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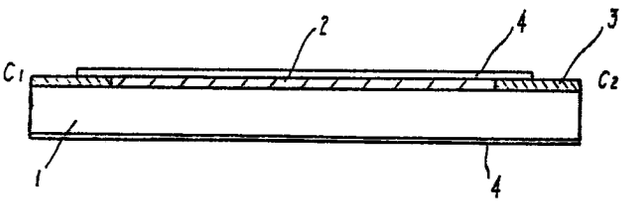
(54) Printed resistor, method for making same and application thereof.

(57) A conductive paint made up of an adhesive, a diluent and conductive particles is applied onto an insulating substrate (1) according to a certain pattern to form a resistive layer (2). The resistive structure so formed can be used in electronic and electric circuits, or as an electrical-thermal energy transforming apparatus.



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Printed Resistor, Method For Making Same And Application Thereof

The present invention relates to a printed resistor, the method for making same and the application thereof, and particularly, to a resistor manufactured by printing, the method for making the resistor and the application of the resistor to electronic and electric circuits.

Resistors and electrodes made of carbon particles, such as carbon resistors and carbon rods, have been commonly used in prior art, however, they are usually made into separated components with particular three-dimensional structures.

Although printed circuit boards have been widely used in electronic apparatus, yet, the printing method in such uses is mainly employed to form metal conductive patterns. The printing method is also used to manufacture thick-film devices, wherein the resistor components are involved, but thick-film techniques are applied to microelectronic circuits only.

In addition, electrical-thermal energy transforming apparatus in prior art have usually been provided with a resistance wire as the energy transforming component. When in operation, however, the local temperature near the resistance wire is very high, resulting in that heat is emitted unevenly. Therefore, if a relatively large area is desired to be heated evenly, a complicated structure will be required. Furthermore, the price of the metal resistance wire is high.

Accordingly, it is a main purpose of the present invention to manufacture a certain resistance pattern by printing a conductive paint on an insulating substrate, in which the paint comprises conductive particles, such as carbon particles, as the main resistance material, an adequate adhesive mixed with the conductive particles, and an adequate diluent for keeping the paint in proper dilution.

It is another purpose of the present invention to provide a method for manufacturing the printed resistor on an insulating substrate by way of printing, or spraying a paint made up of conductive particles, adhesive and thereon, or soaking the substrate in the paint.

It is a further purpose of the present invention to maunfacture printed resistors of different sturctures, resistance values, power rates and parameters of withstand voltage and temperature by way of adjusting properly the composition of the conductive paint and optimizing the design of the resistance pattern and the shape of the insulating substrate, so as to meet the requirements of application to electronic circuits, electric circuits, electrial-thermal energy transforming apparatus and the like.

The raw materials for manufacturing the printed resistor of the present invention comprise:

conductive particles of high resistivity, such as carbon particles, conductive compounds' particles and various kinds of metal particles, all of which will be called conductive particles hereinafter;

adhesive for adhering the above-described conductive

particles, such as resin adhesive, asphalt, plastic, waterglass or printing ink;

diluent for diluting the mixture of the above-described adhesive and conductive particles to form a conductive paint, which can be selected from water, gasoline and various kinds of resolvent to meet the needs of different kinds of adhesive;

an insulating substrate for recieving the above-described paint to form a resistance pattern of a certain configuration thereon, such as paper board, plastic substrate, ceramic substrate, asbestos board, glassfiber board, plaster tablet, wood board, clothes and the like;

a plurality of metal connectors attached to a certain position of the resistance pattern when necessary; and

a surface layer covering one or both sides of the insulating substrate for the purposes of insulating, sealing and/or decorating, such as plastic film, insulating paint, glassfiber clothe and the like.

The method for meanufacturing the printed resistor according to the present invention includes the follwoing steps.

a) Prepare a conductive paint by mixing the conductive particles, adhesive and diluent in a certain ratio. The conductive particles in the paint can be one kind of material, such as carbon, or a combination of different kinds of materials, such as carbon and metal particles. Changing the components of the conductive particles or the ratio of the conductive particles in the paint will result in the change of the resistivity of the resistance pattern finally

formed. The adhesive is mainly used to provide a secure adhesion of the conductive particles to the insulating substrate, and the ratio of the adhesive in the paint will also affect the resistivity of the resistance pattern finally formed. The diluent is employed to keep the paint in proper dilution in order to meet the requirements of the printing method selected. Since all of the diluent will finally evaporate, it does not affect the resistivity of the resistance pattern directively, yet, as the ratio of the diluent in the paint affects the thickness of the resistance pattern, it produces an indirect effect on the resistance value of the printed resistor. When water is used as the diluent, an adequate amount of drying agent, such as plaster stone or white cement, can be added to the paint.

b) Make the insulating substrate into a certain size and shape so that the prepared paint can be applied thereto to form the resistance pattern.

c) Form the configuration according to different methods employed for applying the paint, wherein the the selected method can be printing, spraying or soaking. When the printing method is selected, the relief printing plate or the screen pattern shall be pre-prepared according to predetermined configuration. When the soaking method is chosen, a mask pattern shall be formed on the insulating substrate by using an adequate kind of material, such as wax or paint, according to the desired configuration. When the spraying method is used, a mask board shall be prepared according to the desired configuration. The design of the configuration should enable the resistor obtained thereby to

reach the desired resistance value and to have a proper distribution on the substrate. The configuration can be designed into a conductive strip of a straight line or a curve line, and different values of resistance can be reached by varying the length and width of the conductive strip as well as by applying the conductive paint for several times to change the thickness of the conductive strip.

d) Form metal electrodes as connectors, before or after the applying of the conductive paint, at proper positions of the resistance pattern on the substrate by way of adhering thin metal sheets onto the appointed positions, or by using the conventional method for making the printed circuit board, with the number of electrodes on the substrate being two or more.

e) Employ an adequate method to apply the conductive paint prepared in Step a) onto the insulating substrate made in Step b) according to the configuration formed in Step c) so as to form the desired resistance pattern. The resistance pattern can be formed on one side as well as on both sides of the insulating substrate.

f) Make the substrate into particular shapes to meet different requirements of practical uses before applying the conductive paint or after applying the paint but before the paint dries. When a printing machine is employed, the shaping of the substrate and the applying of the paint can be performed simultaneously.

g) Package the substrate as required by the practical needs by applying insulating paint onto, or adhering plastic film or glassfiber clothe to the resistance pattern after it

is formed on the substrate so as to get the effects of sealing, insulating and/or decorating.

The printed resistor according to the present invention, as the term is used, includes all the resistors manufactured by printing, spraying, soaking or other mechanical or manual methods employing the above-described steps.

The advantages of the printed resistor of the present invention present themselves in that

many kinds of raw materials that cost little are available for the manufacturing of the present printed resistor to meet the requirements of different uses and environments;

the method for manufacturing the printed resistor is easy to carry out and is suitable for large-scale manufacturing;

the configuration of the printed resistor and the size and shape of the insulating substrate can have various designs to meet the requirements of different uses, therefore, the printed resistor of the present invention enables itself to be used widely;

the surface area of the printed resistor is significantly large, so is the area of heat radiation, and as a result, the printed resistor of the present invention is able to serve as an electrical-thermal energy transforming apparatus; and in that

the printing method provides great convenience for the printed resistor manufactured to be decorated on its surface with different colors and patterns.

Further advantages and active effects of the present invention shall come to light as the embodiments of the present invention are described with reference to the accompanying drawings, in which:

Fig. 1A is a plane view showing the printed resistor manufactured according to the method of the present invention;

Fig. 1B is a section view of the printed resistor taken along Line 1B-1B as shown in Fig. 1A;

Fig. 2 is a diagram showing an exemplary resistance pattern of the printed resistor used as a fluorescent lamp ballast; and

Fig. 3 is a diagram showing the printed resistor according to the present invention used either as a resistor array or as an electrical-thermal energy transforming apparatus.

Fig. 1A shows the printed resistor manufactured according to the method of the present invention, in which numeral 1 indicates the insulating substrate; numeral 2 indicates the resistance pattern formed by applying the conductive paint of the present invention; numeral 3 indicates the metal electrodes, and C_1 and C_2represent two connectors of the resistor, respectively. Fig. 1B is a section view taken along Line 1B-1B in Fig. 1A, wherein numeral 4 indicates the packaging layer covering the printed resistor after it has been manufactured for the purposes of insulating, sealing, and/or decorating.

The resistance value between C_1 and C_2 of the printed

resistor in Fig. 1A depends on the composition of the conductive paint, and the length, width and thickness of the resistance pattern. If the conductive paint is made up of graphite + waterglass + water, the ratio between the components is as follows:

graphite: waterglass: water=2.5(g):1.5(ml): 2.5(ml).

After being fully mixed together, the components described above are applied onto a substrate of paper board, forming thereon a resistance pattern with a length of 200 cm, a width of 4.5 cm and a thickness of 0.05 mm.

An aluminium sheet is attached to each end of the resistance pattern as a connector, and the actual resistance value measured after the resistance pattern is fully dried is in the order of 2.5 kΩ. It is understandable that changing the composition of the conductive paint, such as reducing the ratio of the graphite or partially replacing the graphite by insulating particles such as plaster stone, white cement or pigment, will increase the resistance value, while increasing the ratio of the graphite or adding some other conductive particles, such as metal particles, will decrease the resistance value. Similarly, changing the dimensions of the resistance pattern, such as that of the length, width and thickness, will bring about a change of resistance value, and in practice, the thickness of the resistance pattern can be increased by applying repeatedly the conductive paint onto the same pattern. The resistance value can then be varied significantly with the size of the area covered by the resistance pattern substantially unchanged. In practical situations, the printed resistor can be formed on both sides

of the insulating substrate.

The printed resistor shown in Fig. 1A can be used as a separated resistor element, and several similar printed resistors can be manufactured on a single printed circuit board or connection board to replace the conventional separated resistor components used in electronic circuits or electric circuits. A plurality of printed resistors of different resistance values can be manufactured on the same circuit board by changing the configuration of the resistance pattern and/or by applying repeatedly the conductive paints of different composition onto the same substrate (like the chromatograph method in printing techniques).

Fig. 2 shows another embodiment of the present invention. The design of the configuration shown in Fig. 2 can reach a relatively large resistance value in a relatively small area. The printed resistor shown in Fig. 2 can be used as a fluorescent lamp ballast to replace the conventional inductive ballast or resistive-capacitive ballast.

Fig. 3 shows yet another embodiment of the present invention, wherein C_1 to C_6 are six metal connectors located at different positions. Different resistance values can be obtained by varying connections of the corresponding connectors, for example, the largest resistance value between C_1 and C_2 (except open circuit) can be obtained when C_3 and C_4 are short connected, and if C_1 to C_4 are short connected together as one terminal, and C_5 and C_6 are short connected together as the other terminal, the equivalent resistance

value between the two terminals will be the smallest (except short out). It will be very convenient to get various resistor arrays by using designs of the resistance pattern and arrangements of the connectors similar to that shown in Fig. 3. Since the resistance value of the printed resistor is related to the configuration of the resistance pattern, an accurate design of the configuration and even applying of the conductive paint onto the substrate will provide an accurate ratio of the resistance values of the resistor arrays when connected by different ways.

The structure shown in Fig. 3 can be used conveniently as an electrical-thermal energy transforming apparatus (called as electrical-thermal apparatus hereinafter). As the printed resistor has a relatively large area of heat radiation, an even radiation of heat in a relatively large area can be realized by arranging adequately the resistance pattern on the insulating substrate while the heat acumulation on the resistor itself during operation is avoided. Moreover, if a thin substrate is used to form resistance patterns in staggered positions on both sides of it, there can be obtained on the whole substrate a highly even electrical-thermal energy transforming. The local temperature of the substrate will not be high (below 50°C) due to little heat accumulation on the substrate even if the power rate of the electrical-thermal apparatus is relatirely large, therefore to build such an apparatus does not demand much for the part of the materials to be used. When in practical uses that demand a higher temperature, a heat-resisting adhesive, such as waterglass, and heat-resisting

substrate, such as ceramic plate, asbestos board, plaster tablet or glassfiber board can be employed and several layers of the printed resistors can be laminated together to reach a relatively higher temperature (between 50^{o}-200^{o}C). Furthermore, the power rate of such an apparatus can be conveniently varied from time to time by varying the connections between different connectors. The electrical-thermal apparatus described above can be used in different environments and for different purposes, for example, it can be used to maintain a constant working temperature for a precision instrument working in a very cold environment, to replace electric stoves for house-warming, to be made into a bake oven, baking box, drying room or to be used in a laboratory or room that has strict requirements of environmental temperatures. This embodiment of the present invention can be conveniently combined into the structure of the walls of a building or with the decoration of the room during the construction of the building or reparation of the room, so as to further reduce the manufacture and installlation cost.

Since the apparatus has the features of even surface temperature, quick heat radiation and little heat acumulation, not only insulating and sealing of the surface can be carried out easily, but also decorating of the surface by different ways and materials with varionus colours and patterns can be realized satisfyingly. In this way, the apparatus serves as a means for house-warming as well as decorating simultaneously.

The above-described embodiments of the present invention are only used as exemplary illustrations. It is not

difficult for those skilled in the art to make various modifications and amendments to these embodiments, the scope of the present invention is determined by the attached claims.

Claims

1. A method for manufacturing resistors, characterized by comprising the steps of:

(1) preparing a conductive paint by mixing conductive particles and adhesive into a diluent;

(2) making an insulating substrate;

(3) applying said paint onto said substrate according to a predetermined pattern; and

(4) forming a plurality of metal connectors at predetermined positions on said pattern.

2. A method according to claim 1, further comprising the step of:

(5) covering said pattern with a packaging layer of insulating and sealing material.

3. A method according to claim 1, further comprising the step of:

(6) making said substrate into a predetermined shape, which can be performed before or simutaneously with Step 3), or after Step 3) but before said paint dries.

4. A method according to claim 1, wherein said paint-applying in Step 3) can be done by printing, spraying or soaking.

5. A. method according to claim 2, further comprising the step of:

(7) decorating the surfac of said packaging layer by printing or spraying.

6. A method according to claim 1, wherein said Steps 3) and 4) are performed on both sides of said substrate.

7. A resistor comprising

a mixture of conductive particles and adhesive, characterized in that said mixture (2) is attached to an insulating substrate (1) according to a predetermined pattern to form a conductive layer, and a plurality of metal connectors (3) are formed at predetermined positions on said conductive layer, whose resistance value depends on the geometric shape of said pattern, the thickness of said conductive layer and the ratio between said conductive particles, and adhesive.

8. A resistor according to claim 7, wherein said conductive particles are carbon particles, metal particles or their mixture, and said adhesive is resin adhesive, asphalt or waterglass.

9. A resistor according to claim 7, further comprising:

a packaging layer (4) over said substrate and said conductive layer.

10. An electrical-thermal energy transforming apparatus, characterized by comprising:

(1) an insulating substrate (1);

(2) a resistive layer (2) formed on said substrate by applying according to a certain pattern a mixture of conductive particles and adhesive thereon; and

(3) a plurality of metal connectors (3) formed at certain positions on said resistive layer;

whereby said resistive layer radiates heat evenly when said metal conncetors are connected to an electric source.

11. An electrical-thermal energy transforming apparatus according to claim 10, wherein said conductive layer is formed on both sides of said substrate according to patterns arranged in a staggered manner.

12. An electrical-thermal energy transforming apparatus according to claim 10, wherein said resistive layer (2) is formed on one side of said substrate (1).

13. An electrical-thermal energy transforming apparatus according to claim 10, wherein said substrate with said resistive layer thereon is made into a desired shape.

14. An electrical-thermal energy transforming apparatus according to claim 10, wherein said metal connectors are at least three, and a change of connection between said conncetors will change the working power rate of said apparatus.

15. A fluorescent lamp ballast, characterized by comprising:

(1) an insulating substrate;

(2) a resistive layer formed on said substrate by applying according to a certain pattern of conductive particles and adhesive thereon; and

(3) a plaurality of metal connectors formed at certain positions on said resistive layer.

16. A fluorescent lamp ballast according to claim 15, wherein said conductive particles are grapite particles, said adhesive is waterglass.

17. A fluorescent lamp ballast according to claim 15, wherein a packaging layer covers said resistive layer.

18. A fluorescent lamp ballast according to claim 17, wherein said packaging layer is decorated with patterns or colors.

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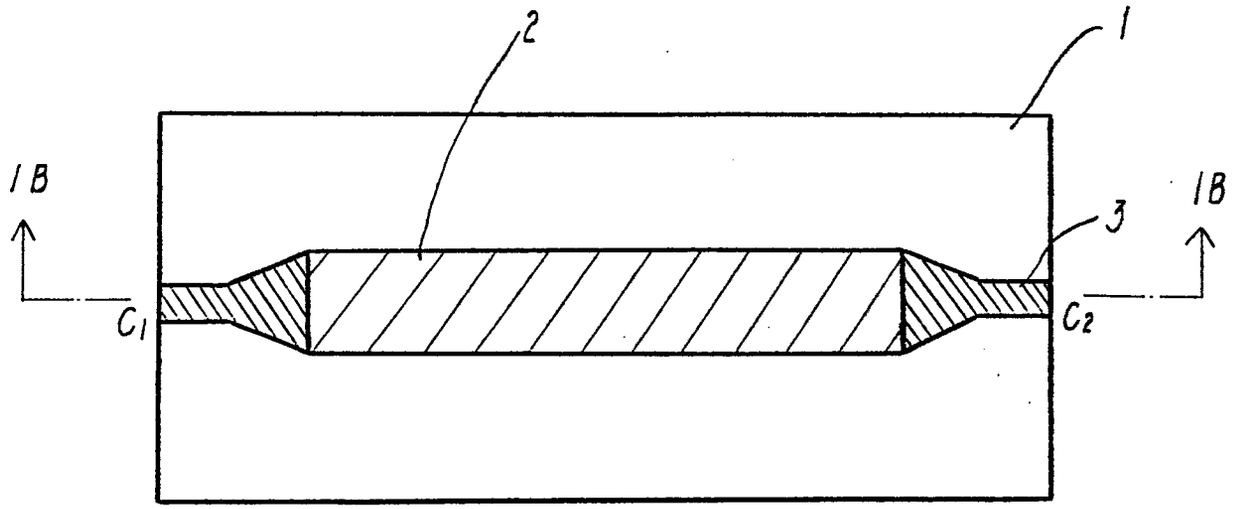

FIG.1A

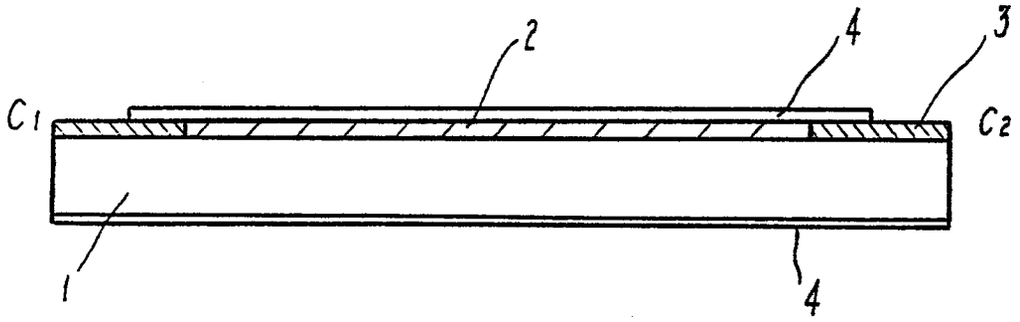

FIG.1B

C12

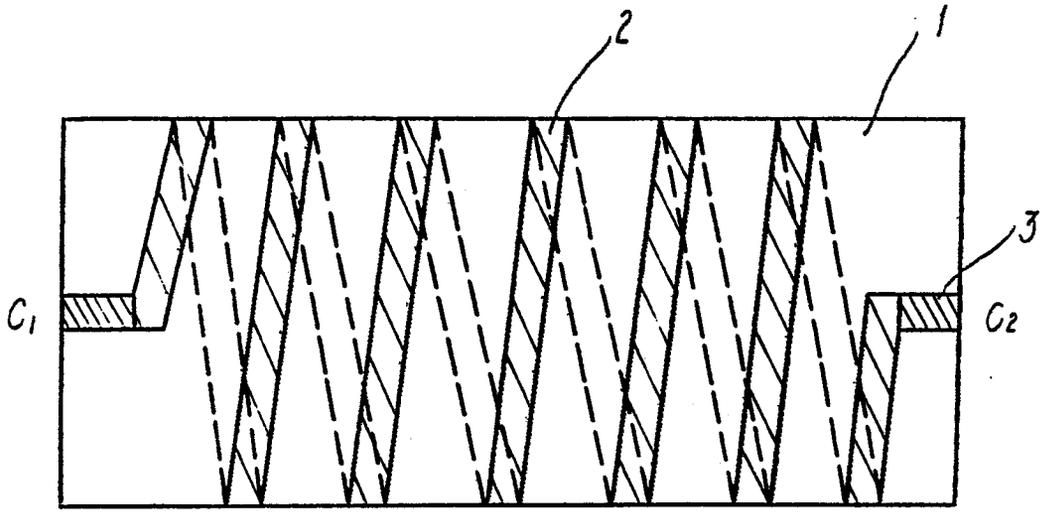

FIG.2

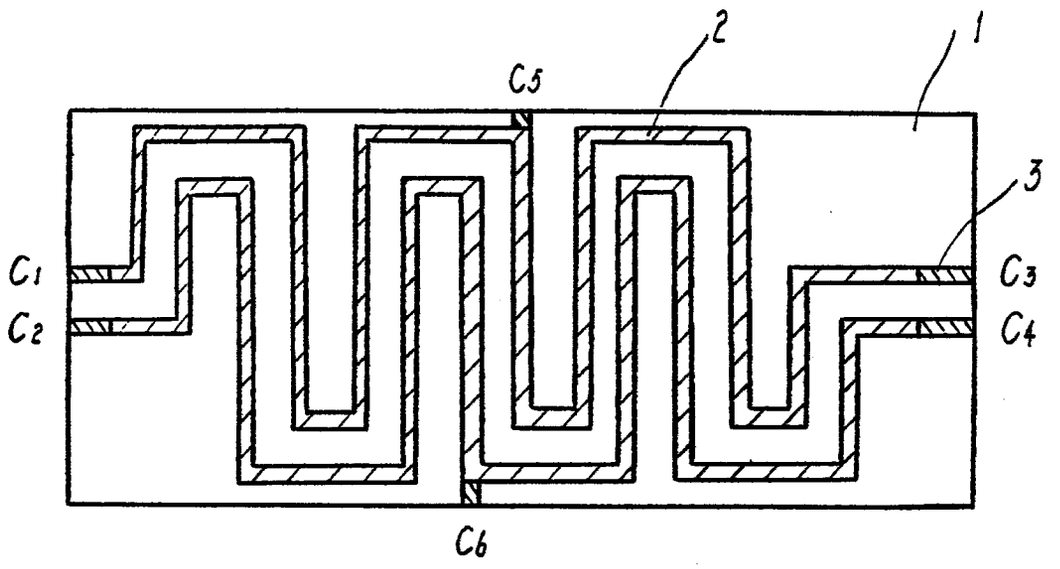

FIG.3

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EUROPEAN SEARCH REPORT

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Application number

EP 85 11 0374

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	GB-A- 690 478 (WARD, BLENKINSOP & CO. LTD.) * Claims 1,2,4-6,9; page 1, lines 41-74; page 2, lines 66-83 *	1,4,7, 8	H 01 C 17/06 H 01 C 7/00 H 05 B 3/12 H 05 B 41/00
X	JEE, JOURNAL OF ELECTRONIC ENGINEERING, vol. 19, no. 188, August 1982, pages 88-91, Tokyo, JP; K. SOGABE: "Thick-film resistor networks: their materials, trimming and production process"okage 88 - page 89, left-hand column, paragraph 1; figure 1	1,2,4, 7-9	
X	MICROELECTRONICS JOURNAL, vol. 12, no. 2, March/April 1981, pages 32-34, Kirkcaldy, Scotland, GB; A.K. MATKARI et al.: "A novel approach for higher yield in thick-film resistors" * Pages 32-33; figure 1 *	1,4,7	TECHNICAL FIELDS SEARCHED (Int. Cl.4) H 01 C
A	DE-A-2 401 784 (SIBIRSKIJ NAUTSCHNO-ISSLEDOWATELSKIJ INSTITUT ENERGETIKI, NOWOSIBIRSK (SOWJETUNION)) * Claims 1,3,6,9; page 18, last paragraph - page 19, paragraph 1; page 19, paragraph 3; page 23, paragraph 1 *	1,2,5, 7-10, 12	

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	09-10-1985	DECANNIERE L.J.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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EUROPEAN SEARCH REPORT

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	FR-A-1 579 597 (ATELIERS CONSTRUCTIONS ELECTRIQUES DE CHARLEROI (ACEC)) * Claims 1-3,7 *	1,7,8, 10,12	
A	DE-A-1 765 774 (ERNST ROEDERSTEIN SPEZIALFABRIK FÜR KONDENSATOREN GmbH) * Claims 1,2 *	1,4,6	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

The present search report has been drawn up for all claims

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THE HAGUE	09-10-1985	DECANNIERE L.J.

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