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(54) **Current-conductive coil and method for manufacturing the same.**

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Description

The present invention relates to a current-conductive coil of a direct cooling type which is used in diagnostic nuclear magnetic resonance devices, nuclear fusion research devices, and the like, and a method for manufacturing the same.

The current-conductive coil employed in diagnostic nuclear magnetic resonance devices, nuclear fusion research devices, and the like is an air core coil of a direct cooling type. In the case of this current-conductive air core coil of a direct cooling type, cooling water is flowed through the hollow portion of a coil conductor to remove heat caused by a current flowing through the coil conductor, thus cooling the coil conductor.

One unit of this current-conductive air core coil represents either the single pancake coil 2 as shown in Fig. 1 or the double pancake coil 4 as shown in Fig. 2. The single pancake coil 2 is constructed by winding a hollow conductor in a spiral and double pancake coil 4 is constructed by connecting pancake coils 6 and 8 at the inner ends thereof, said pancake 6 and 8 having been wound in opposite directions to form a spiral, respectively. The double pancake coil 4 may be constructed by winding a hollow conductor.

One coil unit is formed by piling several or ten and several units of pancake coils one upon the other, and a plurality of these coil units is connected with one another to form a current-conductive air core coil. When the current-conductive air core coil is current-applied, cooling liquid is flowed through each unit of the pancake coil. The reason why water cooling system is provided for each unit of the pancake coil resides in equalizing the temperature distribution over the whole of the current-conductive air core coil to lower flow resistance in the cooling water passage and to enhance the cooling efficiency.

Diagnostic nuclear magnetic resonance devices and nuclear fusion research devices are demanded to use an equalized magnetic field. The strength of the magnetic field caused by the current-conductive air core coil is determined by the coil shape and the current flowing through the coil, while the uniformity thereof is determined by the coil shape. It is therefore necessary that the shape dimension of the coil product is accurate in order to make uniform the magnetic field caused by the current-conductive air core coil.

The conventional current-conductive coil is manufactured, as shown in Fig. 3, in such a manner that an insulating tape 12 is wound around a hollow conductor 10 in the process of winding the conductor 10, whose section is rectangular, in a spiral, and that the single or double pancake coil thus formed is fixed by fixing the conductor by prepreg. As described above, the troublesome process of winding the insulating tape 12 around the conductor 10 when the conductor is wound in a spiral is needed to insulate the conductor from its adjacent one. Therefore, the process of insulating the conductor from its adjacent one in the course of manufacturing the conventional current-conductive coil is a cause which makes it difficult to shorten its manufacturing time. A long air core coil conductor ranging from several hundred meters to several thousand meters is used particularly by diagnostic nuclear magnetic resonance devices and nuclear fusion research devices, and the insulating process for the conductor used, accordingly, takes an extremely long time to manufacture.

The insulating tape 12 is wound around the conductor 10 in such a way that the insulating tape 12 is partly overlapped upon itself. Therefore, steps corresponding to the thickness of the overlapped insulating tape 12 are formed on the surface of the insulating tape wound around the conductor. The dimension accuracy of the single or double pancake coil thus wound is poor because of these steps, thus making it difficult to create a uniform magnetic field using the conventional current-conductive coil.

As shown in Figs. 3 and 4, a reliably sufficient insulation is achieved by winding the insulating tape 12 around the conductor 10. However, in the case of diagnostic nuclear magnetic resonance devices, a high degree of insulation is achieved, though the current flowing through the conductor is small. In short, the insulation process applied to the conventional conductor is more than enough in the case of diagnostic nuclear magnetic resonance devices.

Prior art document AU—B—521 297 discloses a stack of pancake coils in which each pancake coil consists of a current conductor coil comprising a conductor wound in a spiral and having a pair of inner and outer fixing faces when viewed in the direction in which the conductor is wound in a spiral. A prepreg tape is interposed between the adjacent fixing faces of the conductor, said prepreg tape being wide enough to cover the fixing face, extending along the fixing face and being made of insulating material such as polyethylene teraphthalate or other suitable insulating material preimpregnated with thermosetting resin. Pads of glass fibre are provided between two adjacent pancake coils to form insulating means between these pancake coils.

Further, prior art document JP—A—5 752 107 describes a resin-immersed moulded coil which is produced by disposing a bare conductor and a hollow sleeve formed by weaving fibrous material in parallel-winding them and immersing it with resin.

In a similar arrangement, prior art document JP—A—53 141401 shows straight line strip-like conductors between which there is provided some insulating material made of glass cloth or nylon fabric coated with thermosetting adhesive varnish.

Finally, similar to the above-mentioned document AU—B—521 297 also prior art document GB—A—715 226 discloses also a stack of pancake coils, each of said coils being formed by a conductor wound in a spiral. The coils are electrically insulated from each other by interposing disks of insulating material between adjacent coils.

An object of the present invention is to provide a current-conductive coil and a method for manufacturing the current-conductive coil, which simplifies its electrically-insulating process in order to substantially shorten its manufacturing time, and enables its dimension accuracy to be made extremely high in order to create a highly-equalized magnetic field.

According to the present invention, there is provided a current-conductive coil comprising two pancake coils each including a rectangular conductor wound in a spiral and having a pair of inner and outer fixing faces when viewed in the direction in which the conductor is wound in a spiral, a prepreg tape extending along the fixing face and with a width enough to cover the fixing face, the prepreg tape being interposed between the adjacent fixing faces of the conductor to fix the fixing faces and electrically insulate the fixing faces from each other by being fused and solidified, and insulating means between the two pancake coils, said current-conductive coil being characterized in that said insulating means comprises a circular prepreg sheet sandwiched between the two pancake coils which are coaxially provided with their wound-directions opposed to each other, said pancake coils being fixed and electrically insulated from each other by fusing and solidifying of said prepreg sheet and the prepreg sheet consisting of a plurality of portions which are laid on the ring-shaped plain face of the pancake coils and arranged in the circumferential direction thereof.

Further, according to the present invention, there is provided method for manufacturing the current-conductive coil comprising: a first process of winding a rectangular conductor in a spiral and sandwiching a prepreg tape between the already-wound portion and to-be-wound portion of the conductor to form a single pancake coil, said prepreg tape having substantially the same width as that fixing face of the already-wound portion of the conductor where the to-be-wound portion of the conductor is wound, the method being characterized by further comprising a second process of coaxially putting two single pancake coils one upon the other with a circular prepreg sheet consisting of a plurality of portions which are laid on the ring-shaped plain face of the pancake coil and arranged in the circumferential direction of the pancake coil, and a third process of heating the prepreg tape and the prepreg sheet under a pressurized condition to fix the wound conductor and the single pancake coils to each other and to insulate the fixing face of the conductor from its adjacent one and one of the single pancake coils from each other.

The double pancake coils can be manufactured by putting the two single pancake coils one upon the other with the prepreg sheet sandwiched between them, and heating the prepreg sheet to fix the single pancake coils with each other and to insulate them from each other. The double pancake coils can be thus manufactured more easily. In summary, the present invention enables the current-conductive coil to be manufactured with greater ease, at higher speed and with a lower cost in order that a uniform magnetic field may be created by the current-conductive coil.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a perspective view showing a single pancake coil;

Fig. 2 is a perspective view showing a double pancake coil;

Fig. 3 is a perspective view showing the conventional method of manufacturing the current-conductive coil;

Fig. 4 is a perspective view showing the conventional current-conductive coil sectioned partly;

Fig. 5 is a perspective view showing a method for manufacturing the current-conductive coil;

Fig. 6 is a perspective view showing a single pancake coil sectioned partly;

Fig. 7 is a perspective view showing a process of insulating a double pancake coil; and

Fig. 8 is a sectional view showing a modification of the conductor.

Figs. 5, 6 and 7 show manufacturing processes of current-conductive coils in which Fig. 5 is a perspective view showing a process for winding the conductor, Fig. 6 a perspective view showing a single pancake coil sectioned partly, and Fig. 7 a perspective view showing an insulating process performed when single pancake coils are put one upon the other to make a double pancake coil according to the invention.

A single pancake coil 20 shown in Fig. 5 includes a hollow conductor 22 wound in a spiral, and a prepreg tape 40 interposed along the conductor 22 when this is wound. The conductor 22 has a substantially rectangular section, and a hollow portion 24 in the center of its section extending along its longitudinal axis and through which cooling water flows. Four corners of the conductor 22 are chamfered to form chamfered portions 26.

The prepreg tape 40 is prepared by cutting the prepreg in such a way that it is wide enough to cover the face of the conductor where the conductor is brought into contact with its adjacent inside one during the winding process. The prepreg itself is made by impregnating a sheet-shaped reinforcing material such as fabric, paper and mat with thermosetting resin. The thermosetting resin may be polyester, epoxydiaryl phthalate, phenol or solamine. The reinforcing material may be cloth of glass fabric, mat, rope, robe, paper, cotton fabric, nonwoven polyester fabric, or kraft paper. The glass cloth, for example, is immersed in epoxy resin liquid to impregnate both faces of the cloth with epoxy resin, thus making the prepreg. The prepreg is not sticky, and is easy to cut and treat. When the prepreg is heated under pressurized conditions, the resin impregnated in it becomes liquid to fill the space between the conductor and its adjacent inside one, and then hardens to fix the conductor.

When the hollow coil conductor 22 is wound in a spiral, it is wound with the prepreg tape 40

interposed between its already-wound portion 28 and its to-be-wound portion 30, as shown in Fig. 5. As the result, the prepreg tape 40 is sandwiched between the outer circumferential face (fixing or overlapping face) of its inside portion and the inner circumferential face (fixing or overlapping face) of its outside portion to cover the whole of each of these faces, so that the single pancake coil 20 in which its inside portion (or already-wound portion) has been electrically insulated from its outside portion (or to-be-wound portion) can be obtained.

Two single pancake coils 20 are then coaxially put one upon the other with prepreg sheets 42 sandwiched between them. In this case, however, the direction in which one of the pancake coils 20 is wound is made opposite to that of the other. The prepreg may be cut in a ring and then arranged on one of the pancake coils 20. However, it is preferable that the prepreg be cut into four prepreg sheets 42, for example, corresponding to the shape divided from the ring-shaped plain face of the pancake coil 20, and that these four prepreg sheets 42 are connected with one another in the circumferential direction of the pancake coil 20 and then arranged thereon. The dimension errors relating to the plain face of the pancake coil 20 and the shape of the prepreg sheets can be thus absorbed by the manner of arranging four prepreg sheets 42 on the plain face of the pancake coil 20. As a result, the plain face of the pancake coil 20 can be covered completely by the prepreg sheets 42 to thereby insulate one of the pancake coils 20 from the other electrically.

These two pancake coils 20 are then fixed under a pressurized condition by means of a tool such as a metal frame. The pancake coils 20 thus pressurized and fixed are heated and dried in a heating furnace such as an electric furnace. The resins impregnated in the prepreg tape 40 and sheets 42 thus becomes liquid to fill the spaces between the inner and outer circumferential faces of the conductors 22 and also between the pancake coils 20. As it hardens, insulating layers of resin are formed between the circumferential faces of the conductors 22, and between the plain faces of the pancake coils 20 to fix the conductors 22.

When a prepreg made by impregnating glass cloth with epoxy resin is used, the resin becomes hardened by heating the prepreg at 130 to 150°C for 8 to 10 hours. On the other hand, when another prepreg made by impregnating unwoven polyester fabric with epoxy resin is used, the resin becomes hardened by heating the prepreg at 120°C for two hours.

The conductor 22 has chamfer portions 26 formed at the four corners thereof, and these chamfer portions 26 serve as passages through which the heated resin moves and through which the excessive resin escapes, thus enabling the insulating layer of resin to be uniform. Even if any error is caused when the prepreg is cut to a tape 40 or even if any positional error is caused when the conductor 22 is wound, the conductor 22 is separated from its adjacent inside and outside ones at their chamfer portions, thus preventing any insulating trouble from happening.

The thickness of the prepreg tape 40 or sheet 42 is determined by voltages applied to the coil line and between the pancake coil lines. In the case of the hollow coil employed in the diagnostic nuclear magnetic resonance device, for example, it is enough to create a magnetic field of several kilo-gausses. Therefore, a voltage of only several tens volts is applied between the pancake coils. Since the insulating resistance of epoxy resin is larger than 10^{14} Ω cm when expressed by the ratio of volume resistance, resistance larger than 30 MΩ can be obtained when the area of the resin layer is 10^4 π cm^2 and its thickness is 0.1 mm. Therefore, the prepreg layer, about 0.1 mm thick, is enough to serve as the insulator in the above application. The prepreg tape 40 or sheet 42 whose thickness is larger than 0.1 mm is usually employed, taking safety into consideration. In the case of the prepreg impregnated with epoxy resin, resistance larger than 100 MΩ can be obtained at a common temperature when the prepreg tape or sheet whose thickness is 0.32 mm is used. When it is intended to form a layer of prepreg whose thickness is 0.6 mm, for example, it is preferable that prepreg tapes or sheets of 0.3 mm thick are used in an overlapped manner rather than the prepreg tapes or sheets of 0.6 mm thick. This is because even if one of the prepreg tapes is slightly shifted from the circumferential face of the conductor 22, some portions of the circumferential face are left uncovered. However, when the tape is overlapped on the circumferential face, the other tape can cover these uncovered portions to secure insulation between the circumferential face and its adjacent one. It is also preferable that the outermost circumferential face of the conductor is covered by a prepreg tape whose thickness is 0.5 mm so as to establish higher insulation, because the outermost circumferential face of the conductor is likely to be subjected to severe circumstances.

It is relatively easy to obtain a coil conductor whose shape dimension is highly accurate, and a prepreg tape or sheet whose thickness is highly accurate. According to the present invention, the conductor is not wound by the insulating tape, but the prepreg tape 40 is overlapped onto the circumferential face of the conductor 22, thus enabling the insulating layer to be high in its dimension accuracy. Therefore, the dimension accuracy of the current-conductive coil is high. The diameter of the finished coil is different by only about 2 mm from the desired diameter even if the coil is a large-sized hollow coil for use in diagnostic nuclear magnetic resonance devices. When the current-conductive coil according to the present invention is used, therefore, a uniform magnetic field can be created. In addition, the insulating process is easily done in the case of the method for manufacturing the current-conductive coil according to the present invention, thus allowing the current-conductive coil to be manu-

factured with more simplicity and at higher speed.

Two pancake coils 20 are press-fixed with the prepreg sheets 42 interposed between them, and then heated to make the conductors adhere as in the above-described embodiment. However, each of the single pancake coils may be formed and then heated to make the conductors also adhere, and the two pancake coils 20 can be press-fixed with the prepreg sheets 42 sandwiched between them, and then heated to make these pancake coils 20 adhere to each other. The conductor is not limited to having a rectangular section; it may also be flat in section, as shown in Fig. 8. In short, it may have a linearly-extending portion at the edge of that area where its inner and outer sections 32 and 34 are opposed face to face. Further, its hollow portion 24 through which the cooling water flows is not limited to having a circular section; it may also be rectangular in section, as shown in Fig. 8.

The pancake coils press-fixed by metal frame have been heated in a heating furnace in the above-described embodiment. However, the resins may be heated by that resistance heat of the conductors themselves which is caused by applying current to the conductors in the pancake coils which have been press-fixed by a metal frame.

Claims

1. A current-conductive coil comprising:

two pancake coils (20) each including a rectangular conductor (22) wound in a spiral and having a pair of inner and outer fixing faces when viewed in the direction in which the conductor is wound in a spiral,

a prepreg tape (40) extending along the fixing face and with a width enough to cover the fixing face, the prepreg tape (40) being interposed between the adjacent fixing faces of the conductor to fix the fixing faces and electrically insulate the fixing faces from each other by being fused and solidified, and

insulating means between the two pancake coils, characterized in that said insulating means comprises a circular prepreg sheet (42) sandwiched between the two pancake coils (20) which are coaxially provided with their wound-directions opposed to each other, said pancake coils (20) being fixed and electrically insulated from each other by fusing and solidifying of said prepreg sheet (42), and the prepreg sheet (42) consisting of a plurality of portions which are laid on the ring-shaped plain face of the pancake coils (20) and arranged in the circumferential direction thereof.

2. A current-conductive coil according to claim 1, characterized in that the conductor (22) has chamfer portions (26) formed at its four corners.

3. A current-conductive coil according to claim 2, characterized in that the prepreg tape (40) and sheet (42) are made by impregnating a reinforcing sheet with thermosetting resin, the resin being made liquid to fill between the fixing faces and also between the pancake coils and then hardened to fix the fixing faces with each other and also the pancake coils with each other, when it is heated.

4. A current-conductive coil according to claim 3, characterized in that the reinforcing sheet is of glass fabric cloth and the thermosetting resin is of epoxy.

5. A method for manufacturing the current-conductive coil comprising:

a first process of winding a rectangular conductor (22) in a spiral and sandwiching a prepreg tape (40) between the already-wound portion (28) and to-be-wound portion (30) of the conductor (22) to form a single pancake coil (20), said prepreg tape (40) having substantially the same width as that fixing face of the already-wound portion (28) of the conductor where the to-be-wound portion (30) of the conductor is wound,

characterized by further comprising a second process of coaxially putting two single pancake coils (20) one upon the other with a circular prepreg sheet (42) interposed between them, the prepreg sheet consisting of a plurality of portions (42) which are laid on the ring-shaped plain face of the pancake coil (20) and arranged in the circumfenrential direction of the pancake coil, and

a third process of heating the prepreg tape (40) and the prepreg sheet (42) under a pressurized condition to fix the wound conductor and the single pancake coils (20) to each other and to insulate the fixing face of the conductor from its adjacent one and one of the single pancake coils (20) from each other.

6. A method according to claim 5, characterized by a fourth process of heating the thus-overlapped two single pancake coils (20) under a pressurized condition to fix the single pancake coils (20) with each other and to electrically insulate the single pancake coils (20) from each other.

7. A method according to claim 5 or 6, characterized in that the prepreg tape (40) and sheet (42) are made by impregnating a reinforcing sheet with thermosetting resin, the resin being made liquid to fill between the pancake coils, and then hardened to fix the fixing faces of the conductor and also the pancake coils with each other, when it is heated.

8. A method according to claim 7, characterized in that the reinforcing sheet is of glass fabric cloth and the thermosetting resin is of epoxy, and the heating temperature ranges from 130°C to 150°C while the heating time ranges from 8 to 10 hours.

Revendications

1. Bobine conductrice de courant, comprenant:

deux bobines plates (20) comportant chacune un conducteur rectangulaire (22) enroulé en une spirale et possédant une paire de faces de fixation interne et externe, lorsqu'on les observe dans la direction où le conducteur s'enroule en spirale,

une bande de matériau préimprégné (40)

s'étendant le long de la face de fixation et ayant une largeur suffisante pour couvrir la face de fixation, la bande de matériau préimprégné (40) s'interposant entre les faces de fixation adjacentes du conducteur de manière à fixer les faces de fixation et à électriquement isoler les faces de fixation l'une par rapport à l'autre par une fusion suivie d'une solidification, et

un moyen d'isolation placé entre les deux bobines plates, caractérisée en ce que ledit moyen d'isolation comprend une feuille de matériau préimprégné circulaire (42) prise en sandwich entre les deux bobines plates (20) qui sont disposées coaxialement de manière que leurs sens d'enroulement soient opposés l'un à l'autre, lesdites bobines plates (20) étant fixées et électriquement isolées l'une de l'autre par fusion et solidification de ladite feuille de matériau préimprégné (42), et ladite feuille de matériau préimprégné (42) étant constituée de plusieurs parties qui sont disposées sur la face plate en forme d'anneau des bobines plates (20) et disposées suivant leur direction circonférentielle.

2. Bobine conductrice de courant selon la revendication 1, caractérisée en ce que le conducteur (22) possède des parties chanfreinées (26) qui sont formées à ses quatre coins.

3. Bobine conductrice de courant selon la revendication 2, caractérisée en ce que la bande (40) et la feuille (42) de matériau préimprégné sont faites par imprégnation d'une feuille de renforcement au moyen d'une résine thermodurcissable, la résine étant rendue liquide afin qu'elle remplisse l'espace existant entre les faces de fixation et également entre les bobines plates, puis durcissant de manière à fixer les faces de fixation entre elles ainsi que les bobines plates entre elles, lorsqu'on la chauffe.

4. Bobine conductrice de courant selon la revendication 3, caractérisée en ce que la feuille de renforcement est faite d'un tissu de fibre de verre et la résine thermodurcissable est faite d'époxy.

5. Procédé de fabrication de la bobine productrice de courant, comprenant:

une première opération consistant à enrouler un conducteur rectangulaire (22) en une spirale et à prendre en sandwich une bande de matériau préimprégné (40) entre la partie déjà enroulée (28) et la partie à enrouler (30) du conducteur (22) afin de former une bobine plate simple (20), la bande de matériau préimprégné (40) ayant sensiglement la même largeur que la face de fixation de la partie déjà enroulée (28) du conducteur où on enroule la partie à enrouler (30) du conducteur,

caractérisé en ce qu'il comprend en outre une deuxième opération consistant à poser coaxialement deux bobines plates simples (20) l'une sur l'autre en interposant entre elles une feuille de matériau préimprégné circulaire (42), la feuille de matériau préimprégné étant constituée de plusieurs parties (42) qui sont étendues sur la face plate en forme d'anneau de la bobine plate (20) et sont disposées dans la direction circonférentielle de la bobine plate, et une troisième opération consistant à chauffer la bande de matériau préimprégné (40) et la feuille de matériau préimprégné (42) sous certaines conditions de pression afin de fixer le conducteur enroulé et les bobines plates simples (20) entre eux et d'isoler la face de fixation du conducteur de la face de fixation adjacente et une des bobines plates simples (20) de l'autre.

6. Procédé selon la revendication 5, caractérisé par:

une quatrième opération consistant à chauffer deux bobines plates simples (20) se chevauchant dans certaines conditions de pression afin de fixer les bobines plates simples (20) entre elles et d'isoler électriquement les bobines plates simples (20) l'une de l'autre.

7. Procédé selon la revendication 5 ou 6, caractérisé en ce que la bande (40) et la feuille (42) de matériau préimprégné sont faites par imprégnation d'une feuille de renforcement au moyen d'une résine thermodurcissable, la résine étant rendue liquide afin qu'elle remplisse la place existant entre les bobines plates, puis durcissant pour fixer les faces de fixation du conducteur et aussi les bobines plates entre elles, lorsqu'on la chauffe.

8. Procédé selon la revendication 7, caractérisé en ce que la feuille de renforcement est faite d'un tissu de fibre de verre et la résine thermodurcissable est faite d'époxy, la température de chauffage s'étendant de 130°C à 150°C, tandis que la durée de chauffage va de 8 à 10 h.

Patentansprüche

1. Stromleitende Wicklung, umfassend

zwei Scheiben- oder Flachspulen (20) mit jeweils einem spiralig gewickelten Leiter (22) mit je einer inneren und äußeren Befestigungsfläche, in der Richtung, in welcher der Leiter spiralig gewickelt ist, gesehen, ein längs der Befestigungsfläche verlaufendes Prepeg-Band (40) einer ausreichend großen Breite, um die Befestigungsfläche zu bedecken, wobei das Prepeg-Band (40) zwischen die beiden benachbarten Bestigungsflächen des Leiters eingefügt ist, um die Befestigungsflächen durch Aufschmelzen und Erstarrenlassen des Prepeg-Band gegeneinander zu befestigen und sie elektrisch voneinander zu isolieren, und

eine zwischen den beiden Flachspulen befindliche Isoliereinrichtung,

dadurch gekennzeichnet, daß die Isoliereinrichtung eine kreisförmige Prepeg-Lage (42) umfaßt, die zwischen die beiden Flachspulen (20) eingefügt ist, welche ihrerseits mit einander entgegengesetzten Wicklungsrichtungen koaxial (zueinander) angeordnet sind, die Flachspulen (20) durch Aufschmelzen und Erstarrenlassen der Prepeg-Lage (42) gegeneinander befestigt und elektrisch isoliert sind und die Prepeg-Lage (42) aus einer Anzahl von Abschnitten besteht,

die auf die ringförmige glatte oder flache Fläche der Flachspulen (20) aufgelegt und in deren Umfangsrichtung angeordnet sind.

2. Stromleitende Wicklung nach Anspruch 1, dadurch gekennzeichnet, daß der Leiter (22) an seinen vier Ecken jeweils Abschrägungen (26) aufweist.

3. Stromleitende Wicklung nach Anspruch 2, dadurch gekennzeichnet, daß Prepeg-Band (40) und -Lage (42) durch Imprägnieren einer Versteifungslage mit wärmehärtendem Harz hergestellt sind, wobei das Harz zum Ausfüllen (der Räume) zwischen den Befestigungsflächen und auch zwischen den Flachspulen durch Erwärmen verflüssigt und sodann zur gegenseitigen Befestigung der Befestigungsflächen und auch der Flachspulen (aus)gehärtet worden ist.

4. Stromleitende Wicklung nach Anspruch 3, dadurch gekennzeichnet, daß die Versteifungslage ein Glasfasergewebe und das wärmehärtende Harz ein Epoxyharz ist.

5. Verfahren zur Herstellung der stromleitenden Wicklung, mit

einem ersten Schritt des Wickelns eines rechteckigen Leiters (22) zu einer Spirale und Einfügen eines Prepeg-Bands (40) zwischen den bereits gewickelten Abschnitt (28) und den zu wickelnden Abschnitt (30) des Leiters (22) zwecks Ausbildung einer einzelnen Flachspule (20), wobei das Prepeg-Band (40) praktisch dieselbe Breite besitzt wie die Befestigungsfläche des bereits gewickelten Abschnitts (28) des Leiters, auf den der (noch) zu wickelnde Abschnitt (30) des Leiters gewickelt wird,

gekennzeichnet durch einen zweiten Schritt, in welchem zwei einzelne Flachspulen (20) unter Zwischenfügung einer kreisförmigen Prepeg-Lage (42) (zueinander) koaxial aufeinandergelegt werden, wobei die Prepeg-Lage aus einer Anzahl von Abschnitten (42) besteht, die auf die ringförmige glatte oder flache Flächen der Flachspule (20) aufgelegt und in Umfangsrichtung der Flachspule angeordnet werden, und

einen dritten Schritt, in welchem das Prepeg-Band (40) und die Prepeg-Lage (42) unter Druck erwärmt werden, um den gewickelten Leiter und die einzelnen Flachspulen (20) gegeneinander zu befestigten und die Befestigungsflächen des Leiters gegenüber der benachbarten (Befestigungsfläche) und die einzelnen Flachspulen (20) voneinander zu isolieren.

6. Verfahren nach Anspruch 5, gekennzeichnet durch einen fünften Schritt, in welchem die einander so überlappenden einzelnen Flachspulen (20) unter Druck erwärmt werden, um die einzelnen Flachspulen (20) gegeneinander zu befestigen und voneinander zu isolieren.

7. Verfahren nach Anspruch 5 oder 6, dadurch gekennzeichnet, daß das Prepeg-Band (40) und die -Lage (42) durch Imprägnieren einer Versteifungslage mit wärmehärtendem Harz geformt werden, wobei das Harz zum Ausfüllen (der Räume) zwischen den Flachspulen durch Erwärmen verflüssigt und sodann zum Befestigen der Befestigungsflächen des Leiters und auch der Flachspulen gegeneinander (aus)-gehärtet wird.

8. Verfahren nach Anspruch 7, dadurch gekennzeichnet, daß die Versteifungslage aus einem Glasfasergewebe besteht und das wärmehärtende Harz ein Epoxyharz ist und daß die Erwärmungstemperatur im Bereich von 130—150°C bei einer Erwärmungszeit im Bereich von 8—10 h liegt.

FIG. 1

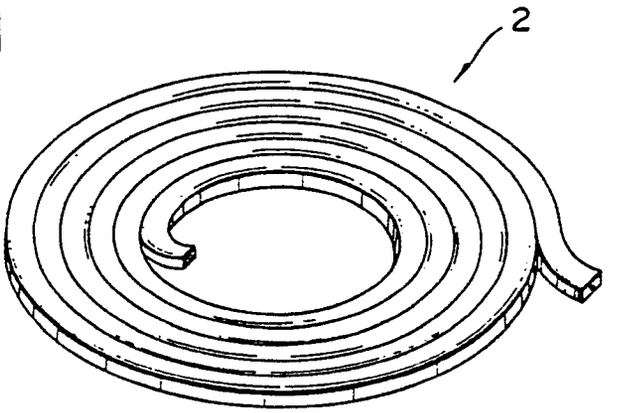

FIG. 2

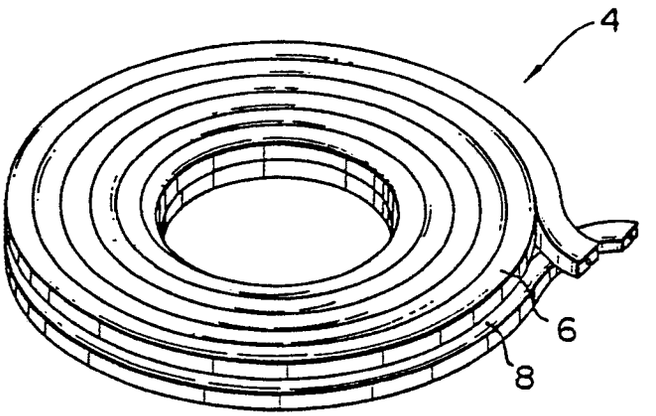

FIG. 3

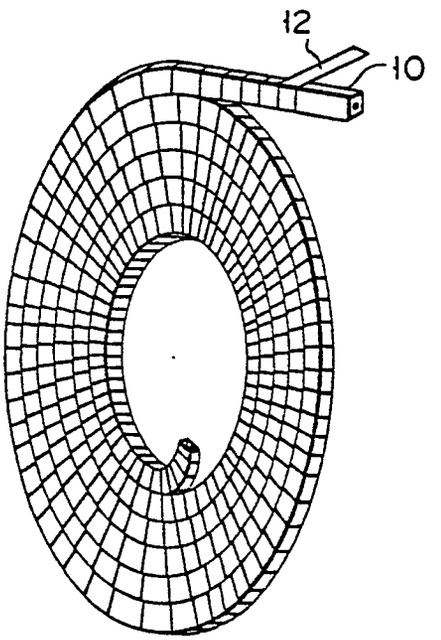

FIG. 4

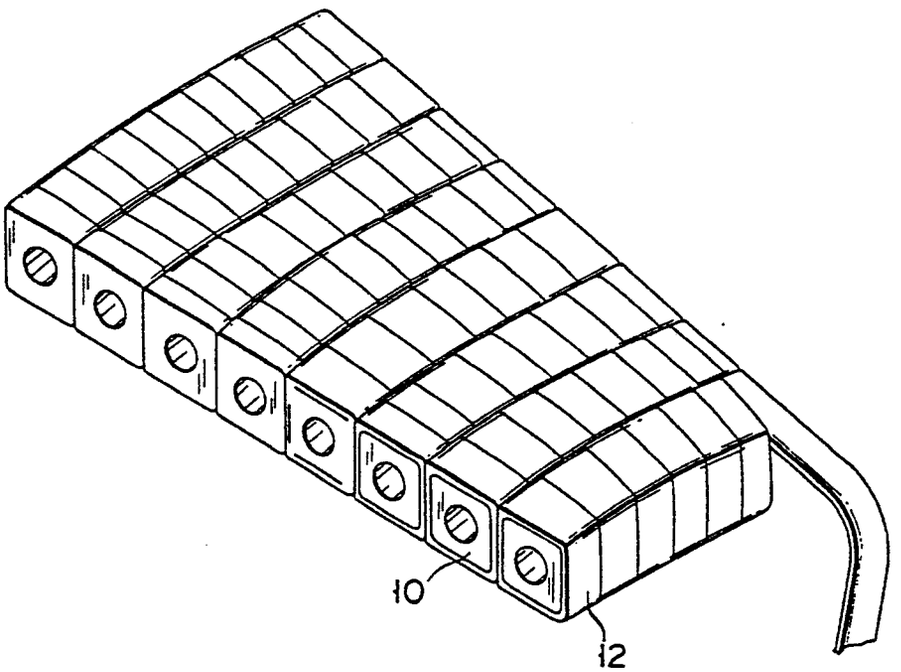

FIG. 5

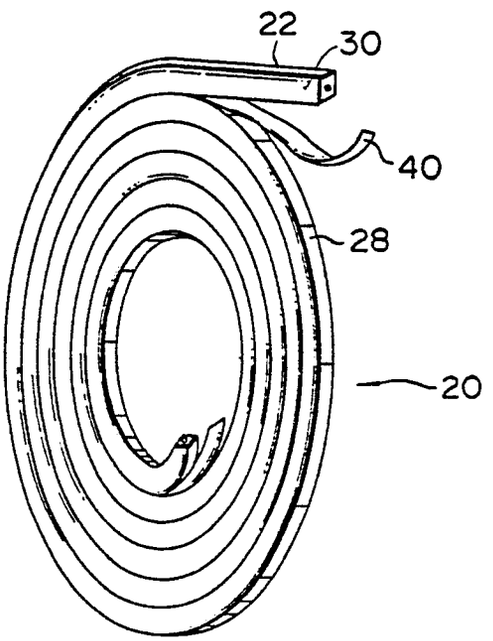

FIG. 6

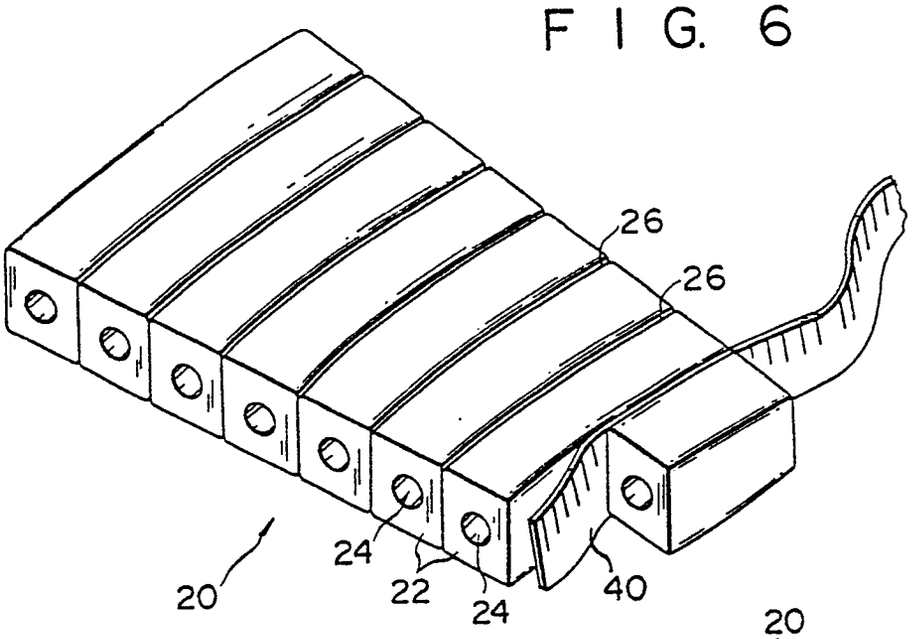

FIG. 7

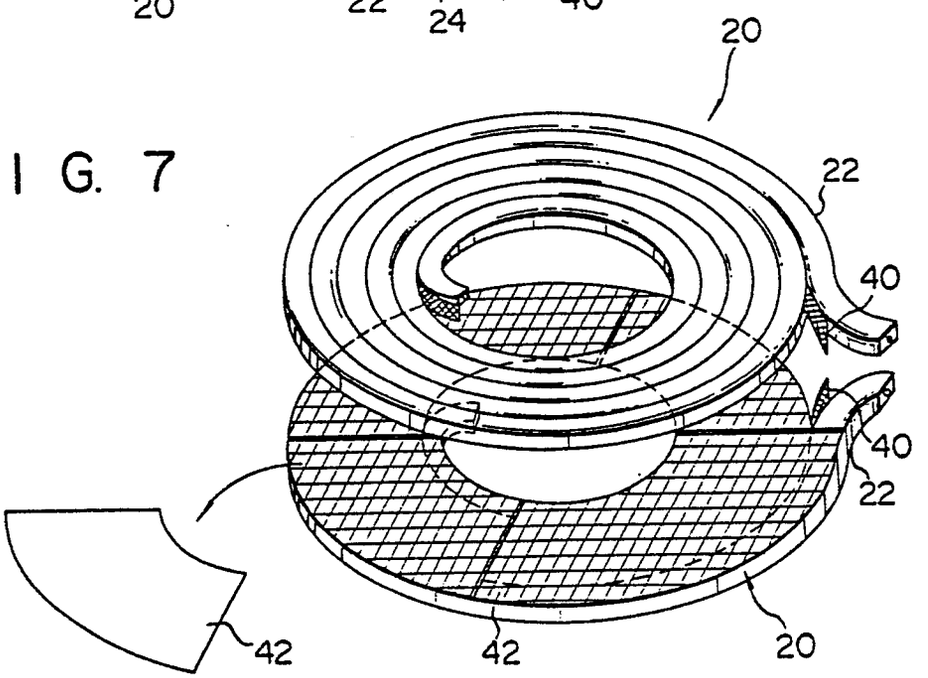

FIG. 8