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(54) A device for determining the location of cooking utensils on a cooking hob

(57) A device for determining the location of cooking utensils on a cooking hob comprises a plurality of heating elements distributed in a matrix pattern below a heat-resistant surface on which the cooking utensil can be placed in a random manner, each heating element being capable of working also as a magnetic field transmitter. The device comprises loops placed substantially around portions of the matrix of heating elements and working as magnetic field receivers. The loops comprise conductors interposed between each couple of adjacent columns or rows of the heating elements, connecting means being provided for linking each loop to a detection circuit.

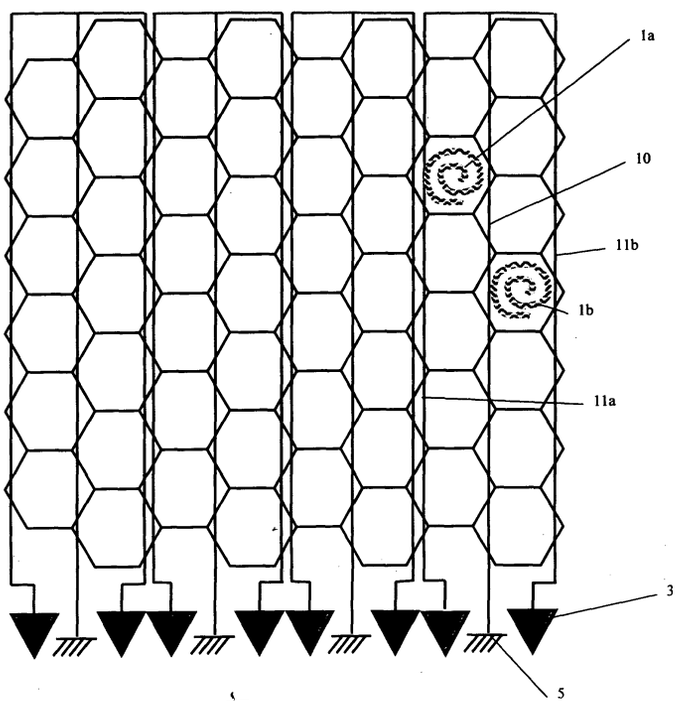

Fig. 2

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Description

[0001] The present invention relates to a device for determining the location of cooking utensils on a cooking hob comprising a plurality of heating elements distributed in a matrix pattern below a heat-resistant surface on which the cooking utensil can be placed in a random manner, each heating element being capable of working also as a magnetic field transmitter, the device comprising loops placed substantially around portions of the matrix of heating elements and working as magnetic field receivers.

[0002] A device of this type is disclosed in EP-A-1206164. In particular, the present invention relates to an improvement of the receiving coil antennae or loops used to pick up the electromagnetic field generated by the heating elements.

[0003] The invention relates also to some enhancing and cost reduction techniques of the pan detection system for cooking hobs with discrete distributed heating elements as disclosed in EP-A-1303168.

[0004] The basic form of said receiving pickup coils or loops, as described in EP-A-1206164, is that of one or more coils made of conducing metal wires or the like laying between the glass-ceramic slab and the heating elements. This basic implementation, even if it works in a satisfactory manner, nevertheless has some practical and technological problems that are addressed in this invention. In particular, the basic known solution presents the following problems:

- the pickup loops are very difficult to be realized with more than one turn because of the space and temperature constraints;
- in order to guarantee good spatial accuracy, the pickup loops cannot be too large compared to the size of the heating elements, this means that the number of loops practically needed are in the range of 1 each 10 cells;
- the implementation of the pickup loops as described in EP-A-1206164 rises problems of cost and mutual mechanical interference of the pickup loops.

[0005] One possible arrangement of the pickup loops, as described in EP-A-1206164 could be similar to that disclosed in attached figure 1. In this example a cooktop made of a matrix of 72 cells arranged in 8 rows and 9 columns is provided with 3 pickup loops, each one capturing the electromagnetic field emitted by the cells of the 3 columns it surrounds. Said solution has the following disadvantages:

- the connection to the electronic receiver requires two leads and two wires per receiving coil,
- neighboring loops must have some mechanical clearance between each other in order to avoid reciprocal touching and guarantee adequate insulation,
- the received signal strength is significantly different between the cells close to the coil loop (1st and 3rd column of each group of columns) and those far from it (2nd column). This requires some means of amplitude compensation.

[0006] In addition to the said disadvantages, the applicant noticed that the spatial resolution of the system, i.e. the ability of detecting only metallic objects lying just over the heating element and not in its surroundings, is generally poor if the pickup loops are significantly larger than the emitting coils which are also the heating elements.

[0007] The present invention solves all the above problems, providing a solution that is economical, easy to be produced, robust and guarantees high and reliable detecting performances. It is an object of the present invention to overcome or minimize the problem associated with the conventional pickup loops, providing a cheaper, more reliable and better performing solution.

[0008] In order to overcome the problem of a poor spatial resolution, a number of research activities were carried out by the applicant. This latter has found that the use of pickup coils as large as one column of heating elements (or one row) greatly increases the spatial resolution (or focus). Unfortunately the physical realization of a number of one coil per each row or column of heating elements is hardly feasible because of the mechanical problem of installing such high number of metallic wires or conducting tracks running parallel to each other, isolated from each other and subjected to temperatures up to 1000 °C.

[0009] The solution according to the invention solves all said issues by using a conductor (i.e. wire, track or the like) interposed between each couple of adjacent rows or columns of the matrix of heating elements, connecting means being provided for linking each loop to a detection circuit.

[0010] A pot detection system according to the invention is based on the cross-inductive principle (or transformer principle), in which each receiving conductor is substantially different than a coil or loop, but it can assume the function of a coil by establishing, for instance by means of electronic multiplexers, a conductive path substantially encircling the magnetic field generated by the emitting coil of the heating element.

[0011] More than one receiving loop is preferably used in order to detect a magnetically induced voltage, said coils being connected together at one or more points and sharing one or more linear conductors.

[0012] According to another embodiment of the present invention, in which a single amplification and detection circuit is used, it is provided an electronic multiplexing circuit that can be used to detect -in distinct times- the voltages developed by magnetic induction in two of at least three points of an electrically conducting material, these two points being substantially equivalent to the terminals of a single turn coil enclosing the mag-

netic field generated by the emitting coil to be sensed.

[0013] According to a further embodiment, in which the electrically conductor detecting body has the shape of a comb, having three or more legs, the differential voltage developed at the free ends of each pair of legs is substantially equivalent to the differential voltage that would be developed at the ends of a coil embracing the same area delimited by the two addressed legs and the common conductor.

[0014] The connection of each loop to the detection circuit may be performed through an electronic multiplexing technique in order to realize loop equivalent conducting paths, starting from non coil-shaped conductive paths, in a manner that will be explained in the following detailed description of different embodiments, given by way of non-limiting example, and illustrated in the accompanying drawings, in which:

- figure 1 is a schematic view of a known detection system with discrete pickup loops;
- figure 2 is a schematic view, similar to figure 1, in which a first embodiment of the present invention is shown;
- figure 3 is a detail of a second embodiment of the present invention, in which a plurality of differential receivers are used;
- figure 4 is a schematic view, similar to figure 1, in which a third embodiment of the present invention is shown, where a couple of multiplexers are used;
- figure 5 is a schematic view, similar to figure 4, in which a fourth embodiment of the present invention is shown.

[0015] With reference to figure 2, a first embodiment of the invention is realized by creating a single turn pickup loop or coil over each column of heating elements by sharing a common "leg" 10 between two adjacent columns, the shared leg being connected to the ground reference 5 of the detection circuit 3. Said arrangement has the advantage that the number of vertical conductors is reduced from 2n to 1.5n, being n the number of loops to be sensed.

[0016] As a man skilled in the art can easily understand, a substantially equivalent solution to that presented in figure 2 can be realized as shown in figure 3, by connecting the common leg 10 to one input of two adjacent differential receivers 3' and the left 11 a and right leg 11 b (among which the common leg 10 is interposed) to the other inputs of said adjacent receivers. In order to guarantee a correct reading of pot presence, appropriate means (as described in EP-A-1206164) must be provided to avoid the simultaneous injection of electromagnetic field into two loops sharing the same common leg 10.

[0017] A third embodiment of the present invention can further reduce the number of vertical conductors needed to implement *n* sensing loops from *1.5n to n+1*. Such embodiment is shown in figure 4, in which the leg-sharing concept is extended to all the legs but the outer ones. Referring to figure 4, the receiving loops are realized by means of electronic multiplexing of the legs on a comb-shaped conductive structure substituting the regular coils of the previous solutions. Said comb-like structure is made of a common edge 12, and a number of legs 2a,.., 21 substantially running parallel to the rows or the columns of heating elements to be sensed for pot presence.

[0018] In order to understand how this solution works, we suppose that, for sensing pot presence, the heating element 6 is used. As described in the prior art, an alternate current is flown into the coil of the heating element 6, thus generating a magnetic field leaking from the cell as a fountain. At the same time, the two electronic multiplexers 7a and 7b are addressed by a suitable electronic control, in order to switch into the differential amplifier 8 the two comb legs 2h and 2i adjacent to the cell 6. This is electrically equivalent to have a real loop wound around the column into which lies the cell 6. In order to reduce the common mode disturbances and the capacitive coupling, it is convenient to tie the common side of the comb's legs to ground as shown in 5, in this way the voltage across the two addressed legs will be nearly purely differential. A substantially equivalent solution is shown in figure 5, in which the comb structure is electrically floating and is brought to ground 5 by means of the electronic multiplexer 7b', while the other multiplexer 7a' connects the other leg to a ground referenced amplifier 8' connected to the detection circuitry 9.

Claims

1. A device for determining the location of cooking utensils on a cooking hob comprising a plurality of heating elements distributed in a matrix pattern below a heat-resistant surface on which the cooking utensil can be placed in a random manner, each heating element being capable of working also as a transmitter or a receiver, the device comprising loops placed substantially around portions of the matrix of heating elements and working as receivers or transmitters respectively, **characterized in that** the loops comprise conductors (10, 11 a, 11 b, 2a, ... 21) interposed between each couple of adjacent columns or rows of the heating elements, and **in that** connecting means are provided for linking each loop to a detection circuit (3, 9).

2. A device according to claim 1, **characterized in that** said connecting means comprise a plurality of ground references (5), each ground reference being interposed between two adjacent conductors connected to the detection circuit (3).

3. A device according to claim 1, **characterized in**

that said connecting means comprise a plurality of differential receivers (3'), couples of first conductors (11 a, 11 b) being connected to inputs of two adjacent differential receivers (3'), second conductors (10) interposed between each couple of first conductors (11a, 11b) being each connected to the other two inputs of said adjacent differential receivers (3').

4. A device according to claim 1, **characterized in that** said connecting means comprise a couple of multiplexers (7a, 7b) adapted to link sequentially first ends of each couple of single consecutive conductors (2a, ...21) to the detection circuit (8, 9) in order to scan the whole matrix, the second ends (12) of such conductors being all connected together.

5. A device according to claim 1, **characterized in that** said connecting means comprise a couple of multiplexers (7b', 7a') adapted to link sequentially first end of each couple of single consecutive conductors to ground (5) and to the detection circuit (8', 9) respectively in order to scan the whole matrix, second ends (12) of such conductors being all connected together.

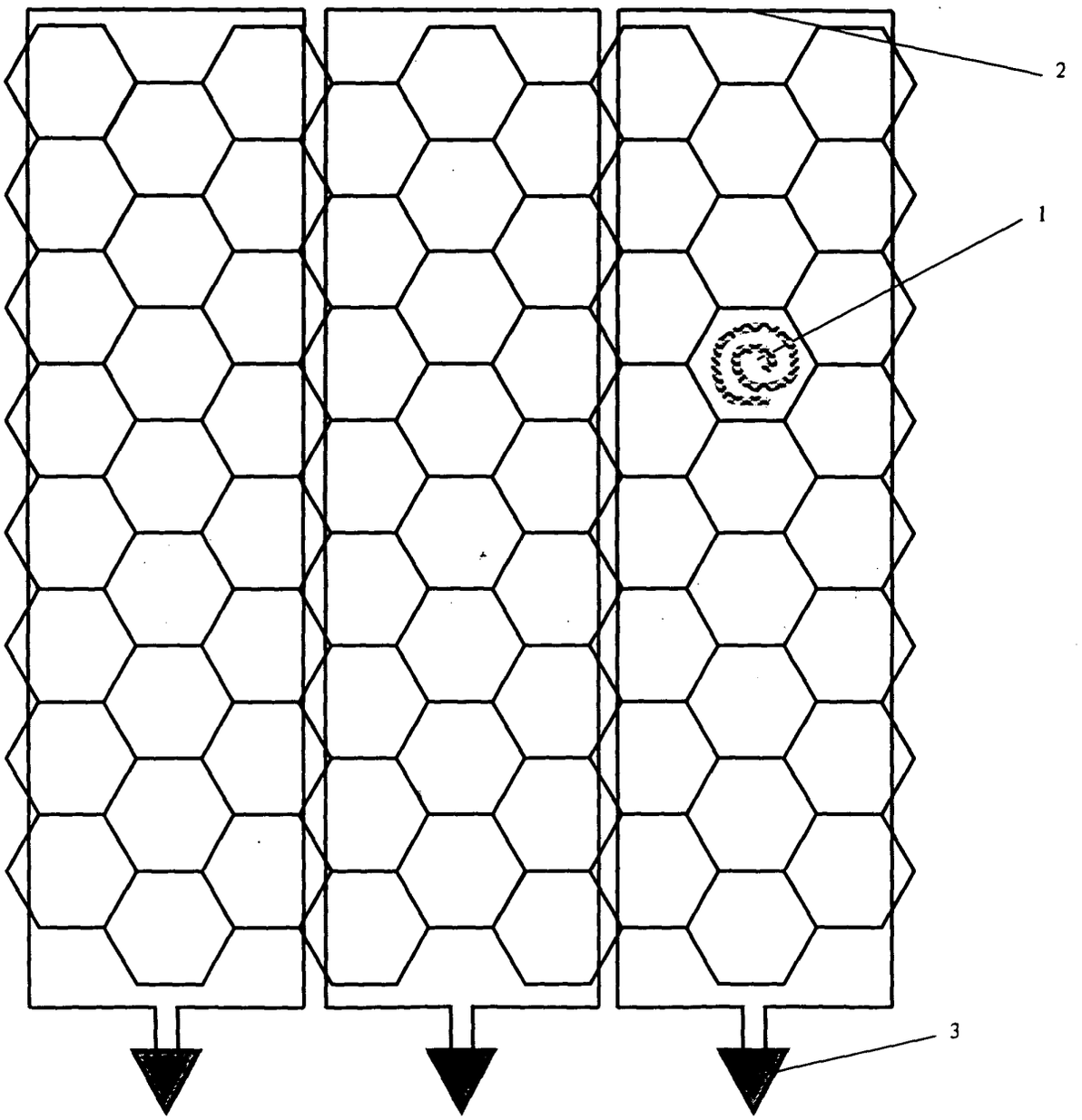

Fig. 1
(PRIOR ART)

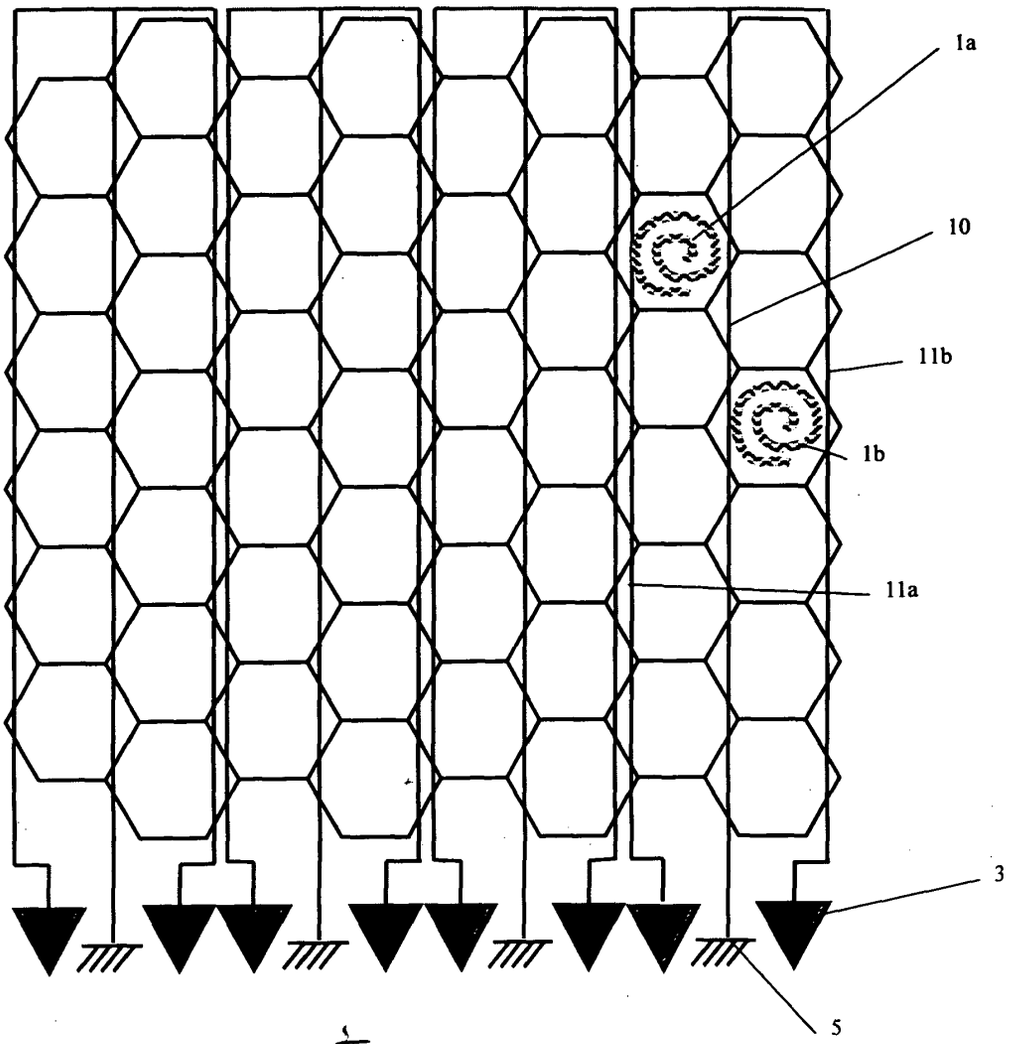

Fig. 2

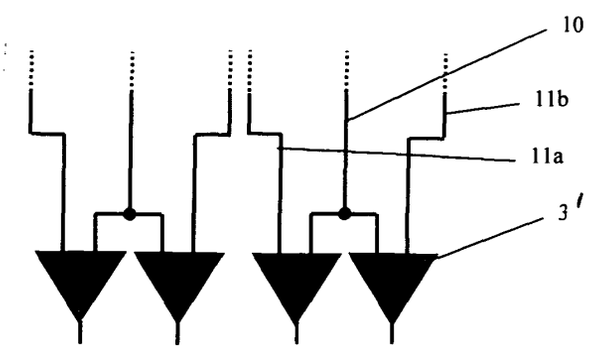

Fig. 3

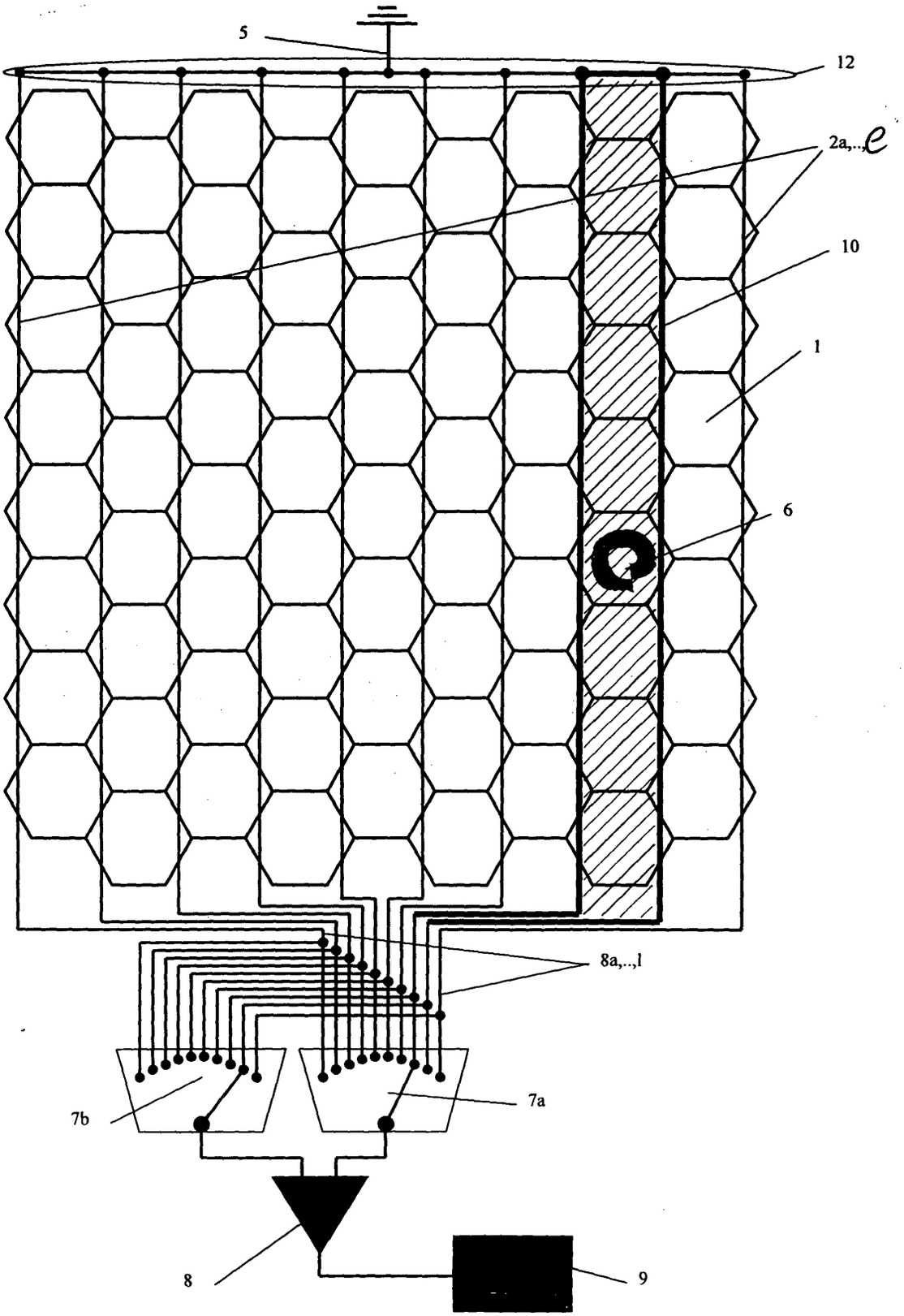

Fig. 4

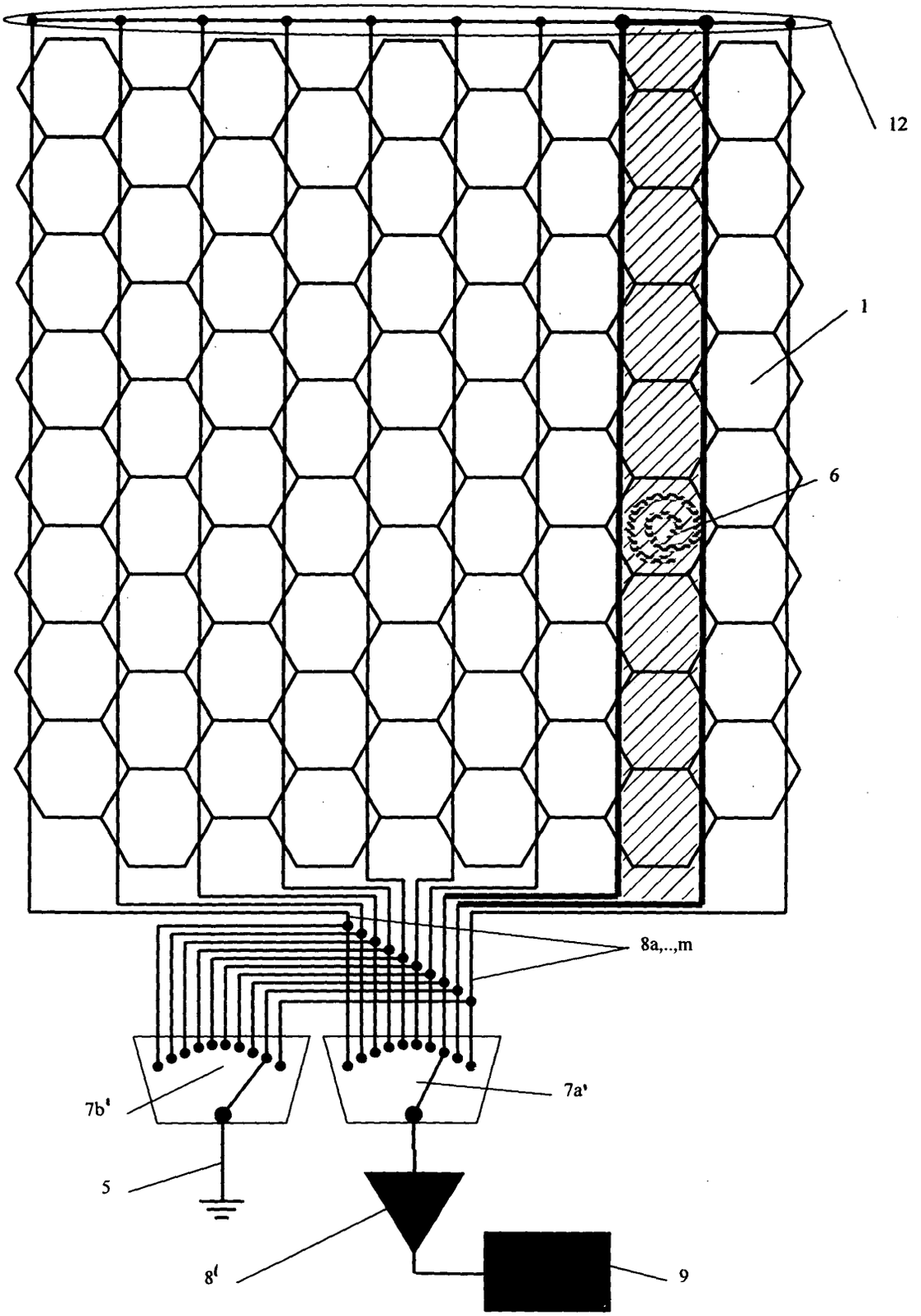

Fig. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 02 8048

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.7)
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A	WO 97/19298 A (ESKILDSEN CHRISTIAN ;ELECTROLUX AB (SE)) 29 May 1997 (1997-05-29) * page 4, line 28 - page 6, line 10; figures 1-3 *	1-5	
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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
MUNICH	11 May 2004	Gea Haupt, M

CATEGORY OF CITED DOCUMENTS

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