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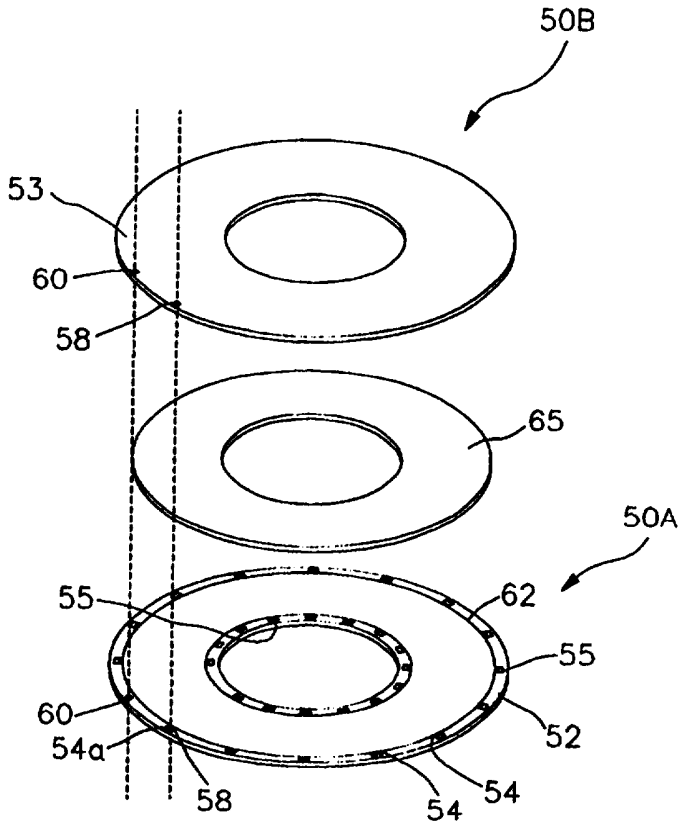
(54) Title: SECONDARY WINDING STRUCTURE OF FLEXIBLE TRANSFORMER

(57) Abstract

A secondary winding structure of a transformer fabricated by laminating circular insulator sheets, each having an opening at the center thereof. The secondary winding structure is composed of two laminated flexible transformer elements and a magnetic layer intervened between the transformer elements. The transformer elements are composed of a first flexible insulator member having a first plurality of conductors on a surface thereof, a second flexible insulator member having a second plurality of conductors on a surface thereof, and first and second insulator layers attached on said first and second insulator members, respectively to expose the respective terminal ends of said first and second conductors. The terminal ends of said first conductors are coupled to those of said second conductors to form a patterned coil which surrounds said first insulator layer, said magnetic layer and said second insulator layer. The first and second transformer elements have first and second pairs of holes, respectively. The first pair of holes are in alignment with the second pair of holes, whereby the first and second transformer elements are aligned with each other to form the patterned coil.



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SECONDARY WINDING STRUCTURE OF FLEXIBLE TRANSFORMER

TECHNICAL FIELD

The present invention relates to a flexible transformer and more particularly to a secondary winding structure of a flexible transformer manufactured by laminating circular sheets having an opening at the center thereof.

BACKGROUND ART

Transformers are utilized in various fields. Transformers are devices that increase or decrease the voltage of alternating current. They are usually fabricated by winding several coils of wire around a large magnetic core. Cores may be cylindrical, but typically toroidal cores are used. One coil, called the primary coil, is connected to the input circuit, in which the voltage is to be changed. The other coil, called the secondary coil, is connected to the output circuit, where the electricity with the changed (increased or decreased) voltage is used.

Since coil winding is a long and tedious process, the design of a commercial transformer is primarily driven by cost. In other words, manufacturers try to minimize core size and coil length. However, there is a practical limit to decreasing the size of transformers, and the smallest transformers, which would be desirable for high frequency applications, are very expensive to produce. A reduction in size usually reduces cost as a result of less material needed to build them, but a continued reduction in size increases cost of assembly exponentially.

U.S. Pat. No. 5,392,020, entitled "FLEXIBLE TRANSFORMER APPARATUS PARTICULARLY ADAPTED FOR HIGH VOLTAGE OPERATION" issued on Feb. 21, 1995 to Chang, discloses a transformer apparatus which utilizes flexible laminated transformer elements.

FIG. 1 illustrates a flexible laminated transformer element 10 which constitutes a secondary winding of Chang's transformer. As shown, element 10 is composed of three sheets. A first insulator sheet 11 is made from a flexible insulating material. A series of parallel conductors 14 are arranged on a surface of first insulator sheet 11. A second insulator sheet 13 is of the same thickness and material as first insulator sheet 11. A series of parallel conductors 16 are arranged on a surface of second insulator sheet 13. Conductors 16 are shown in dashed line in FIG. 1. Holes 15 are formed at the respective terminal end portions of conductors 14 and 16 and enable terminal ends of conductors 14 to be electrically connected to terminal ends of conductors 16 through holes 15. Connected conductors form a zig-zag patterned coil disposed to surround a magnetic sheet 12 which is provided between first and second insulator sheets 11 and 13.

Flexible laminated transformer element 10 is configured to a closed ring configuration shown in FIG. 2 or a spiral configuration shown in FIG. 3 to fabricate a secondary winding. In FIGS. 2 and 3, flexible laminated transformer element 10 is provided between a central primary cylinder 20 and an outer primary cylinder 22. Each of the solid lines designated as number 23 represents magnetic sheet 12, while the dashed lines designated as number 24 represent insulator sheets 11 and 12.

When a secondary coil of a flexible laminated transformer is fabricated according to Chang, there is a problem that an edge portion of element 10 may be cut or folded because of the curvature difference between central and outer portions of flexible laminated transformer element 10 which is fabricated to the closed ring configuration or the spiral configuration.

DISCLOSURE OF INVENTION

The present invention is devised to solve the

foregoing problem. It is an object of the present invention to provide a secondary winding structure of a flexible transformer capable of being assembled easily and having higher voltage build-up ratio.

To achieve the above object of the present invention, there is provided a secondary winding structure of a flexible transformer comprising:

a first flexible transformer element consisting of a first flexible insulator member of a circular disc shape having an opening at the center thereof and a first plurality of conductors formed on a surface thereof, and a first insulator layer of a circular disc shape having an opening at the center thereof, the first insulator layer being attached on the surface of the first insulator member to expose terminal ends of each of the first plurality of conductors;

a second flexible transformer element consisting of a second flexible insulator member of a circular disc shape having an opening at the center thereof and a second plurality of conductors formed on a surface thereof, and a second insulator layer of a circular disc shape having an opening at the center thereof, the second insulator layer being attached on the surface of the second insulator member to expose terminal ends of each of the second plurality of conductors, the second flexible transformer element being laid on the first flexible transformer element so that the surface of the first insulator member is confronted with the surface of the second insulator member;

a magnetic member of a circular disc shape having an opening at the center thereof, the magnetic member being intervened between the first and second flexible transformer elements so that the terminal ends of the first conductors can come in contact with those of the second conductors; and

connecting members provided at the terminal ends of the respective first and second conductors for electrically connecting the first and second conductors to

form a patterned coil which surrounds the first insulator layer, the magnetic layer and the second insulator layer.

The first conductors are arranged in a first radial configuration in which the formation of a conductor is omitted, and the second conductors are arranged in a second radial configuration in which the formation of a conductor is omitted and have the terminal ends which are positioned to come in contact with the terminal ends of the first conductors to form the patterned coil.

Perferably, the first transformer element has a first pair of holes which are positioned adjacent to each other at an outer peripheral end portion thereof, one hole being formed at a point where the formation of a conductor is omitted, and the other hole being formed passing through an outer terminal end of a conductor of the first conductors adjacent to the point of the first transformer element, and the second transformer element has a second pair of holes for being aligned with the second pair of holes, the pair of holes being positioned adjacent to each other at an outer peripheral end portion thereof, one hole being formed at a point where the formation of a conductor is omitted, and the other hole being formed passing through an outer terminal end of a conductor of the second conductors adjacent to the point of the second transformer element, whereby the first transformer element is in alignment with the second transformer element to form the patterned coil.

BRIEF DESCRIPTION OF DRAWINGS

The above object and other advantages of the present invention will become more apparent by describing in detail preferred embodiments thereof with reference to the attached drawings in which:

FIG. 1 is a perspective view of a conventional flexible laminated transformer element;

FIG. 2 is a top plan view showing a conventional transformer having a closed ring configuration;

FIG. 3 is a top plan view showing a conventional transformer having a spiral configuration;

FIG. 4A is a top plan view of a first flexible transformer element according to the present invention;

FIG. 4B is a top plan view of a second flexible transformer element according to the present invention;

FIG. 5 is a top plan view of the first flexible transformer element having an insulator layer attached thereon and a magnetic layer laid on the insulator layer;

FIG. 6 is an exploded view of a secondary coil of a transformer which is fabricated by use of the flexible transformer elements according to the present invention; and

FIG. 7 is an exploded view of a secondary winding of a transformer which is fabricated by use of three secondary coils according to the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

The preferred embodiment of the present invention will be described in detail with reference to FIGs. 4 to 7.

FIGs. 4A and 4B show flexible transformer elements 50A and 50B according to the embodiment, respectively. Element 50A consists of an insulator sheet 52 and a plurality of conductors 54 of a radial configuration formed on a surface of insulator sheet 52. Insulator sheet 52 is a circular disc with an opening at the center thereof and fabricated of a flexible film which is made from an insulating material such as polyimide or polyester. Solder layers 55 are formed at terminal ends of the respective conductors 54 by, for example, solder plating. Element 50B consists of an insulator sheet 53 and a plurality of conductors 56 of a radial configuration formed on a surface of insulator sheet 53. Conductors 56 are configured to fabricate a coil in cooperation with conductors 54. That is, when element 50A is laid on element 50B, terminal ends of the respective conductors 56

are superimposed on those of the respective conductors 54 to fabricate a coil. Solder layers 55 are formed at terminal ends of the respective conductors 56 by, for example, solder plating. Element 50B is equal to element 50A in material and shape except for the configuration of conductors 56.

Conductors 54 and 56 are formed by attaching a copper film on the respective insulator sheets 52 and 53 by use of an adhesive agent or depositing a copper layer thereon by conventional film deposition techniques using sputtering procedures and then patterning the copper film or the copper layer by conventional evaporation techniques using photolithographic procedures.

First and second holes 58 and 60 are formed at an outer peripheral edge portion of insulator sheet 52. First hole 58 of insulator sheet 52 passes through an outer terminal end of a conductor 54a, and second hole 60 of insulator sheet 52 is located adjacent to first hole 58 on a point of the outer peripheral edge portion of insulator sheet 52 at which the formation of a conductor is omitted. First and second holes 58 and 60 are also formed at an outer peripheral edge portion of insulator sheet 53. First hole 58 of insulator sheet 53 is located on a point of the outer peripheral edge portion of insulator sheet 53 at which the formation of a conductor is omitted, and second hole 60 of insulator sheet 53 passes through an outer terminal end of a conductor 56a adjacent to first hole 58 of insulator sheet 53.

As shown in FIG. 5, an insulator layer 62 is a circular disc with an opening at the center thereof and is attached on a surface of insulator sheet 52 to cover the major portion of a plurality of conductors 54 formed on the surface. That is, insulator layer 62 is of a size capable of exposing terminal ends of the respective conductors 54. Though not shown, an insulator layer having the same size and the same shape as insulator layer 62 is attached on a surface of insulator sheet 53 on which a plurality of conductors 56 are formed. FIG. 5 shows

flexible transformer element 50A including insulator layer 62 attached thereon and magnetic layer 65 laid on insulator layer 62. Insulator layer 62 may be fabricated from the same material as insulator sheet 52. Preferably, magnetic layer 65 is slightly smaller than insulator layer 62 in dimensions.

FIG. 6 shows the coupling relationship between the flexible transformer elements according to the present invention to fabricate a secondary coil of a transformer. Insulator layer 62 is attached on insulator sheet 52, and magnetic layer 65 is laid on insulator layer 62. Though not shown, a plurality of conductors 56 shown in FIG. 4B and an insulator layer for covering the major portion of the conductors are provided on a surface of insulator sheet 53, the insulator layer having the same shape as insulator layer 62 shown in FIG. 4A. Each of insulator sheets 52 and 53 has first and second holes 58 and 60. Insulator sheet 53 is laid on insulator sheet 52 so that first and second holes 58 and 60 of insulator sheet 53 are in alignment with those of insulator sheet 52, respectively. A plurality of conductors 54 of insulator sheet 52 are electrically connected to a plurality of conductors 56 (FIG. 4A) of insulator sheet 53 by heat pressing or reflow soldering, respectively. Connected conductors form a zig-zag patterned coil disposed to surround magnetic layer 65 which is provided between insulator sheets 52 and 53. As a result, the fabrication of a secondary coil is completed.

FIG. 7 shows a secondary winding of a transformer according to the present invention. The secondary winding consists of three secondary coils of the present invention, but the number of the secondary coils is not limited especially. Each of first to third secondary coils 70, 70′ and 70" has first and second holes 58 and 60, 58′ and 60′, 58" and 60". First hole 58 of first secondary coil 70 is in alignment with second hole 60′ of second secondary coil 70′. First secondary coil 70 is electrically connected to second secondary coil 70′ by

means of, for example, soldering first and second secondary coils 70 and 70' through first hole 58 and second hole 60' in alignment with each other. First hole 58' of second secondary coil 70' is in alignment with second hole 60" of third secondary coil 70". Second secondary coil 70' is electrically connected to third secondary coil 70" by means of, for example, soldering second and third secondary coils 70' and 70" through first hole 58' and second hole 60" in alignment with each other. However, the connection between first to third secondary coils 70, 70' and 70" may be accomplished by means of connecting conductive wires which are led from the respective first to third secondary coils 70, 70' and 70".

Conductive wires for electrically connecting the secondary winding of the present invention with peripheral device are led from second hole 60 of first secondary coil 70 and first hole 58" of third secondary coil 70", respectively.

With the secondary winding of the present invention, a primary winding of Chang as well as a conventional coil winding is utilized.

While the present invention has been particularly shown and described with reference to particular embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be effected therein without departing from the spirit and scope of the invention as defined by the appended claims.

CLAIMS

1. A secondary winding structure of a transformer comprising:

a first flexible transformer element consisting of a first flexible insulator member of a circular disc shape having an opening at the center thereof and a first plurality of conductors formed on a surface thereof, and a first insulator layer of a circular disc shape having an opening at the center thereof, said first insulator layer being attached on the surface of said first insulator member to expose terminal ends of each of said first plurality of conductors;

a second flexible transformer element consisting of a second flexible insulator member of a circular disc shape having an opening at the center thereof and a second plurality of conductors formed on a surface thereof, and a second insulator layer of a circular disc shape having an opening at the center thereof, said second insulator layer being attached on the surface of said second insulator member to expose terminal ends of each of said second plurality of conductors, said second flexible transformer element being laid on said first flexible transformer element so that the surface of said first insulator member is confronted with the surface of said second insulator member;

a magnetic member of a circular disc shape having an opening at the center thereof, said magnetic member being intervened between said first and second flexible transformer elements so that the terminal ends of said first conductors can come in contact with those of said second conductors; and

connecting members provided at the terminal ends of the respective first and second conductors for electrically connecting said first and second conductors to form a patterned coil which surrounds said first insulator layer, said magnetic layer and said second insulator layer,

wherein said first conductors are arranged in a first radial configuration in which the formation of a conductor is omitted, and said second conductors are arranged in a second radial configuration in which the formation of a conductor is omitted and have the terminal ends which are positioned to come in contact with the terminal ends of said first conductors to form said patterned coil.

2. The secondary winding structure of a transformer as claimed in claim 1, wherein said first transformer element has a first pair of holes which are positioned adjacent to each other at an outer peripheral end portion thereof, one hole being formed at a point where the formation of a conductor is omitted, and the other hole being formed passing through an outer terminal end of a conductor of said first conductors adjacent to the point of said first transformer element, and said second transformer element has a second pair of holes for being aligned with said second pair of holes, said pair of holes being positioned adjacent to each other at an outer peripheral end portion thereof, one hole being formed at a point where the formation of a conductor is omitted, and the other hole being formed passing through an outer terminal end of a conductor of said second conductors adjacent to the point of said second transformer element, whereby said first transformer element is in alignment with said second transformer element to form said patterned coil.

3. The secondary winding structure of a transformer as claimed in claim 1, wherein said first and second insulator members are an insulator film which is made from one selected from polyimide and polyester.

4. The secondary winding structure of a transformer as claimed in claim 1, wherein said first and second insulator layers are an insulator film which is made from one selected from polyimide and polyester.

5. The secondary winding structure of a transformer as claimed in claim 1, wherein said connecting members are solder layers which are formed at the respective terminal ends of said first and second conductors.

6. The secondary winding structure of a transformer as claimed in claim 1, wherein said first and second conductors are copper layers which are deposited on said first and second insulator members.

7. A secondary winding structure of a transformer comprising:

a first flexible transformer element consisting of a first flexible insulator member of a circular disc shape having an opening at the center thereof and a first plurality of conductors formed on a surface thereof, and a first insulator layer of a circular disc shape having an opening at the center thereof, said first insulator layer being attached on the surface of said first insulator member to expose terminal ends of each of said first plurality of conductors;

a second flexible transformer element consisting of a second flexible insulator member of a circular disc shape having an opening at the center thereof and a second plurality of conductors formed on a surface thereof, and a second insulator layer of a circular disc shape having an opening at the center thereof, said second insulator layer being attached on the surface of said second insulator member to expose terminal ends of each of said second plurality of conductors, said second flexible transformer element being laid on said first flexible transformer element so that the surface of said first insulator member is confronted with the surface of said second insulator member;

a magnetic member of a circular disc shape having an opening at the center thereof, said magnetic member being intervened between said first and second flexible transformer elements so that the terminal ends of said

first conductors can come in contact with those of said second conductors; and

connecting members provided at the terminal ends of the respective first and second conductors for electrically connecting said first and second conductors to form a patterned coil which surrounds said first insulator layer, said magnetic layer and said second insulator layer,

wherein said first conductors are arranged in a first radial configuration in which the formation of a conductor is omitted, and said second conductors are arranged in a second radial configuration in which the formation of a conductor is omitted and have the terminal ends which are positioned to come in contact with the terminal ends of said first conductors to form said patterned coil,

wherein said first transformer element has a first pair of holes which are positioned adjacent to each other at an outer peripheral end portion thereof, one hole being formed at a point where the formation of a conductor is omitted, and the other hole being formed passing through an outer terminal end of a conductor of said first conductors adjacent to the point of said first transformer element, and said second transformer element has a second pair of holes for being aligned with said second pair of holes, said pair of holes being positioned adjacent to each other at an outer peripheral end portion thereof, one hole being formed at a point where the formation of a conductor is omitted, and the other hole being formed passing through an outer terminal end of a conductor of said second conductors adjacent to the point of said second transformer element, whereby said first transformer element is in alignment with said second transformer element to form said patterned coil,

wherein said first and second insulator members are an insulator film which is made from one selected from polyimide and polyester,

wherein said first and second insulator layers are an insulator film which is made from one selected from

polyimide and polyester,

wherein said connecting members are solder layers which are formed at the respective terminal ends of said first and second conductors, and

wherein said first and second conductors are copper layers which are deposited on said first and second insulator members.

FIG. 1
PRIOR ART

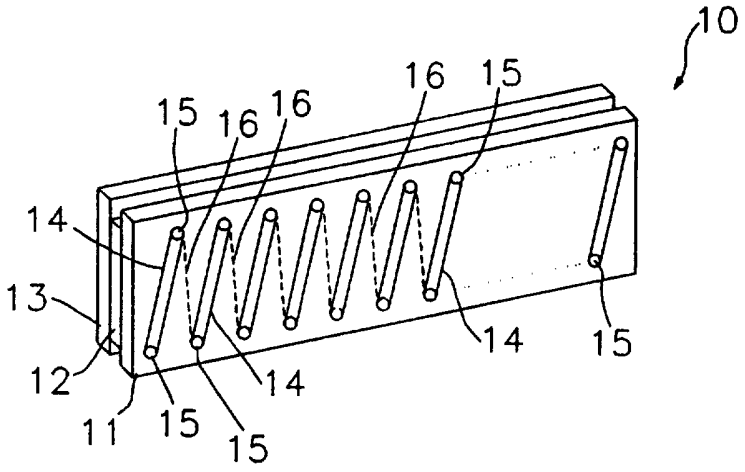


FIG. 2
PRIOR ART

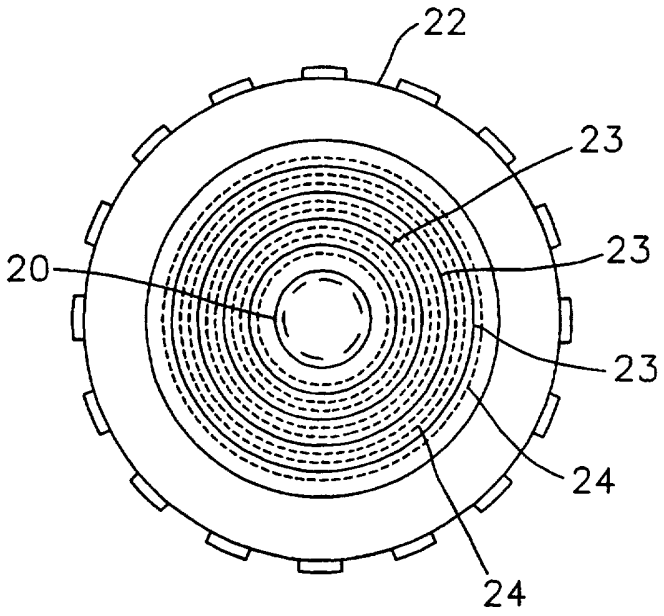


FIG.3
PRIOR ART

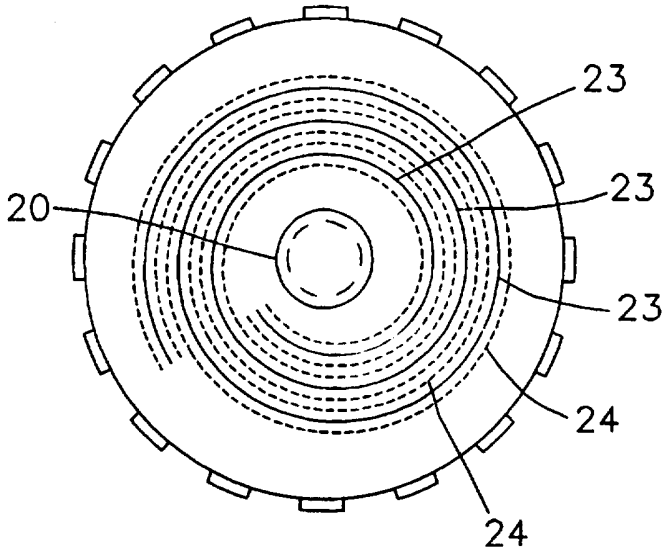


FIG.4A

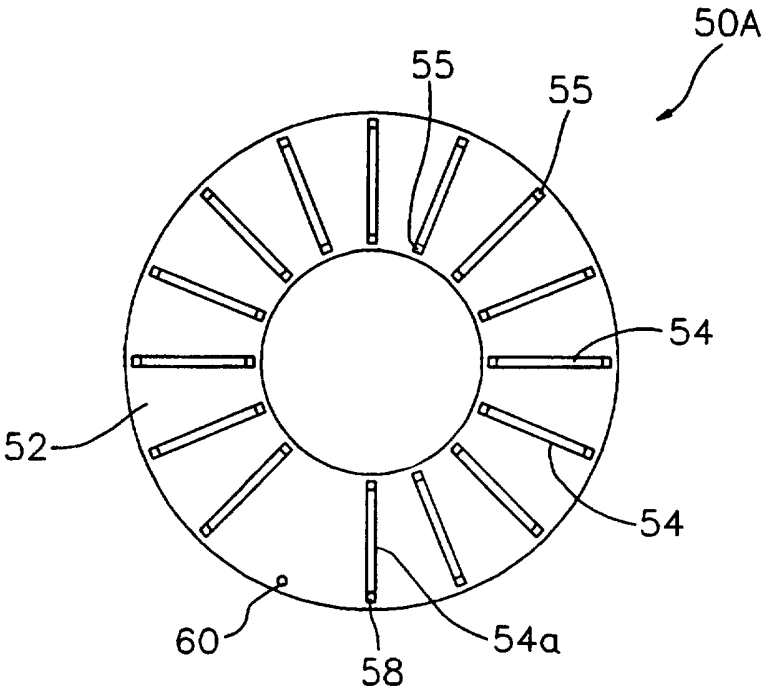


FIG.4B

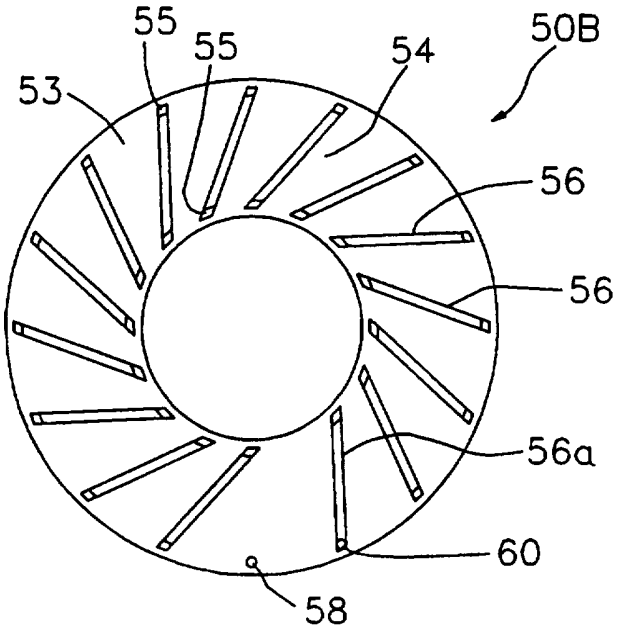


FIG.5

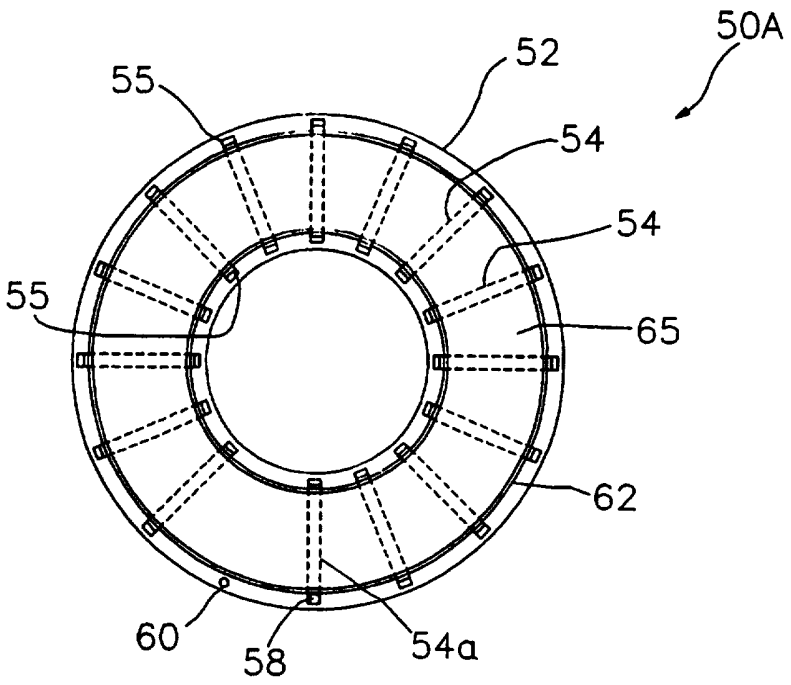


FIG.6

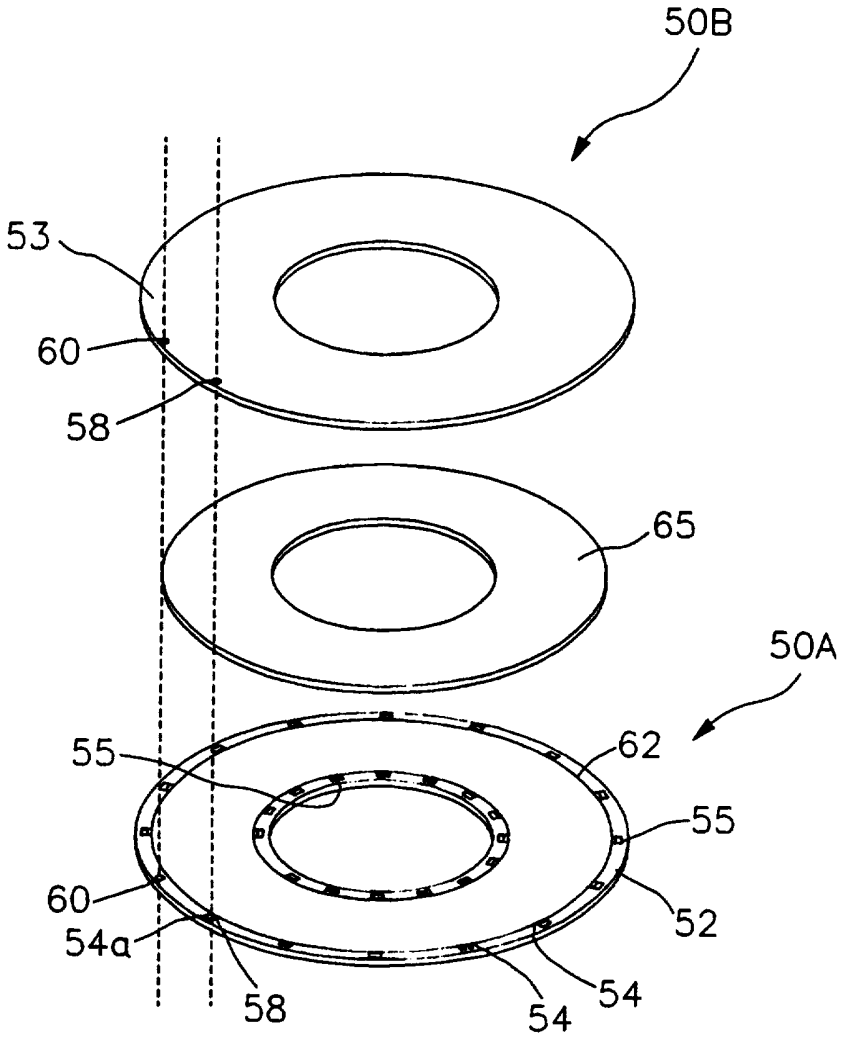
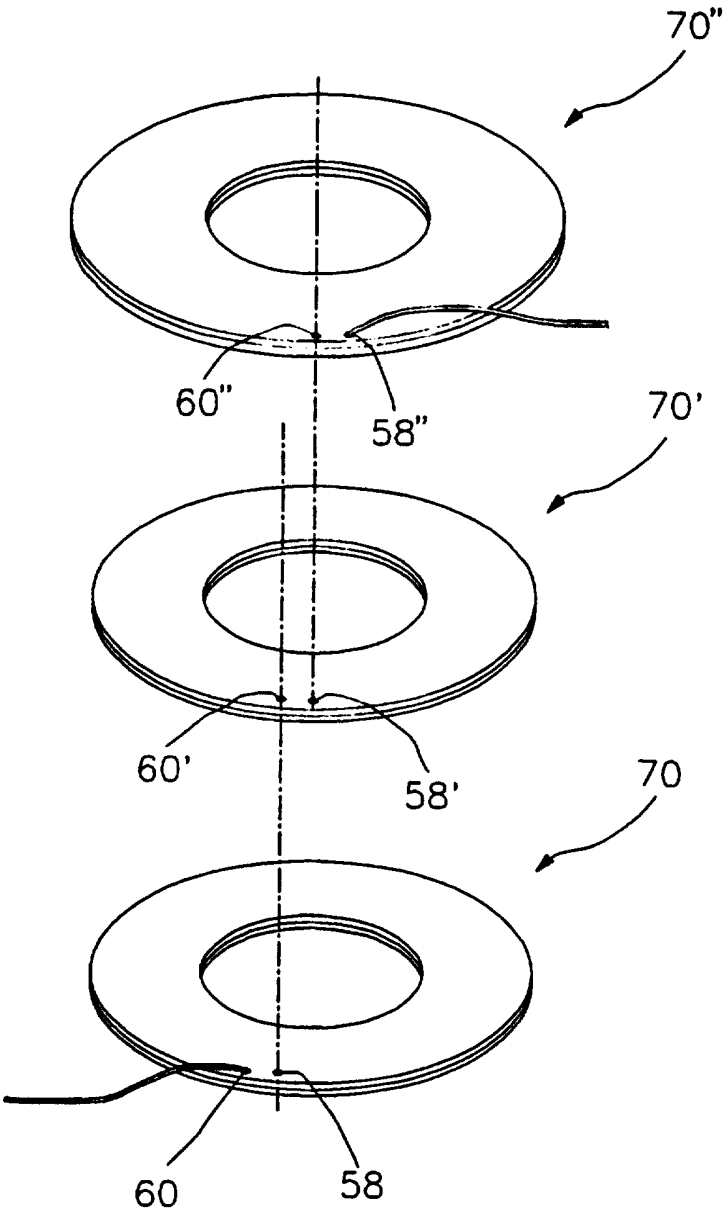


FIG.7



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR 96/00253

A. CLASSIFICATION OF SUBJECT MATTER

IPC[6]: H 01 F 38/42, 41/04

According to International Patent Classification (IPC) or to both national classification and IPC

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, JAPIO, EPOQUE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DD 290 738 A5 (VEB) 06 June 1991 (06.06.91), page 3, lines 14-33; fig.1,2.	1-6,7
Y	US 5 392 020 A (CHANG) 21 February 1995 (21.02.95), column 5, line 9 - column 11, line 19.	1-6,7

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Date of the actual completion of the international search	Date of mailing of the international search report
21 February 1997 (21.02.97)	19 March 1997 (19.03.97)
Name and mailing address of the ISA/ AT AUSTRIAN PATENT OFFICE Kohlmarkt 8-10 A-1014 Vienna Facsimile No. 1/53424/535	Authorized officer Schlechter Telephone No. 1/53424/448

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR 96/00253

Im Recherchenbericht angeführtes Patentdokument Patent document cited in search report Document de brevet cité dans le rapport de recherche	Datum der Veröffentlichung Publication date Date de publication	Mitglied(er) der Patentfamilie Patent family member(s) Membre(s) de la famille de brevets	Datum der Veröffentlichung Publication date Date de publication
DD A5 290738	06-06-91	keine - none - rien	
US A 5392020	21-02-95	CA C 2150953	28-01-97
		EP A1 730778	11-09-96
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