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(71) Applicant: **The Superior Electric Company**
383 Middle Street
Bristol Connecticut 06010(US)

(72) Inventor: **Watt, Julian Alexander**
58 South Eagle Street
Terryville Connecticut 06786(US)
Inventor: **Lenzing, Richard Steven**
35 Garden Street
Farmington Connecticut 06032(US)

(74) Representative: **Blatchford, William Michael et al**
Withers & Rogers 4 Dyer's Buildings Holborn
London EC1N 2JT(GB)

(54) Longitudinally contoured conductor for inductive electrical devices.

(57) An improved conductor for an inductor device of the type having varying current carrying requirements along the length of the conductor, the improvement comprising having the conductor contoured such that the cross sectional area of the conductor varies substantially directly as the current carrying requirements of the conductor vary. In one embodiment, a coil for a variable transformer is cut from a cylinder of conductor material by numerically controlled machine, producing a contoured conductor and eliminating the requirement for coiling or winding of the conductor.

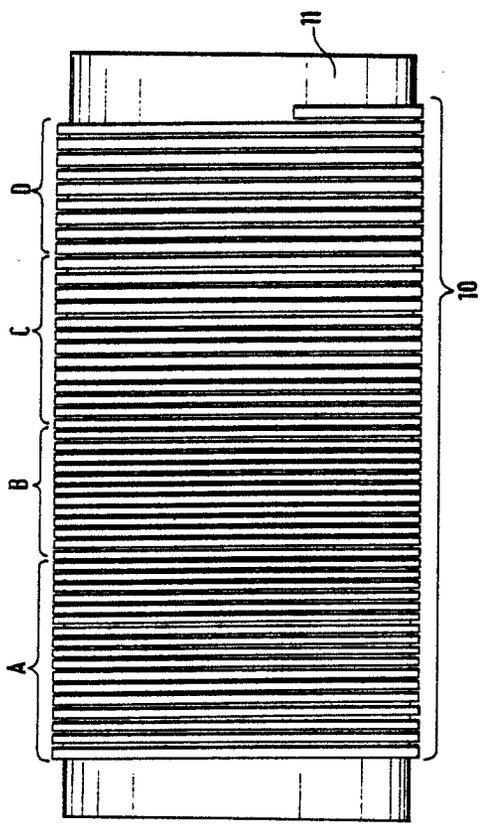

FIG.4.

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LONGITUDINALLY CONTOURED COIL FOR INDUCTIVE ELECTRICAL DEVICES

BACKGROUND OF THE INVENTION

1. Field of the Invention.

The present invention is related to inductive electrical devices in which there is a varying current density, and more particular to a longitudinally contoured conductor for such devices which minimizes the quantity of required conductor material.

2. Background Art

Inductive electrical devices are well known and widely used in electrical systems as energy transfer or storage elements and include, for example, variable transformers and certain types of choke coils and reactors in which a coiled conductor induces a voltage in itself or another coil, frequently in association with a paramagnetic flux-carrying material.

The conductors of such devices are typically formed of round, rectangular, or square conductors with the conductor in any such device having a uniform cross section substantially throughout its length. The current handling requirements in a conductur in such devices may change with respect to the position in the conductor; however, by using constant cross-section conductors, the coils are designed to withstand the maximum currents throughout the coil when, in actuality, only certain portions of the coil carry the maximum currents. This conventional configuration wastes conductor material and results in a device that is heavier and larger than need be for the current carried.

SUMMARY OF THE INVENTION

The present invention overcomes the above limitations of conventional devices by providing a coil for an inductive device that is longitudinally contoured so that is has maximum cross sectional area in those sections where maximum current is carried and lesser cross sectional areas, proportional to the current carrued, in other sections of the coil. A suggested method of producing such a coil also results in a greatly simplified manufacturing process.

BRIEF DESCRIPTION OF THE DRAWING

Figure 1 is a graph of current versus coil position for a typical variable transformer.

Figure 2 is a graph showing an improved coil cross sectional for the variable transformer of Figure 1 according to the present invention.

Figure 3 shows material used and saved over conventional construction in the variable transformer of Figure 2.

Figure 4 is a view of a coil constructed according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the Drawings, Figure 1 is a graph, for a typical variable transformer, of the maximum current handling requirement of the transformer coil versus the turn position on the coil. Curves are shown for both constant current load operation and constant impedance load operation. For constant current load operation, it is seen that, at the beginning of the coil, the current is at its maximum, drops to about one-half maximum, and then rises to and remains at maximum along the last 20 percent of the coil. For constant impedance load operation, the current is at a low level along the first half of the coil and then rises along the rest of the coil.

Figure 2 shows how a coil might be contoured, in accordance with the present invention, for the transformer requirements shown on Figure 1. The contouring indicated satisfies the requirements for both constant current and constant impedance load conditions. At the beginning of the coil, the cross sectional area is relatively large to handle constant current load conditions, drops to a lower level when the current is relatively low under either load condition, and then rises to its maximum toward the end of the coil to handle the maximum current under constant impedance load operation.

Figure 3 is Figure 2 shaded to show coil material saved in a coil in accordance with the present invention over conventional construction. The lower, shaded area shows the relative amount of coil material used in a coil contoured in accordance with the invention, and the upper, shaded area shows the relative amount of coil material saved over a standard coil. It follows that the entire shading shows the relative amount of material used on a standard coil. For the design under construction, there is a savings of about 20 percent in coil material.

Figure 4 shows a coil constructed in accordance with the present invention and includes a conductor 10 on the surface of a tube of insulating material 11. Beginning at the left end of the coil 10, section "A" begins with relatively wide coil turns decreasing to the minimum width section "B". the width of the coil turns increases through section "C" to the maximum width coil turns in section "D" at the right end of the coil 10. The contouring is substantially shown on Figure 2.

The coil may be cut from a solid tube of electrical grade copper. Prior to cutting the contoured turns, the coil is stabilized by threading the inside diameter of the copper tube, screwing it onto the outside diameter of a threaded tube of the insulating material 11, and bonding these two pieces together. The bonding may be achieved by vacuum impregnating the assembly with transformer varnish, thus thoroughly stabilizing the future coil. After this stabilization process has been completed, the coil is cut from the copper tube by a numerically controlled machine. Numerically controlled machining can easily vary the pitch of the cuts made through the copper tube, thus achieving the desired coil conductor width variances through simple numerically controlled programming.

The completed coil, stabilized on the insulating tube, requires very little finish machining. The procedure also allows an accurate brush guide to be easily machined into the coil, if the coil is of the type requiring a contact brush.

In addition to having an economical coil, another advantage to the present invention is in eliminating complicated manufacturing processes and costly tooling. Specifically, it eliminates the need for winding/coiling rectangular or square wire and the complicated process of accurately positioning and stabilizing turns of the transformer's coil.

While the present invention has been described as applied to a conductor in the form of a cylindrical helix, it will be understood that it is applicable to other inductor devices with other shapes of conductors such as toroids. It will also be understood that it is not necessary that the coil be mounted on an insulating tube.

It will be understood that what has been disclosed is a novel current conductor for inductor devices of the type having varying current densities along the conductor, the conductor having a contoured cross section such that the cross sectional area of the conductor varies substantially directly as the current carrying requirements of the conductor vary.

Since certain changes may be made in carrying out the above invention without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying Drawing shall be interpreted as illustrative and not in a limiting sense.

It is also intended that the following Claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

Claims

1. An induction device having a conductor with varying current carrying requirements along the length of the conductor, characterised by having the conductor contoured such that the cross sectional area of the conductor varies substantially directly as the current carrying requirements of the conductor vary.

2. An induction device according to claim 1, wherein the conductor comprises a cylindrical helix.

3. An induction device according to claim 2 wherein the cylindrical helix is formed from a cylinder of conductive material.

4. An induction device according to claim 3 wherein the cylinder of conductive material is mounted on an insulating tube prior to forming the helix.

5. An induction device according to claim 4 wherein the helix is formed by cutting the cylinder of conductive material in a numerically controlled machine.

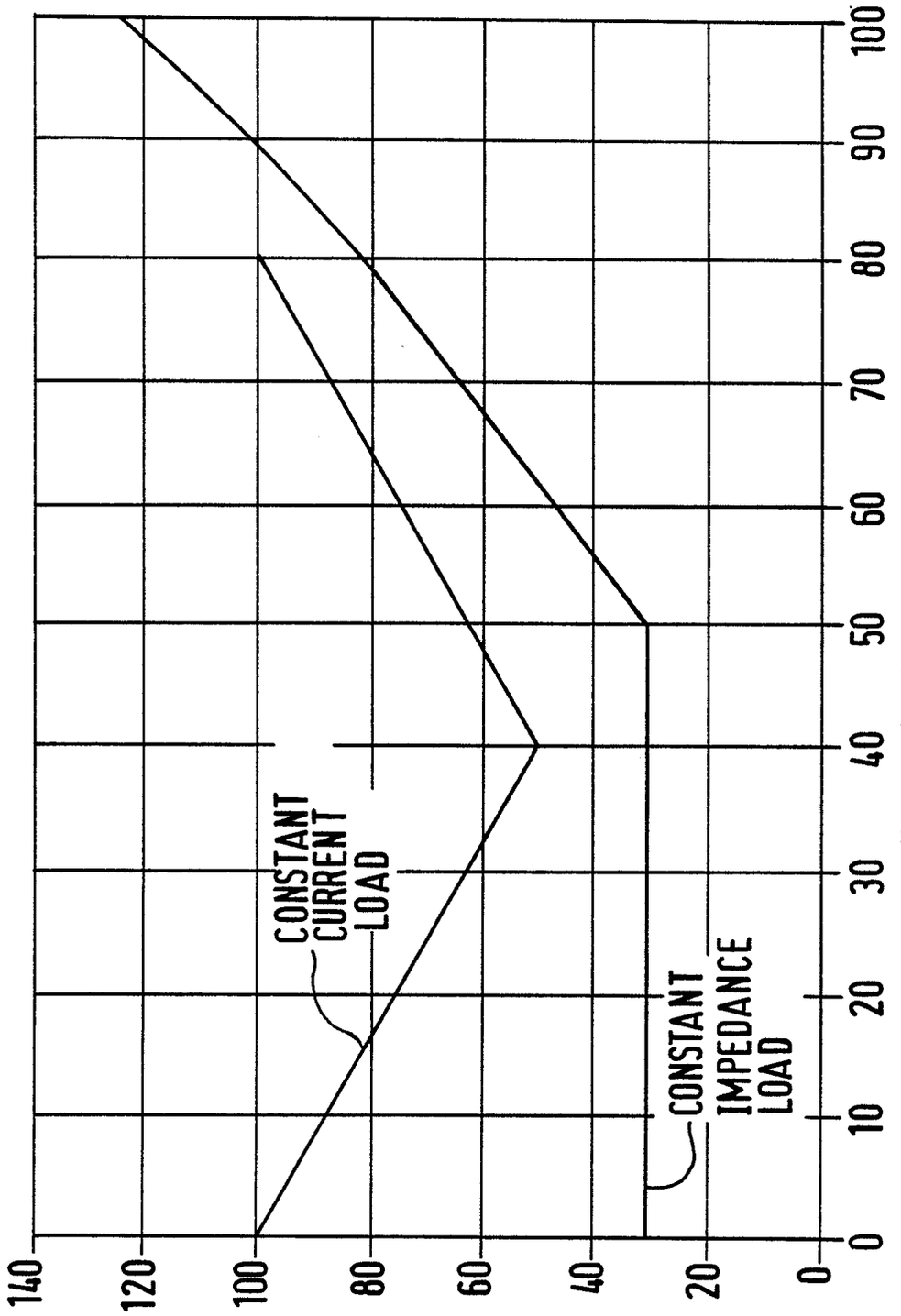

MAXIMUM CURRENT HANDLING REQUIREMENT (RELATIVE)
140
120
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
90
100
TURN POSITION ON COIL (% OF COIL TURNS)
CONSTANT CURRENT LOAD
CONSTANT IMPEDANCE LOAD

FIG.1.

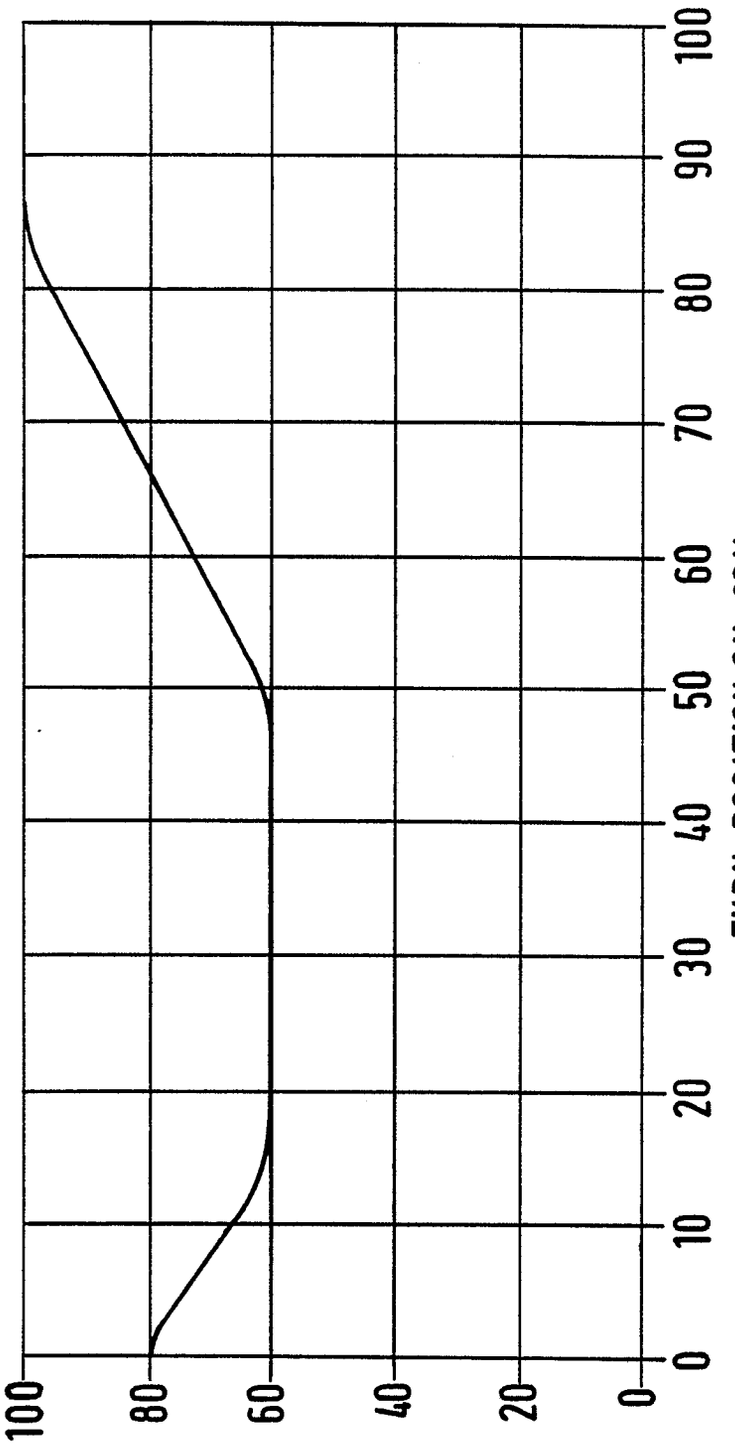
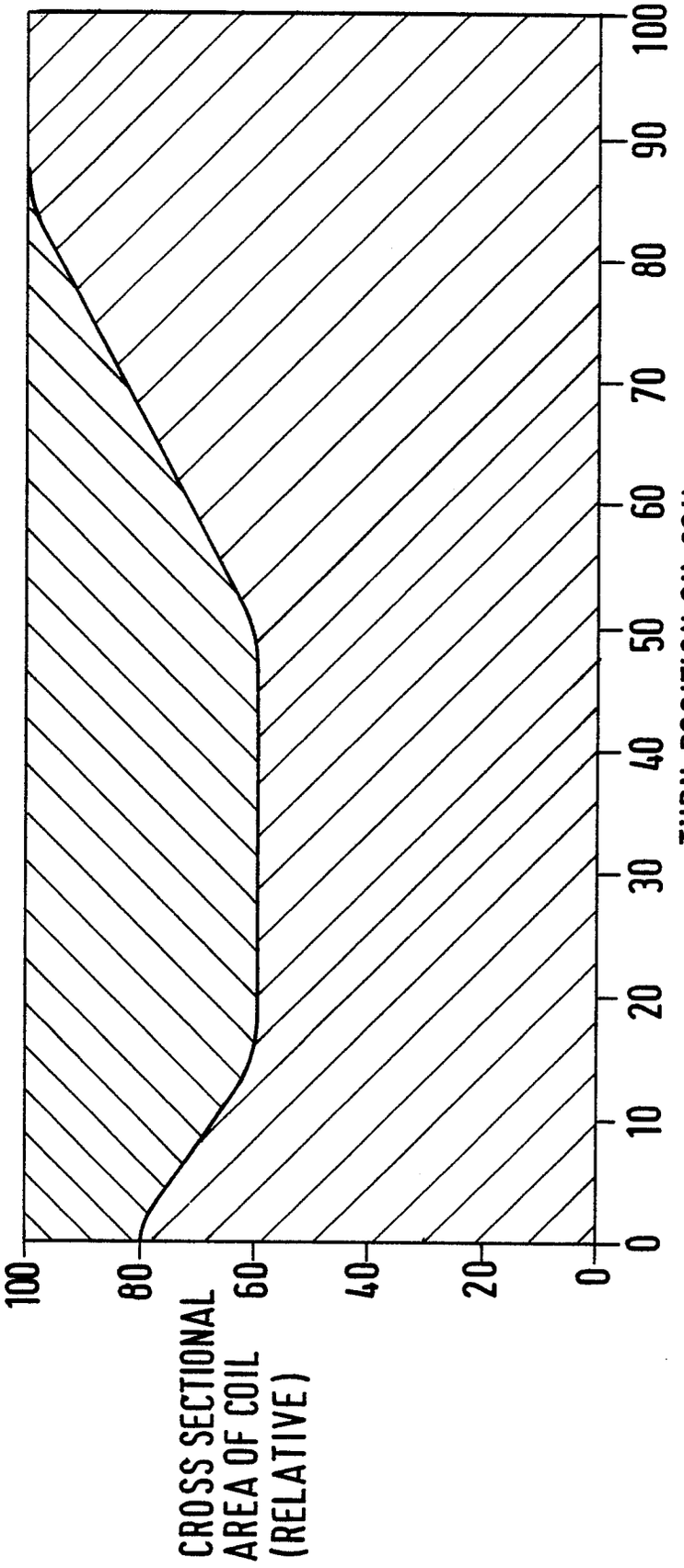

CROSS SECTIONAL AREA OF COIL (RELATIVE)
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
90
100
TURN POSITION ON COIL (% OF COIL TURNS)

FIG.2.


CROSS SECTIONAL AREA OF COIL (RELATIVE)
100
80
60
40
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60
70
80
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100
TURN POSITION ON COIL (% OF COIL TURNS)

FIG. 3.

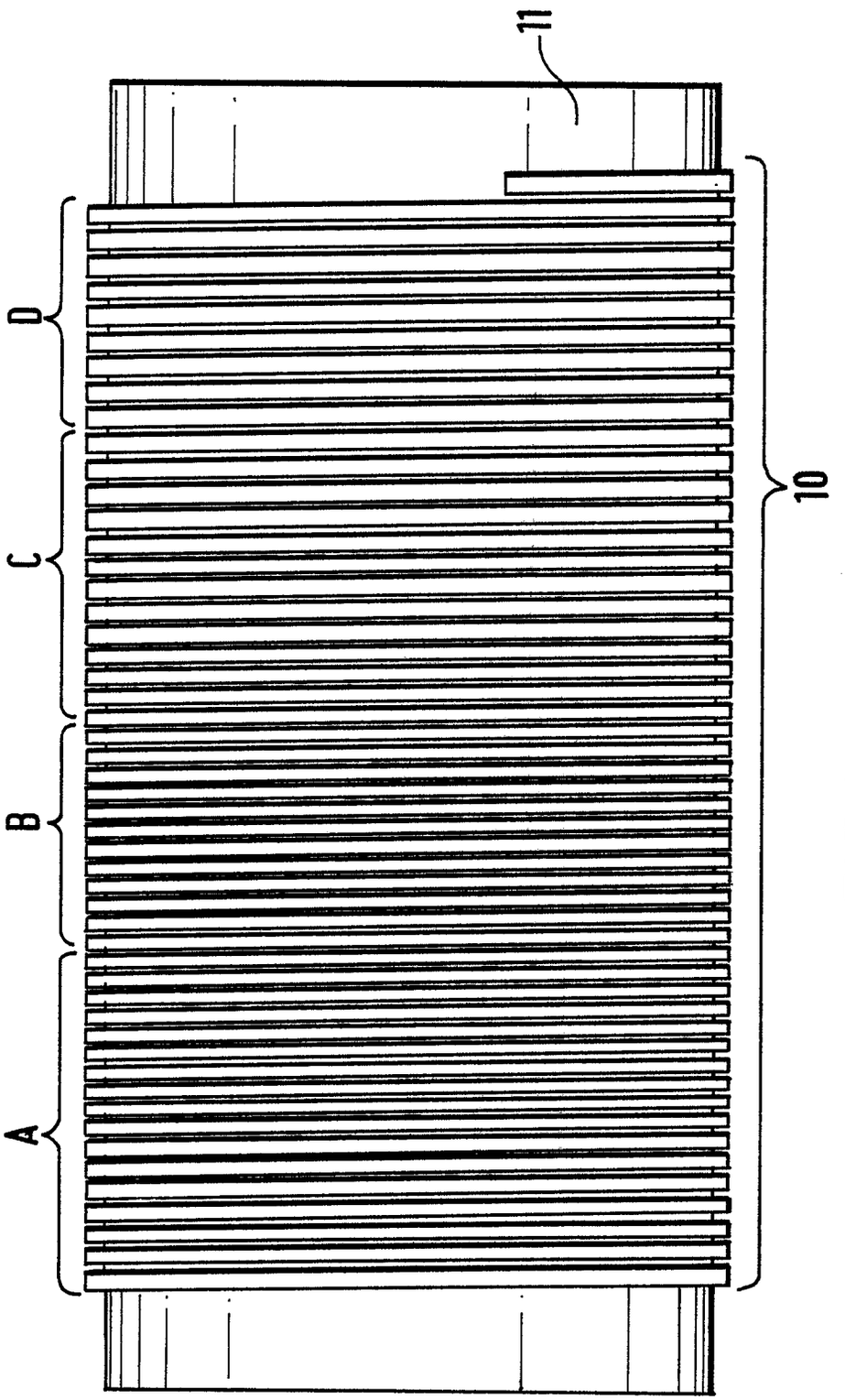

FIG.4.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 87 30 7425

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)
Y	FR-A-1 209 196 (CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE) * Page 5, right-hand column, line 20 - page 7, right-hand column, the end *	1	H 01 F 27/28
Y	US-A-4 135 173 (GENERAL ELECTRIC) * Column 4, line 15 - column 5, line 24 *	1	
A	DE-C- 414 841 (E. SCHRÖDER) * Page 2, lines 46-49 *	2,3	
A	DE-C- 295 188 (A. PFRETZSCHNER) * Page 2, lines 25-52 *	2-4	
A	DE-C- 950 871 (STANDARD ELEKTRIK AG)		
A	US-A-3 731 243 (A.R. DAVIS)		
A	FR-A-1 308 052 (COMPAGNIE GENERALE D'ELECTRICITE)		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

H 01 F 27/00
H 01 F 29/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	02-12-1987	VANHULLE R.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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E : earlier patent document, but published on, or after the filing date
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