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COMMONWEALTH OF AUSTRALIA
Patents Act 1952
APPLICATION FOR A STANDARD PATENT



We, SECTION 34(4)(a) DIRECTION SEE FOLIO 9
Churchill NAME DIRECTED NEMA POWER COVER, INC.
hereby a ALL 15 WESTINGHOUSE AVENUE, PITTSBURGH, PENNSYLVANIA 15217, United
entitled: STATES OF AMERICA

"REPAIRABLE TRANSFORMER HAVING AMORPHOUS METAL CORE"

which is described in the accompanying complete specification.

DETAILS OF BASIC APPLICATION:



<u>Country</u>	<u>Date</u>	<u>Number</u>
United States of America	21st August, 1987	087,929

Our address for service is:

ADDRESSES FOR SERVICE
ALTERED

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Dated this 29th day of July, 1988

WESTINGHOUSE ELECTRIC CORPORATION
by their Patent Attorneys
HALFORD & MAXWELL:

To: Commissioner of Patents
File: 88 1 163

[Signature]

APPLICATION ACCEPTED AND AMENDMENTS

ALLOWED 9.11.90

5001406 02/08/88

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952-1954

DECLARATION IN SUPPORT OF A CONVENTION
APPLICATION UNDER PART XVI FOR A PATENT

In support of the Convention Application made under Part XVI of the Patents Act 1952-1954 by WESTINGHOUSE ELECTRIC CORPORATION for a patent for an invention entitled "REPAIRABLE TRANSFORMER HAVING AMORPHOUS METAL CORE"

I, D. R. Lackey
of R.D. #3, Box 277A, Export, Pennsylvania 15632, USA
United States of America, do solemnly and sincerely declare as follows:

1. I am authorized by WESTINGHOUSE ELECTRIC CORPORATION, the applicant for the patent, to make this declaration on its behalf.

2. The basic application as defined by Section 141 of the Act was made in the United States of America on August 21, 1987, by the inventor nominated in clause (3) below.

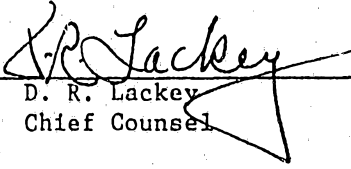
3. TERRENCE EARL CHENOWETH of 1710 Robin Hood Road, Watkinsville, GA 30677, USA is the actual inventor of the invention and the facts upon which WESTINGHOUSE ELECTRIC CORPORATION is entitled to make the application are as follows:

The said WESTINGHOUSE ELECTRIC CORPORATION is the assignee of the said TERRENCE EARL CHENOWETH.

4. The basic application referred to in paragraph 2 of this declaration was the first application made in a convention country in respect of the invention the subject of the application.

Declared at Pittsburgh, Pennsylvania

This 29th day of July, 19 88 .


D. R. Lackey
Chief Counsel

To,
THE COMMISSIONER OF PATENTS,
COMMONWEALTH OF AUSTRALIA.

(12) PATENT ABRIDGMENT (11) Document No. AU-B-20350/88
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 606442

- (54) Title
REPAIRABLE TRANSFORMER HAVING AMORPHOUS METAL CORE
- International Patent Classification(s)
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- (21) Application No. : 20350/88 (22) Application Date : 02.08.88
- (30) Priority Data
- (31) Number (32) Date (33) Country
087929 21.08.87 US UNITED STATES OF AMERICA
- (43) Publication Date : 23.02.89
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- (56) Prior Art Documents
AU 581135 53244/86 H01F 41/02 3/04
AU 534655 86642/82 H01F 41/12 27/32 5/06 H02K 3/30 15/12
WO 87/03738
- (57) Claim

1. A method of making a repairable transformer having a wound amorphous metal core with a core joint in a cut leg of non-circular cross-section, which comprises completely enclosing said core in materials that prevent the escape of particles of said amorphous metal, where some of said materials are impregnated with a curable adhesive, and curing said adhesive to bond materials impregnated therewith to said core, while preventing said adhesive from bonding to the edges of said cut leg and to the edges of the radii that adjoin said cut leg.

2. A method of making a repairable transformer having an annealed wound amorphous metal core with a core joint in a cut leg of non-circular cross-section which

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comprises covering uncut legs of said core with a substrate impregnated with a curable adhesive, while leaving said cut leg and both adjoining radii uncovered; curing said adhesive, whereby said adhesive bonds to said core; opening said core joint; placing at least one coil over at least one leg that adjoins said cut leg; closing said core joint; and covering the edges of said cut leg and both adjoining radii with a porous substrate without bonding said porous substrate to the edges of said cut leg or to the edges of radii that adjoin said cut leg.



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Form 10

PATENTS ACT 1952

COMPLETE SPECIFICATION

(ORIGINAL)

FOR OFFICE USE

Short Title:

Int. Cl:

Application Number:
Lodged:Complete Specification—Lodged:
Accepted:
Lapsed:
Published:

Priority: 21st August, 1987

Related Art:

This document contains the
amendments made under
section 49 and is correct for
printing.

Name of Applicant: **TO BE COMPLETED BY APPLICANT**
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Complete Specification for the invention entitled:

"REPAIRABLE TRANSFORMER HAVING AMORPHOUS METAL CORE"

The following statement is a full description of this invention, including the best method of performing it known
to ~~XXXXXX~~ us:—

* Note: The description is to be typed in double spacing, pica type face, in an area not exceeding 250 mm in depth and 160 mm in
width, on tough white paper of good quality and it is to be inserted inside this form.

This invention relates to repairable transformers having amorphous metal cores, and particularly to such transformers having wound rectangular cores with one cut leg containing a core joint.

5 Despite its high cost, amorphous metal is gradually replacing electrical grade steel in transformer cores because it is a lower loss material. A wound core transformer can be made from amorphous metal by winding an amorphous metal sheet into a core, cutting one leg of the
10 core, and forming the metal into a rectangular shape. The amorphous metal is then annealed, which converts it into a very brittle material. At this point, the core, except for the cut leg, may be protected by the application of a resinous coating. This prevents damage to the core and the
15 escape of broken fragments of amorphous metal into the transformer where they might cause shorts. The cut leg is opened, coils are placed over other legs of the core and the cut leg is closed and sealed. The final assembly is accomplished by placing the core with the coils mounted
20 over its legs into a tank of oil where it is tested at high voltage. If the transformer fails due to a defect in one of the coils, however, the core must be scrapped because the amorphous metal core cannot be disassembled without damage. While the percentage of defective transformers is
25 very low, the high cost of the amorphous metal cores means

that a significant loss is incurred when a core must be scrapped.

It is the main object of this invention to make transformers having amorphous metal cores repairable, so that if a coil of the transformer is defective it can be replaced without damaging the amorphous metal core.

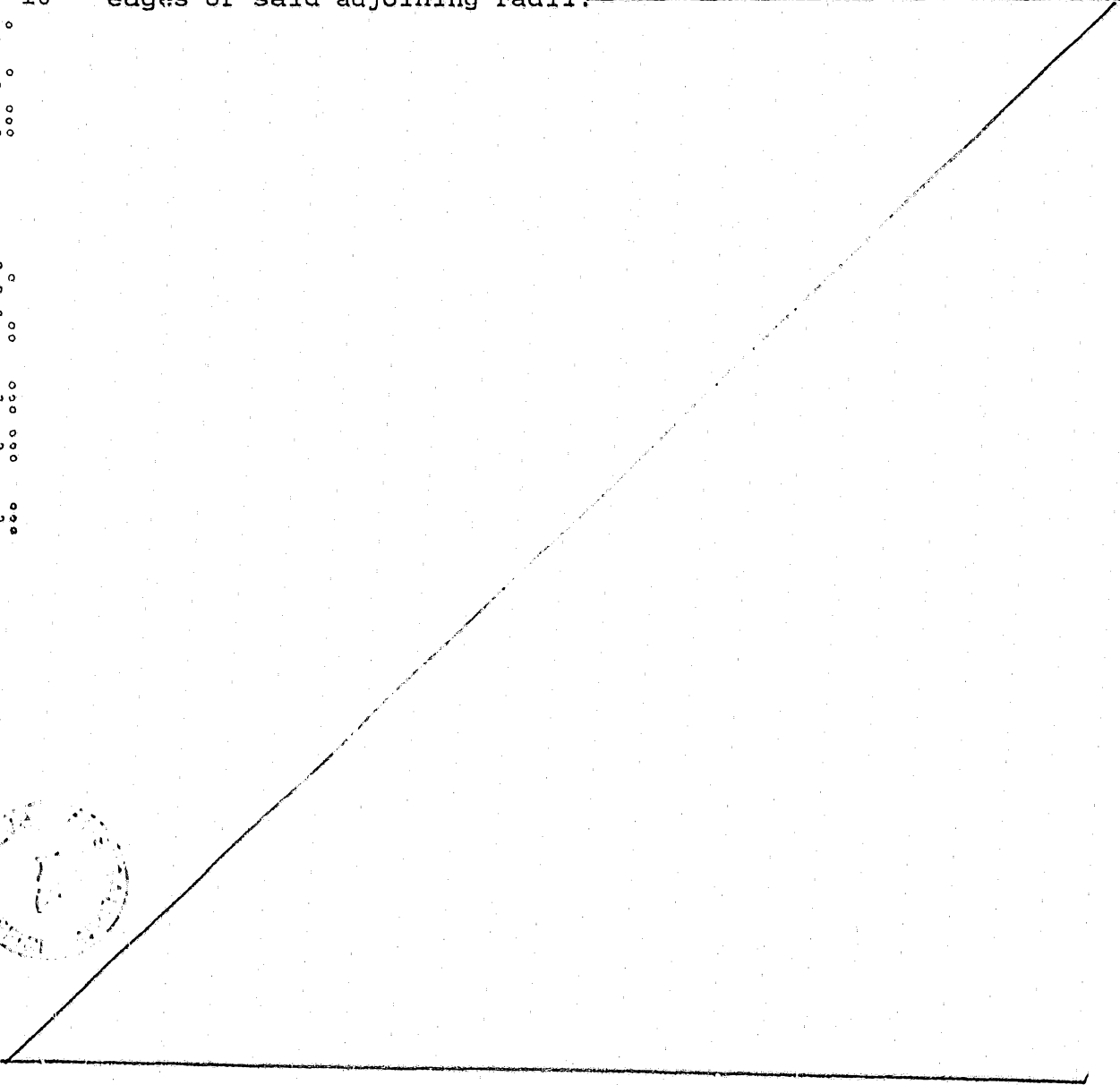
Accordingly, the present invention resides in a method of making a repairable transformer having a wound amorphous metal core with a core joint in a cut leg of non-circular cross-section, which comprises completely enclosing said core in materials that prevent the escape of particles of said amorphous metal, where some of said materials are impregnated with a curable adhesive, and curing said adhesive to bond materials impregnated therewith to said core, while preventing said adhesive from bonding to the edges of said cut leg and to the edges of the radii that adjoin said cut leg.

The invention also includes a repairable transformer which comprises an annealed wound amorphous metal core having a core joint in a cut leg of non-circular cross-section; a first adhesive impregnated reinforcing material bonded to said core, other than to the edges of said cut leg or to the edges of the radii adjoining said cut leg, so as to prevent the escape of particles of said amorphous metal; a coil over each leg that adjoins said cut leg; and porous material covering the edges of said cut leg and said adjoining radii, where said porous material is not bonded to said edges or to



the edges of said adjoining radii.

Further according to the invention is a method of repairing the transformer of the last preceding paragraph which comprises removing the porous material from the cut leg
5 and adjoining radii, opening said cut leg of non-circular cross-section, removing a coil, replacing said removed coil with another coil, closing said cut leg, applying a porous material to the edges of said cut leg and to adjoining radii without bonding said porous material to said edges or to the
10 edges of said adjoining radii.



Transformers having amorphous metal cores can now be made in such a way that they can be repaired without damage to the amorphous metal core. Although the amorphous metal core is still encapsulated to prevent damage to the core and to prevent the escape of fragments from the core, the encapsulation over the leg that is cut and the adjoining radii is not permitted to bond to the edges of the core or to the edges of adjoining radii. Thus, if a transformer made according to this invention is tested at high voltage and is found to contain a defective coil, the protective covering over the cut leg and the adjacent radii can be removed without damaging the amorphous metal core. The cut leg can be opened to permit the replacement of the defective coil. The cut leg is reclosed and is resealed. It is therefore no longer necessary to discard an expensive amorphous metal core when it is assembled with a defective coil.

In order that the invention can be more clearly understood, a convenient embodiment thereof will now be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 is an isometric view showing an amorphous metal core in an early stage of preparation according to a method of the present invention,

Figure 2 is an isometric view showing the core of Figure 1 with the cut leg open for the placement of coils over the two long legs,

Figure 3 shows the core of Figure 2 with the cut leg closed after placement of coils over the long legs, and

Figure 4 shows the core of Figure 3 with the cut leg sealed.

Referring to Figure 1, an amorphous metal core 1 consists of two juxtaposed corelettes 4 and 5. Each corelette is formed over a carbon steel mandrel 2 and is placed in an electrical steel jacket 3 to further protect the amorphous metal. Each corelette was pressed into a rectangular shape and annealed after legs 6 and 7 were cut

through. The edges 8 and 9 of the remaining legs of the corelettes are covered with a adhesive-impregnated substrate 10, which extends over the edges and is cured to bond to the edges of the corelettes.

5 In Figure 2, legs 6 and 7 have been opened and are positioned in a vertical direction for the acceptance of coils. In Figure 3, coils 11 and 12 have been placed over the longer legs of core 1 and cut legs 6 and 7 have been reclosed. By means of a support (not shown) for coils 10 11 and 12, a space 13 has been provided above and below the coils to prevent stressing of the amorphous metal from contact with the coils. A cotton cloth 14 has been placed over the exposed edges of the cut leg and the adjacent radii 15 and 16, both outside and in between corelettes 4 and 5. Cotton cloth 14 overlaps the exposed edges of legs 15 6 and 7, and the overlapped portions are bonded to the legs with dabs of adhesive. (In an alternative procedure, which is presently preferred, cotton cloth 14 is applied during the step shown in Figure 1 and is cut when the leg is 20 opened as shown in Figure 2). A substrate 17, similar or identical to the substrate 10, is wrapped over the cotton cloth and the cut leg at the position of the cut and is impregnated with adhesive in spots which are cured to hold it in place. The adhesive in the adhesive-impregnated 25 substrate 17 bonds to cotton cloth 14 but does not seep through the cotton cloth and does not contact amorphous metal core 1.

In Figure 4 additional adhesive-impregnated substrate 18 is placed over the gap between the two 30 corelettes, and additional adhesive-impregnated substrate 19 covers the space between adhesive-impregnated substrate 18 and cotton cloth 14. All the adhesive-impregnated substrates are then cured. Thus, while the adhesive bonds to jacket 3, to mandrel 12, and to the exposed edges of 35 three legs of the amorphous metal, it never bonds to the edges of the amorphous metal on the cut leg or to the radii that adjoin the cut leg.

The assembly is then placed into an oil filled tank under vacuum, and is tested at high voltage. Should one of the coils 11 or 12 prove to be defective during the test, or, if two or more corelettes are used and one or more corelette is defective, the assembly is removed from the tank and the protective coverings 14, 17, 18, and 19 are cut away. The cut legs 6 and 7 of the corelettes can then be opened as shown in Figure 2 so that the defective coil or corelette can be removed and replaced. The procedures shown in Figures 3 and 4 are then repeated to reseal the cut leg.

The cotton cloth 14 permits air trapped in the core to be replaced with oil when the core is placed in oil under vacuum, but does not permit particles of amorphous metal to pass into the oil outside the coil. If the air pressure in the core is not released, it stresses the core and impairs its magnetic properties. Other air-porous materials that can be used, besides cotton cloth, include glass cloth, polyester cloth, and similar materials.

The substrate may consist of any type of adhesive-impregnable or porous material that has the required physical, chemical, and electrical properties. Suitable materials include glass and various organic fibrous materials such as polyesters, polyimides, and polyamides; glass is preferred for its strength and good insulating properties. The substrate material is preferably woven for greater strength, though matted material may also be used. We have found by experiment that a substrate must be used, as an adhesive without a substrate does not have sufficient strength to hold the amorphous metal in place.

Examples of adhesives that can be used to impregnate the substrate material include UV curable, heat curable, or two-part resins that cure when the two parts are mixed. UV curable resins are preferred as they do not require a heating and cooling period and therefore are much faster to cure. Epoxy, polyester, phenolic, and other

types of organic resinous materials can be used. The preferred resin is a UV curable modified epoxy urethane resin sold under the designation "F-13" by Westinghouse Electric Corporation and described in U.S. Patent Specification No. 4,481,258.

Any number of cores can be used in the transformer, and the invention is not intended to be limited to the two-legged core-form transformer shown in the drawings. For example, the invention is also applicable to shell form transformers, where a single coil (having two or more windings) encircles the butted legs of two cores. The amorphous metal core need not be rectangular, but may have any other suitable shape, such as cruciform (rectangular, but with a circular cross-section) or torus (circular or oval with a rectangular or circular cross-section). The amorphous metal core may consist of a single corelette, or of multiple corelettes where a transformer of greater width is desirable than the available width of amorphous metal. Amorphous metal is a commercially available material sold by Allied Signal Corporation under the trade designation "METGLAS" in a nominal thickness of about 1 mil and a width of from 1 inch to 8 inches. It is generally made of iron, boron, and silicon, and typically contains about 80% (by weight) iron, 14% boron, and 4% silicon, and may also contain carbon, nickel, and other elements. It is prepared by rapidly quenching a thin sheet of metal. (See U.S. Patent Specification No. 3,845,805 for additional information.) This invention is applicable to any type of transformer containing an amorphous metal core where the core is wound and cut, but the transformer is preferably a distribution oil-cooled transformer as the teachings of this invention are most applicable to this type of transformer.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method of making a repairable transformer having a wound amorphous metal core with a core joint in a cut leg of non-circular cross-section, which comprises completely enclosing said core in materials that prevent the escape of particles of said amorphous metal, where some of said materials are impregnated with a curable adhesive, and curing said adhesive to bond materials impregnated therewith to said core, while preventing said adhesive from bonding to the edges of said cut leg and to the edges of the radii that adjoin said cut leg.

2. A method of making a repairable transformer having an annealed wound amorphous metal core with a core joint in a cut leg of non-circular cross-section which comprises covering uncut legs of said core with a substrate impregnated with a curable adhesive, while leaving said cut leg and both adjoining radii uncovered; curing said adhesive, whereby said adhesive bonds to said core; opening said core joint; placing at least one coil over at least one leg that adjoins said cut leg; closing said core joint; and covering the edges of said cut leg and both adjoining radii with a porous substrate without bonding said porous substrate to the edges of said cut leg or to the edges of radii that adjoin said cut leg.

3. A method according to claim 2, wherein the adhesive is UV curable.

4. A method according to claim 2 or 3, wherein the substrate is UV transparent.



5. A method according to claim 4, wherein the substrate is woven glass.

6. A method according to any of claims 2 to 5, wherein the porous substrate is cotton cloth.

7. A method according to any of claims 2 to 6 wherein the core is on a steel mandrel and is enclosed in a steel jacket.

8. A method according to any of claims 2 to 7 wherein the core is rectangular, has a rectangular cross-section, and a coil is placed over each leg that adjoins the cut leg.

9. A repairable transformer which comprise; an annealed wound amorphous metal core having a core joint in a cut leg of non-circular cross-section; a first adhesive impregnated reinforcing material bonded to said core, other than to the edges of said cut leg or to the edges of the radii adjoining said cut leg, so as to prevent the escape of particles of said amorphous metal; a coil over each leg that adjoins said cut leg; and porous material covering the edges of said cut leg and said adjoining radii, where said porous material is not bonded to said edges or to the edges of said adjoining radii.

10. A method of repairing the transformer of claim 9 which comprises removing the porous material from the cut leg and adjoining radii, opening said cut leg, removing a coil, replacing said removed coil with another coil, closing said cut leg, applying a porous material to the edges of said cut leg and to adjoining radii without bonding said porous material to said edges or to the edges of said adjoining radii.



11. A method of making a repairable transformer substantially as described herein with particular reference to Figs. 1 to 4 of the accompanying drawings.

12. Repairable transformers when made by a method as claimed in any of claims 1 to 8 or claim 11.

13. A method of making a repairable transformer as hereinbefore described with reference to the accompanying drawings.

DATED this 31st day of October, 1990.

ASEA BROWN BOVERI, INC.

Patent Attorneys for the Applicant:

PETER MAXWELL & ASSOCIATES

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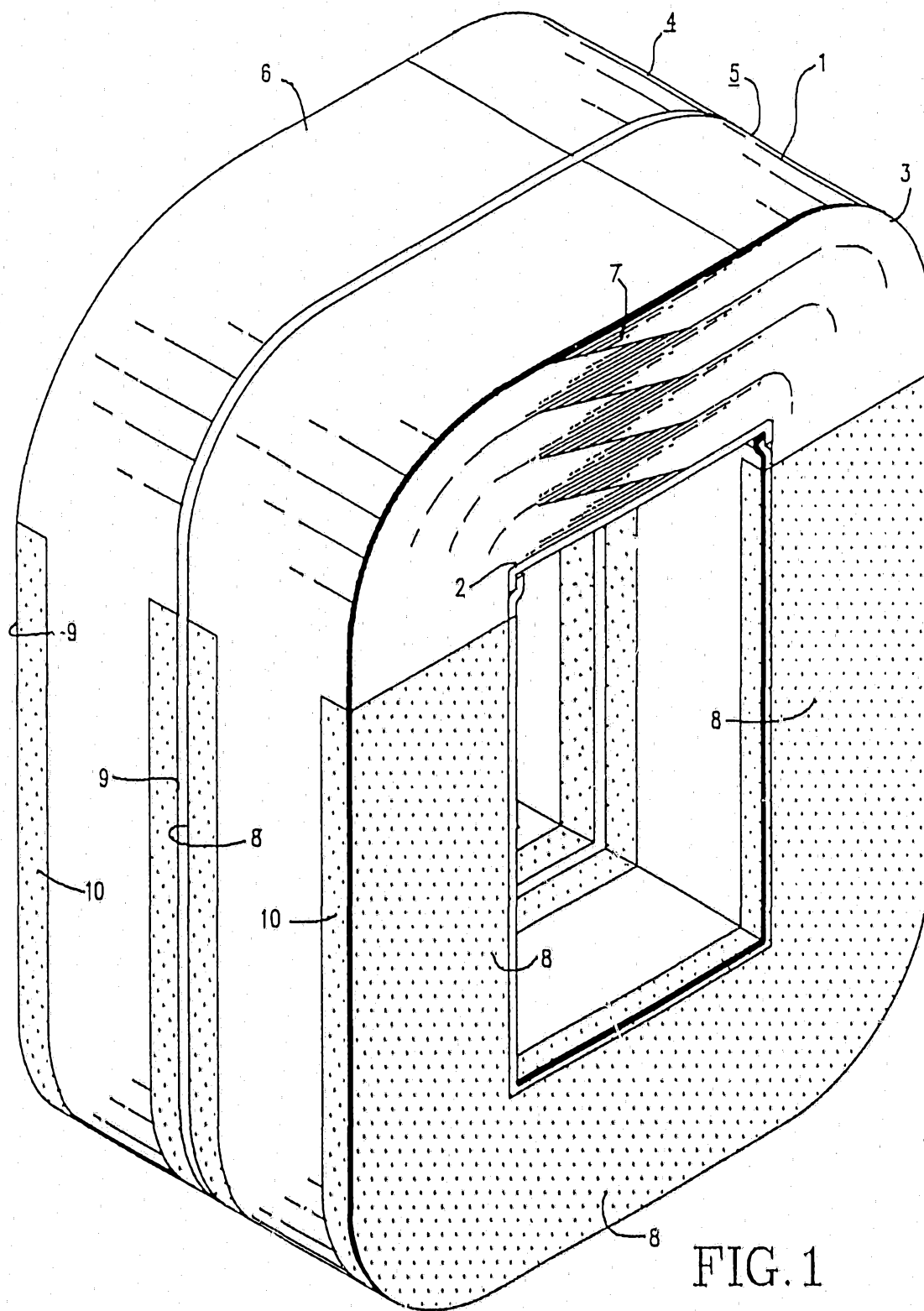


FIG. 1

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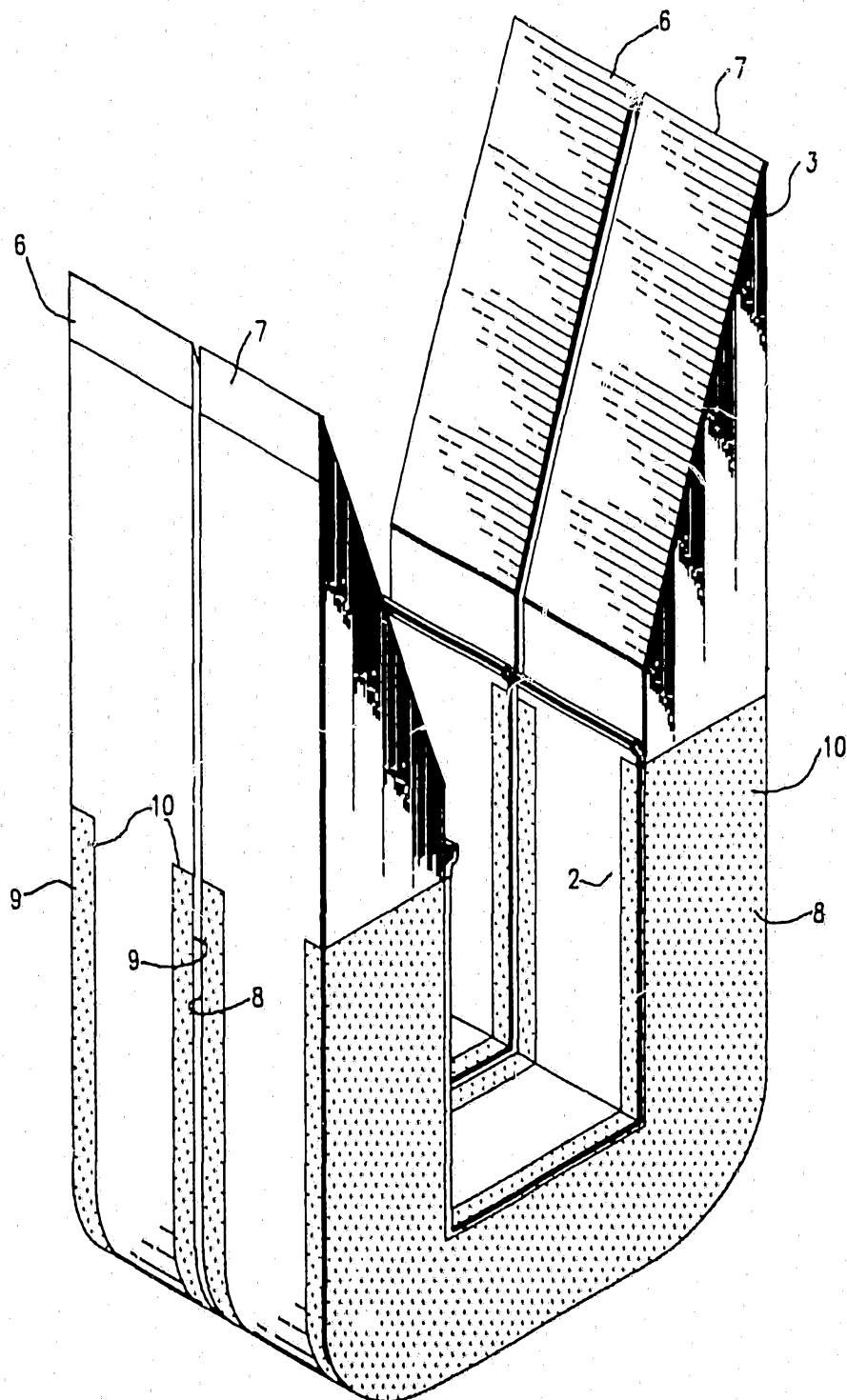


FIG. 2

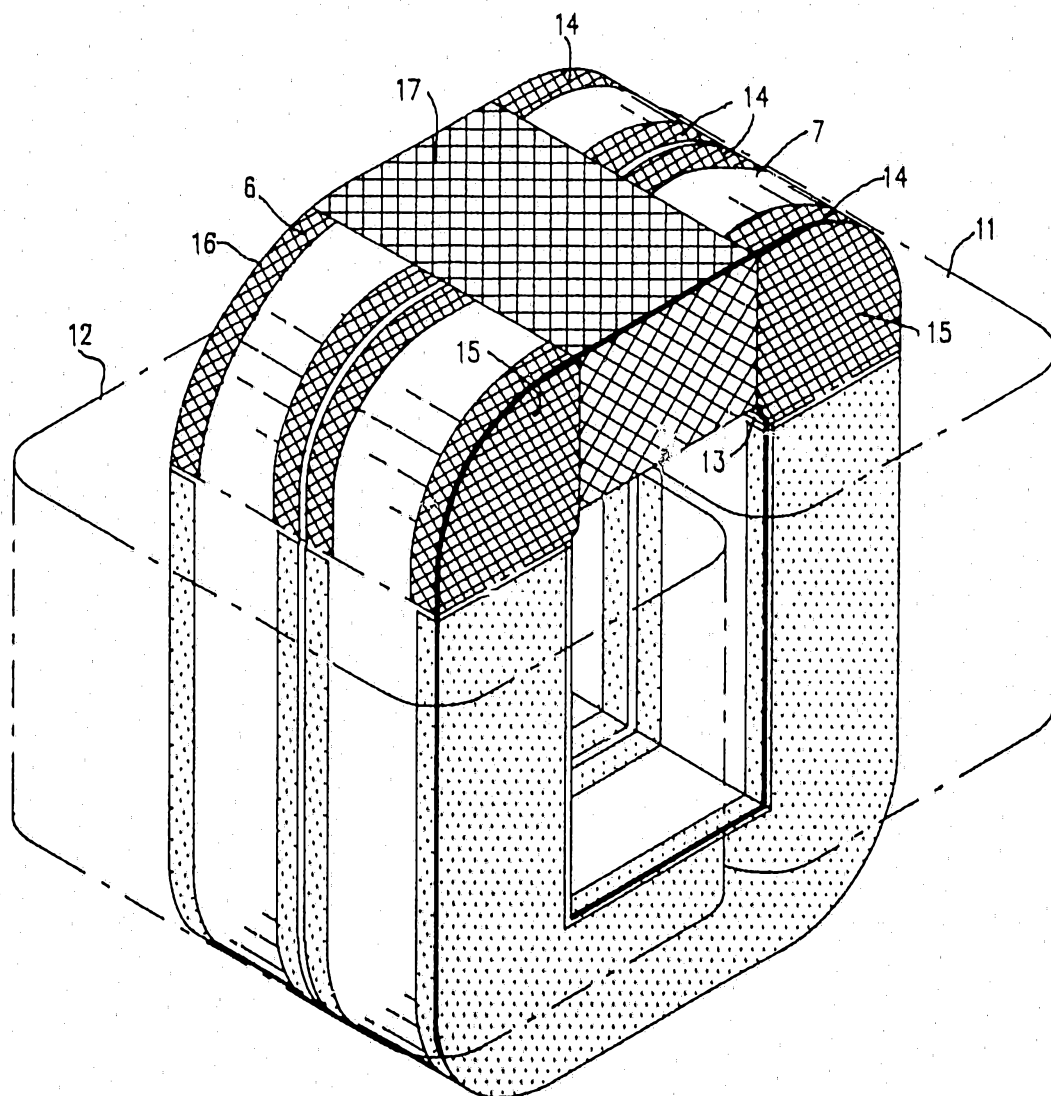


FIG. 3

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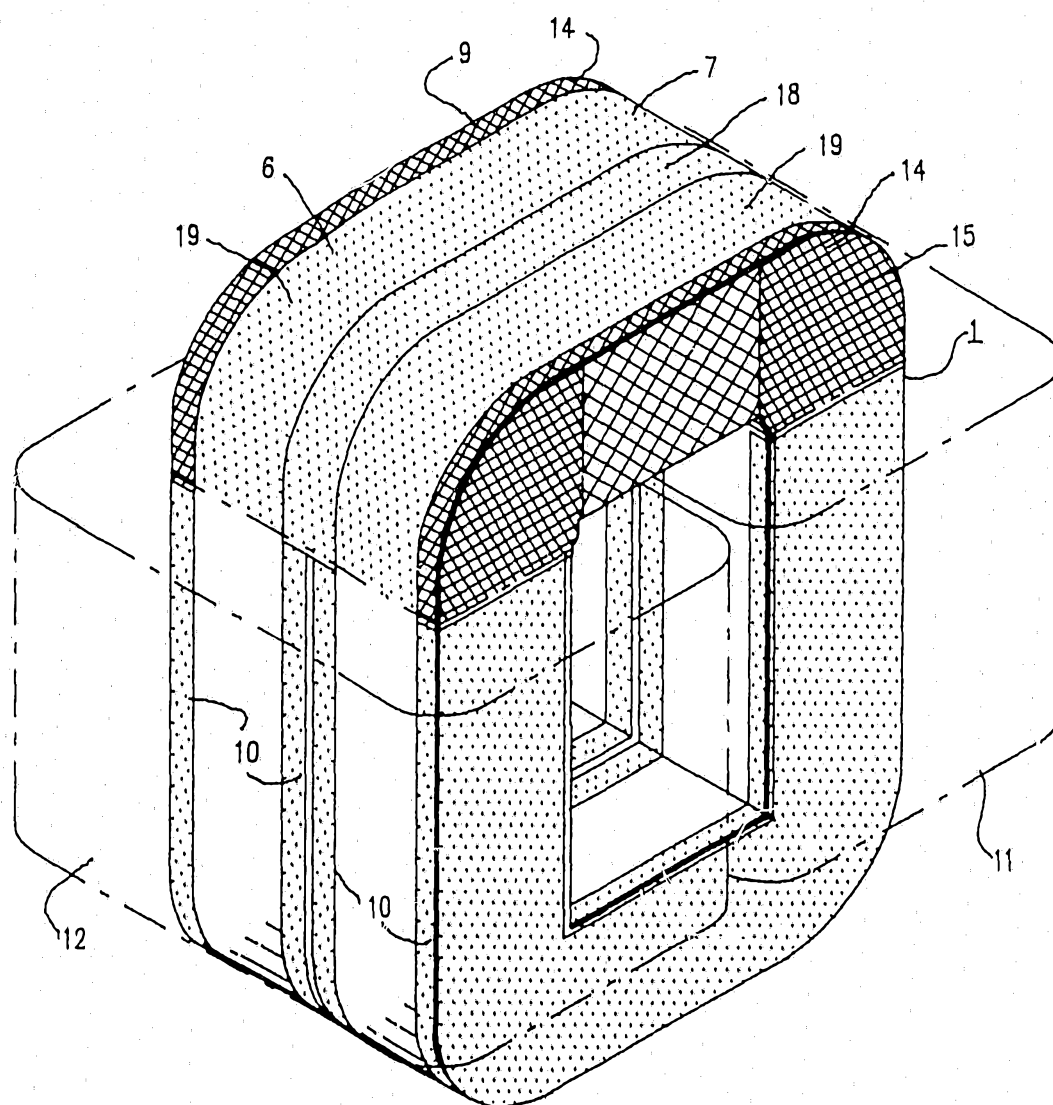


FIG. 4