink unit, each connected by a tube 51 to the fins unit 0.

Depicted is a stack of the various switches 52 and of the evaporator units 54 of the successive heat pipes. This stack is held under pressure by means of a suitable device 53 (clamp).

The other end of the insulated heat pipes 51 is connected to a fins unit represented diagrammatically by the reference 0.

The present invention aims to propose a device which uses IGBT modules whilst making it possible to solve the problem of the insulation rating for a power supply voltage markedly higher than the voltage for which the insulation of the IGBT module is designed. For the moment, IGBT components possess insulation adapted to the 1500 VDC network whereas in some applications, a power supply network voltage (Ucat) of 3000 VDC is used.

Figure 2a represents a basic diagram of an IGBT module. An IGBT module usually comprises several semiconductors 21 arranged on a baseplate 11. Usually, insulation 12 is provided so as to insulate the various semiconductors 21 and the control and connecting terminals 4 of the baseplate 11.

Figure 2b represents, in the form of a diagrammatic section, a converter module according to the present invention comprising one or more IGBT modules or housings 10 fixed to the hgeat sink unit 14, itself connected to the fins 0 so as to remove the heat generated by the IGBT housings while operating.

According to a first important characteristic of the present invention, additional insulation 13 outside the IGBT module 10 is provided between the fins 0 and the heat sink unit 14.

According to another important characteristic of the present invention, the heat sink unit 14 to which the IGBT module or modules 10 are fixed is connected to a potential intermediate between the potential of the fins 0, generally earth (0 V), and the top potential of the power supply of the power converter (+Ucat).

This advantageously makes it possible to guarantee insulation of the IGBT modules without their own insulation being overly stressed.

Furthermore, this additional insulation does not have to be dimensioned so as to withstand the entire voltage of the power supply network, but only to withstand the potential difference between the intermediate potential and earth (0 V).

Figure 3 represents a perspective view of a branch of a three-level inverter comprising two times two IGBT modules.

According to this embodiment, it is observed that the two pairs of IGBT modules 101, 102 on the one hand and 103, 104 on the other hand, face one another and are fixed to the same evaporator unit 14 of a heat pipe which is itself insulated from the set of fins 0. This arrangement allows easy and simple mounting which limits the space used as far as possible. This module forms a branch of a three-level inverter.

Figure 4 represents a perspective view of a module forming two branches of a three-level inverter comprising two times three (2×3) IGBT modules.

According to this preferred embodiment, three modules such as described in Figure 4 are associated with a rheostatic braking chopper module (not represented). In the case where the rheostatic braking function is not necessary, the braking chopper module can be replaced with a peak-limiter module such as represented in Figure 7.

Figure 5 describes the principle of operation of the device according to the present invention in a particular case of an application in respect of a converter module with insulated heat pipes, as represented in Figure 3.

The heat sink is of the heat-pipe type, its condenser, represented by a series of fins 0, is set to earth potential whilst the IGBT modules are fixed to the evaporator unit 14. According to the present invention, insulation 13 is provided between the condenser 0 and the evaporator 14. The evaporator unit 14 will be brought to a voltage which is half the input voltage of the converter, by means of a resistive divider.

The output voltage from the converter varies as a function of the state of the static switches of which it is composed, and lies between 0, which is the bottom potential of the converter, and U catenary, which is the power supply voltage of the converter. Likewise, the voltage on the terminals of the semiconductors also lies between the power supply voltage of the converter Ucat and 0. On the other hand, the voltage applied to the insulation 13 of the IGBT modules will lie between [-Ucat/2] and [+Ucat/2] and, in absolute value, will lie between 0 and Ucat/2.

Figure 6 shows how the detection of a breakdown in insulation may be performed. In the event of a breakdown in the insulation of an IGBT module or even of a heat pipe, the potential of the evaporator of the heat pipe will no longer be fixed solely by the resistive divider (R1, R2). It will a priori be different from the potential obtained by the resistive divider before the insulation breakdown. For this, it is sufficient to measure the value of the potential of the evaporator and to compare it with its theoretical value, which will be obtained for example via a resistive divider (R3, R4) with the same characteristics but which is not connected to the evaporator of the heat pipe, as represented in details in Figure 5. This will make it possible to detect the insulation defect easily.

Figure 7 represents a peak-limiter module which can be associated with one or more modules such as represented in Figures 3 and 4 so as to limit the voltage on the input capacitor. It should be noted that this peak-limiter possesses no heat sink. The latter is replaced with a straightforward plate to which are fixed the various IGBT modules. This plate is advantageously connected to a device for setting to potential according to the present invention.

CLAIMS

1. Power converter supplied with a DC supply voltage (Ucat) and composed of static switches of the IGBT type, exhibiting the form of at least one IGBT module (10) fixed directly to a heat sink unit (14) itself connected to fins (0) or the like, characterized in that insulation (13) is provided between the heat sink unit (14) and the fins (0) and in that the heat sink unit (14) to which the IGBT module or modules (10) are fixed is connected to a potential intermediate between the potential of the fins (0) and the top point of the power supply voltage (+Ucat) of the power converter.

2. Power converter according to Claim 1, characterized in that the setting of the heat sink unit (14) to the intermediate potential is performed at the average of the potentials of the fins (0) and of the top point of the supply voltage of the power converter (+Ucat).

3. Power converter according to Claim 1 or 2, characterized in that the fins (0) are earthed.

4. Power converter according to any one of the preceding claims, characterized in that the setting of the heat sink unit (14) to the intermediate potential is carried out by means of a resistive divider (R1, R2).

5. Power converter according to any one of the preceding claims, characterized in that several IGBT modules (10) constituting the static switches of the converter are arranged on the same heat sink unit (14).

6. Power converter according to Claim 5, characterized in that two pairs of IGBT modules (101, 102 and 103, 104) facing one another two by two, are arranged on the same heat sink unit (14), the heat sink unit (14) being a heat-pipe evaporator unit.

7. Power converter according to Claim 5, characterized in that a voltage peak-limiter (20) is associated with the IGBT modules (10).

8. Process for detecting a defect in the insulation of a power converter according to any one of the preceding claims, characterized in that the intermediate potential obtained preferably by a resistive divider (R1, R2) is measured and compared with its theoretical value obtained preferably by another resistive divider (R3, R4).

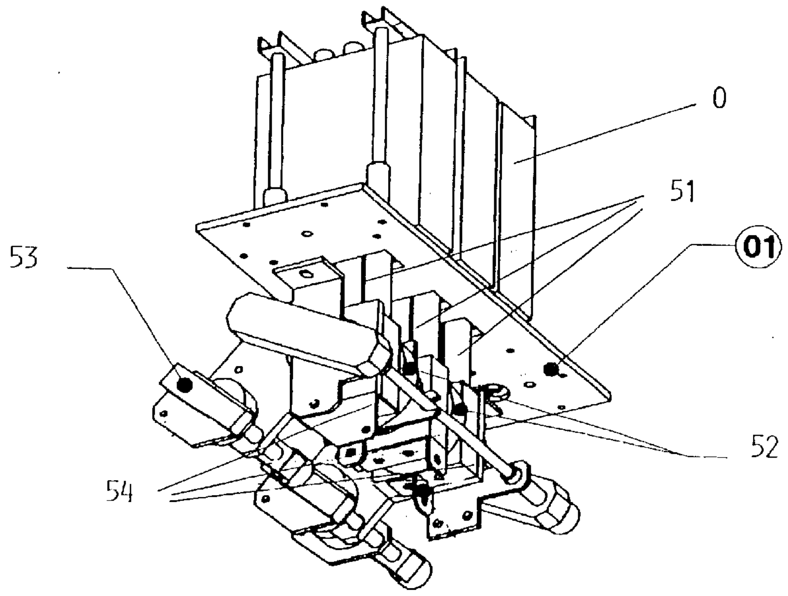


FIG.1

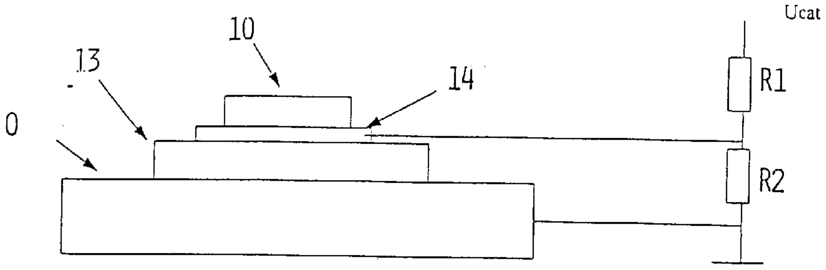


FIG.2b

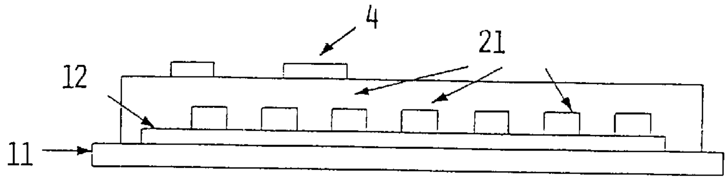


FIG.2a

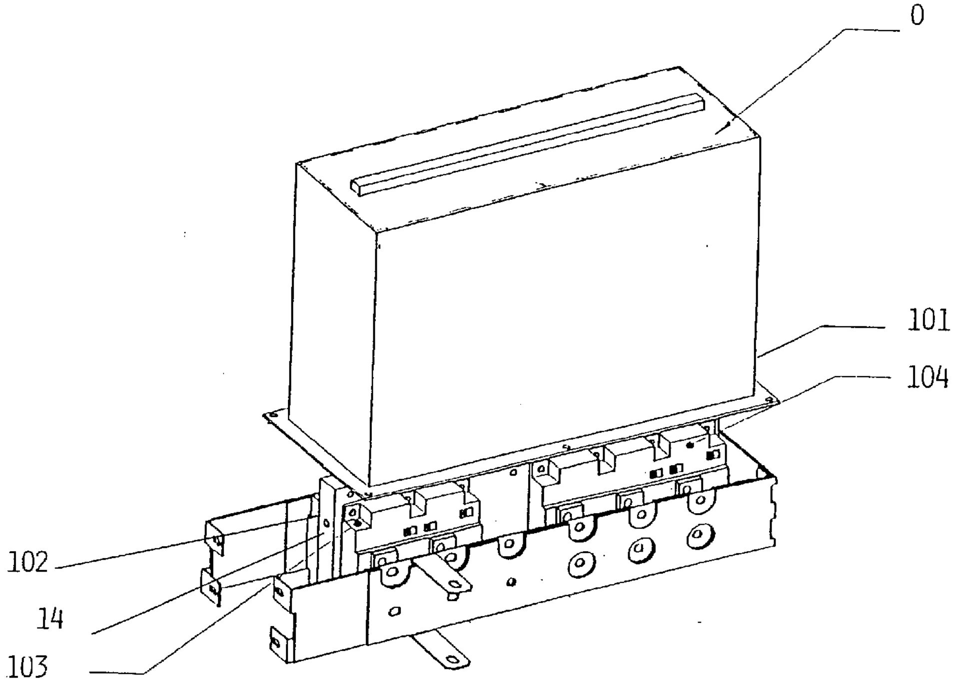


FIG.3

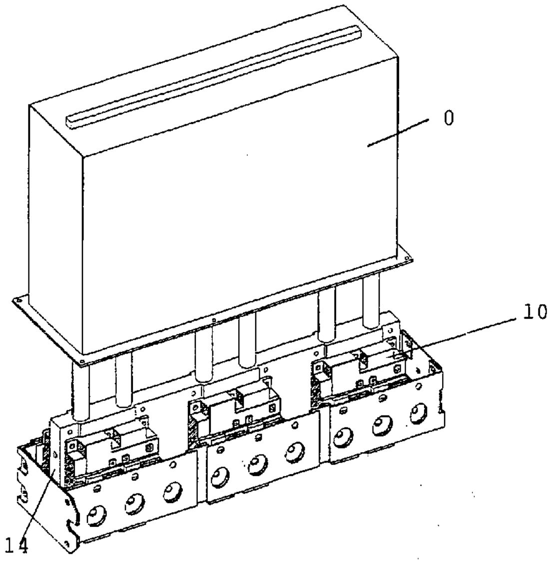


FIG. 4

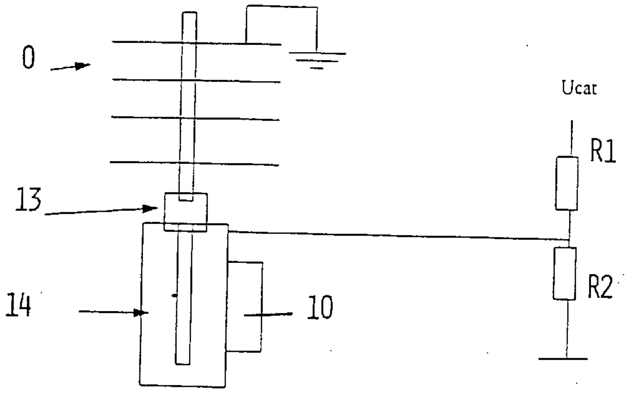


FIG. 5

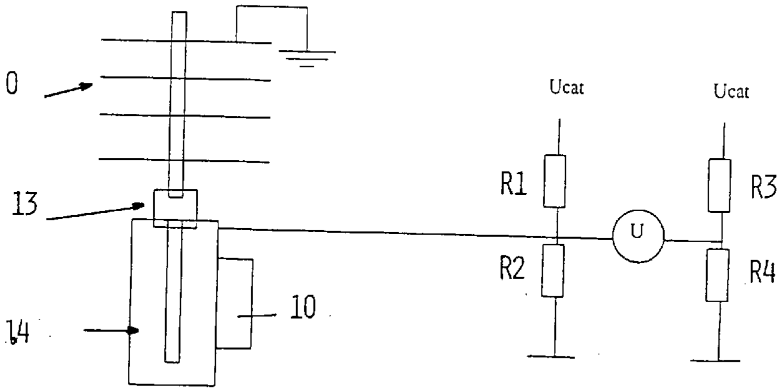


FIG. 6

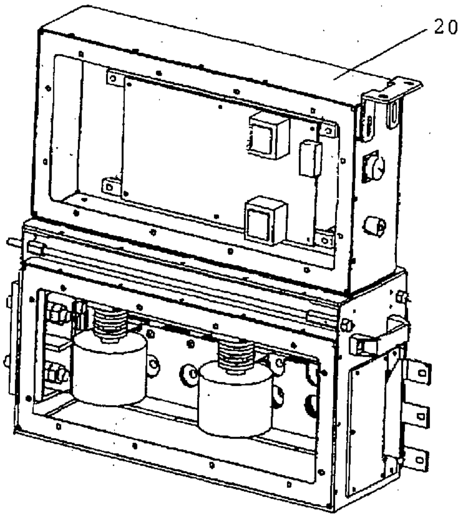


FIG. 7