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(54) An inductance coil device and a manufacturing method thereof.

(57) This invention provides a small sized inductance coil and in particular, provides a small sized flat type inductance coil (11). The inductance coil (11) comprises a coiled electroconductive member (15) having a wide dimension and a narrow dimension in directions intersecting one another in cross section and coiled so that the direction of the wide dimension of said coiled electroconductive member (15) is parallel to a coiling axis of said coiled electroconductive member (15) and that an outline of said coiled electroconductive member (15) is formed in a plane.

According to the above structure, the inductance coil (11) does not become so large, because the width of the electroconductive member (15) in the direction which is parallel to the plane is small.

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The present invention relates to an inductance coil. In particular, the invention relates to an inductance coil which is suitable for use as a flat-type inductance coil and is improved in the structure of the electroconductive member thereof such as a wire.

Conventionally, a flat-type inductance coil is used for a compact or small sized circuit because of its thinness. Usually, the flat-type inductance coil is made by coiling an electroconductive wire which is, for example, made of copper and is coated with electrically insulating materials.

Recently, smaller flat-type inductance coils are required. Therefore, many kinds of design elements have been researched and changed for the purpose of making a smaller flat-type inductance coil.

However, the electroconductive wires of the conventional flat-type inductance coils are circular in cross section and the cross sectional shape of the electroconductive wire of the conventional flat-type inductance coil has not been changed. Thus, there is a possibility to further decrease its size by changing the cross sectional shape of the electroconductive wire.

Accordingly, it is an object of the present invention to decrease the size of an inductance coil.

To accomplish the object described above, the present invention provides an inductance coil, comprising:

an coiled electroconductive member having end portions and having a wide dimension and a narrow dimension in directions intersecting one another in cross section and coiled around a coiling axis so that the direction of the wide dimension of the coiled electroconductive member is parallel to the coiling axis of the coiled electroconductive member and that an outline of the coiled electroconductive member is formed in a plane.

In the accompanying drawings:

Fig. 1 is a schematic perspective view of an inductance coil and a board mounting the inductance coil according to a first embodiment of the present invention;

Fig. 2 is a schematic view showing a process for coiling an electroconductive wire 15 of the first embodiment;

Fig. 3 is a schematic perspective view of an inductance coil and a board mounting the inductance coil according to a second embodiment of the present invention;

Fig. 4 is a schematic plane view of an inductance coil device according to a third embodiment of the present invention;

Fig. 5 is a schematic sectional view of Fig. 4;

Fig. 6 is a schematic perspective view showing a structure of the inductance coil device using a pair of inductance coils and a board according to a fourth embodiment of the present invention;

Fig. 7 is a schematic sectional view of the inductance coil device according to the fourth embodiment;

Fig. 8 is a perspective view showing a method for making an insulating board used in the present invention;

Fig. 9 is a perspective view of another insulating board used in the present invention;

Fig. 10 is a schematic sectional view of Fig. 9;

Fig. 11 is a schematic plane view of the inductance coil device according to a fifth embodiment;

Fig. 12 is a sectional view of Fig. 11;

Fig. 13 is a schematic view showing another embodiment of a pair of connecting members used in the inductance coil device 81 of the Fig. 12;

Fig. 14 is a schematic sectional view of the inductance coil device according to a sixth embodiment of the present invention;

Fig. 15 is a schematic view showing a table used in processes for coiling an electroconductive wire for the purpose of manufacturing an inductance coil device;

Fig. 16 is a schematic sectional view showing one of the processes for coiling an electroconductive wire for the purpose of manufacturing an inductance coil device;

Fig. 17 is a schematic sectional view showing another process for coiling an electroconductive wire for the purpose of manufacturing an inductance coil device;

Fig. 18 is a schematic sectional view showing another process for coiling an electroconductive wire for the purpose of manufacturing an inductance coil device; and

Fig. 19 is a schematic sectional view showing a process for coiling an electroconductive wire for the purpose of manufacturing an inductance coil device.

Referring to the accompanying drawings, various embodiments of the present invention will be described. However, in the drawings, the same numerals are applied to similar elements in the drawings, and therefore the detailed descriptions thereof will not be repeated.

Fig. 1 is a schematic perspective view of an inductance coil and a board mounting the inductance coil according to a first embodiment of the present invention. An inductance coil 11 is mounted on a board 13 such as a circuit board. The board 13 is not always necessary. An inductance coil 11 is made from an electroconductive wire 15 which is coated with an electrically insulating layer 17 other than an inner extended portion 19 and an outer extended portion 21 of the electroconductive wire 15. The inner extended portion 19 and the outer extended portion 21 are provided so that electric power or electric signal is supplied to the inductance coil 11 through the inner extended portion 19 and the outer extended portion 21 of the electroconductive wire 15. The inner extended portion 19 and the outer extended portion 21 are extended integrally from end portions of the electroconductive wire 15. However, different electroconductive pieces may be used instead of using the electroconductive wire 15. Therefore from another point of view, it may be thought that the inner extended portion 19 and the outer extended portion 21 are not parts of the coil. The electroconductive wire 15 is made from, for example, copper and has a shape similar to a rectangular shape in cross section. It is necessary for the electroconductive wire 15 to have a wide width and a narrow width in directions intersecting one another in cross section. Thus, the electroconductive wire 15 may have an ellipse shape in cross section. The electroconductive wire 15 is coiled into a spiral shape, a voltex shape or a scroll form. In this case, the coiling axis is almost parallel to a direction of the wide width of the electroconductive wire 15. Further, the electroconductive wire 15 is coiled so that the surface of the coiled electroconductive wire 15 constitutes a plane. In other words, the electroconductive wire 15 is coiled so that the outline of the coiled electroconductive wire 15 forms a plane. In addition to the above, the surfaces of the coiled electroconductive wire 15 facing one another are fixed to one another with adhesives and the coiled electroconductive wire 15 is also fixed to the board 13 with adhesives. Thus, the coiled electroconductive wire 15 normally will not lose its shape.

Fig. 2 is a schematic view showing a process for coiling an electroconductive wire 15. The first step is compressing an electroconductive wire which has a circular cross section and is coated with an insulating layer in order to form the electroconductive wire having a rectangular cross section, using a pair of rollers 23 and 23. As adhesives (not shown) are supplied to the rollers 23 and 23, the surfaces of the compressed wire touched by rollers 23 are coated with the adhesives. Thermosetting resin such as epoxy resin or silicone resin is used as the adhesives. Adhesives which are set by ultraviolet radiation (UV-radiation setting resin) may also be used. The compressed wire is supplied to a turntable 25 having a rolling shaft 27, which rotates (direction A in Fig. 2) and rolls up the compressed wire. The thermosetting resin sets by receiving hot air from a hot air nozzle 29 right after the compressed wire is rolled up. When UV-radiation setting resin is used, UV-radiation is supplied to the UV-radiation setting resin. A stick 31 presses the wire in order to roll up the wire securely.

The inductance coil 11 described above is smaller than the conventional inductance coil using a wire which is circular in cross section. Neverthless, it has the same inductance value as the conventional inductance coil, because the space factor, i.e. the ratio of the volume of the coiled wire 15 to the volume of the inductance coil 11 of the present invention is larger than that of the conventional inductance coil. In other words, spaces or gaps around the coiled wire 15 in the inductance coil 11 of the present invention are less or smaller, respectively, than spaces or gaps around the coiled wire in the conventional inductance coil. In particular, the flat surfaces of the coiled wire further increase the space factor of the coiled wire.

Fig. 3 is a schematic perspective view of an inductance coil and a board mounting the inductance coil according to a second embodiment of the present invention. It is different from the first embodiment in that the inductance coil 33 of the second embodiment has a tap 35 at a certain position of the coiled wire 15 for receiving or supplying electric power or electric signals and that the inner extended portion is extended to the outside of the coiled wire. It is also different from the first embodiment in that the directions of the wide widths of the extended portions 19 and 21 of the inductance coil 33 extended to the outside of the coiled wire are parallel to the board 13. The electroconductive wire 15 turns by 90° at boundaries between a coiled portion and each one of extended portions 19 and 21.

The inductance coil 33 of the second embodiment has the advantage that it is small or compact in size because the electroconductive wire 15 of the inductance coil 33 has a rectangular shape in cross section and the direction of the wide width of the electroconductive wire 15 is parallel to the axis of coiling, the same as the inductance coil 33 of the first embodiment. The inductance coil 33 of the second embodiment has further advantages as follow.

The tap 35 of the second embodiment is a metal leaf with flat surfaces on both sides thereof, and one of the flat surfaces is attached to the flat surface of the electroconductive wire 15. Therefore, the attaching strength of the tap 35 is stronger in the second embodiment than in case of a electroconductive wire having a circular shape in cross section.

Furthermore, the thickness of the coil 33 in axial direction does not double in spite of partially doubled layers of the electroconductive wire 15 because the direction of the wide width of the inner extended portion 19 is parallel to the board 13 in an area where the inner extended portion 19 is overlaid on the coiled wire.

Fig. 4 is a schematic plane view of an inductance coil device using a pair of inductance coils according to a third embodiment of the present invention. Fig. 5 is a schematic sectional view along the line I-I of Fig. 4. A coil device 41 is composed of first and second inductance coils 43 and 45 which are stacked. Each inductance coil has a structure similar to the inductance coil of the first embodiment of the present invention. Electroconductive wires 47 and 49 of first and second inductance coils 43 and 45 have an elliptical shape in cross section and are coiled so that the direction of the wide width of each coiled electroconductive wire is parallel to a coiling axis and that an outline of each coiled electroconductive wire is formed in a plane. The surfaces of the coiled wires 47 and 49 facing one another and next to one another are almost flat. Further, inductance coils 43 and 45 are stacked so that the coiling axes of the first and second coils 43 and 45 coincide with one another.

Accordingly, not only each coil, but also the stacked coil device 41 have the same advantage as the coils of the first and second embodiments in that they are small in width.

The first and second coils 43 and 45 have a central space 51 at the center thereof, respectively. The central space 51 is provided for the purpose that the first and second coils 43 and 45 are electrically connected with one another in the central space 51. The details are as follows. An inner end portion 53 of the first inductance coil 43 and an inner end portion 55 of the second inductance coil 45 have a elliptical shape in cross section, respectively, and are positioned in the central space 51. The direction of the wide width of each inner end portion is parallel to the plane which is formed by the outline of the coil because each electroconductive wire turns in the central space 51 by 90°. Thus the wide and flat surfaces of the inner end portions 53 and 55 face one another and contact one another. Other elements, such as insulating layers (not shown), adhesives (also not shown) for fixing the coiled wires to one another, outer extended portions of the electroconductive wires, and so on are provided in the same way as in the first and second embodiments.

The inductance coil device 41 of the third embodiment has a particular advantage in that the thickness of the device does not exceed double because the electrical connection between inductance coils 43 and 45 is disposed only in the central space 51 not protuding therebeyond. If the electrical connection between inductance coils 43 and 45 were disposed outside the coils, the lead wire from the inner end portion of the electroconductive wire would increase the thickness of the stacked coil device 41. The inductance coil device 41 of the third embodiment has another particular advantage in that the strength of the connection between inner end portions 53 and 55 of the inductance coils 43 and 45 is stronger than in the case of the inner end portions 53 and 55 having a circular shape in cross section, since the contact surfaces of the inner end portions 53 and 55 are almost flat and thus, the contact surfaces of the inner end portions 53 and 55 are larger. Further, the inductance coil device 41 of the third embodiment has an advantage in that there is enough space for processing of connecting inner end portions 53 and 55, for example by soldering or welding, and thus, it is easy to connect inner end portions 53 and 55. Moreover, even if a large space is provided in the center of the coils, the coil device does not become so large, because the width of the electroconductive wires in the direction of the coil plane is small.

Even if electroconductive wires with a circular shape in cross section are used instead of the electroconductive wires 43 and 45 of the third embodiment shown in Fig. 4 and Fig. 5, a inductance coil device using the electroconductive wires with a circular shape in cross section has the advantages in that the thickness of the overall device does not increase more than double, and that there is enough space for processing of connecting the inner end portions. Further, if the electroconductive wires have inner end portions with flat contact surfaces, the inductance coil device has the advantage in that the strength of the connection between inner end portions 53 and 55 of the inductance coils is stronger than in the case of the inner end portions having a circular shape in cross section.

Fig. 6 is an explosive schematic perspective view showing a structure of an inductance coil device using a pair of inductance coils and a board according to a fourth embodiment of the present invention, and Fig. 7 is a schematic sectional view of the fourth embodiment. An inductance coil device 61 is composed of the inductance coil device 41 of the third embodiment and an insulating board 63 having a connecting member 65. The details are as follow. A pair of inductance coils 43 and 45 are attached to both sides of the insulating board 63, respectively, with adhesives. Therefore the inductance coils 43 and 45, and the board 63 are fixed to each other. Each inductance coil has the same structure as the inductance coil of the third embodiment. The connecting member 65 is made of electroconductive members penetrating the insulating board 63. Each inner end portion of the inductance coils 43 and 45 has a flat surface, respectively, and each flat surface of the inner end portion is connected with one of the surfaces of the connecting member 65 by means of, for example soldering or welding, respectively.

The inductance coil device 61 has similar advantages as the third embodiment. The first is that there is a enough space for processing of connecting inner end portions. The second is that the strength of the connection between inner end portions 53 and 55 of the inductance coils is stronger than in the case of the inner end portions having a circular shape in cross section. The inductance coil device 61 has the same advantage as the third embodiment in that the coil device 61 does not become so large, because the width of the electroconductive wires in the direction which is parallel to the coil plane is small.

The inductance coil device 61 of the fourth embodiment has a particular advantage in that the insulating board 63 secures insulation of the coils 43 and 45 from each other and forms a coil gap with a certain distance between the coils 43 and 45 for regulating a mutual-inductance value. This advantage is obtained even if the inductance coil device 61 uses wires with a circular shape in cross section.

The insulating board 63 is made by a manufacturing process comprising a step for inserting the connecting member 65 into a hole to be formed to penetrate through the board 63. However, the insulating board 63 may be made by a manufacturing process comprising a step for slicing a insulating rod 67, in a certain thickness, which has an electroconductive rod 69 buried therein so that the insulating rod 67 and the electroconductive rod 69 have a common axis, as shown in Fig. 8.

Further, an insulating board 71 shown in Fig. 9 and Fig. 10 may be used instead of the insulating board 63 shown in Fig. 6 and Fig. 7. Fig. 9 is a perspective view of such another insulating board used in the present invention and Fig. 10 is a sectional view of Fig. 9 taken along a line II-II. The insulating board 71 has a hole 73 penetrating through the board 71 and the surface of the board 71 near the hole 73 is coated with an electroconductive film 75. The electroconductive film 75 is formed, for example by plating copper. A pair of coils are connected to the film 75 so as to provide an electrical connection between the coils.

An inductance coil device 81 according to a fifth embodiment is shown in Fig. 11 and Fig. 12. Fig. 11 is a schematic plane view and Fig. 12 is a sectional view of Fig. 11 taken along a line III-III. The inductance coil device 81 is composed of a pair of inductance coils 83 and 85 which have an connecting member 87 (89), respectively. The connecting members 87 and 89 are electroconductive and are formed in disk shape having notches 91 and 93. Each inductance coil 83 (85) is made from an electroconductive wire 95 (97) coiled around the connecting members 87 and 89. The electroconductive wire 95 (97) has a ellipse shape in cross section. A direction of the wide width of the coiled wires 95 and 97 and a direction of inner end portions 99 and 101 are the same direction as in the third embodiment shown in Fig. 4 and Fig. 5, respectively. The inner end portion 99 (101) of the electroconductive wire 95 (97) is inserted into and fitted to the notch 91 (93), and is connected electrically to the connecting member 87 (89), respectively. Both connecting members 87 and 89 are connected electrically to one another, and thus the electroconductive wires 95 and 97 are also connected electrically to one another. A plurality of possible or suitable, respectively, cross sections of the electroconductive wires 95 and 97 are described in a modified form in Fig. 12.

The inductance coil device 81 of the fifth embodiment has the same advantage as the third embodiment shown in Fig. 4 and Fig. 5, in that the coil device 91 does not become so large, because the width of the electroconductive wires in the direction parallel to the coil plane is small.

Further, the inductance coil device 81 has some particular advantages. The thickness of the inductance coil device 81 does not exceed than double, because the inductance coil device 81 does not have an insulating board like the insulating board 63 of the inductance coil device 61 in Fig. 7, and further because the thicknesses of the connecting members 87 and 89 are equal to or below the thicknesses of the electroconductive wires 95 and 97. The inductance coils 95 and 97 are connected mechanically and electrically to one another, because the contact surfaces of the inductance coils 95 and 97 are flat and thus large.

These particular advantages described above may also be obtained in an inductance coil device having a pair of electroconductive wires which have a circular shape in cross section, instead of having the electroconductive wires 95 and 97 which have the ellipse shape in cross section.

Fig. 13 is a schematic view showing another embodiment of a pair of connecting members used in the inductance coil device 81 of the Fig. 12. A pair of connecting members 111 and 113 is formed in disk shape having notches 91 and 93 like the connecting members 87 and 89 shown in Fig. 11 and Fig. 12. Each connecting member 111 (113) has a recess 115 (119) on one side and a shoulder 117 (121) on the other side, respectively. The shoulder 117 of the connecting member 111 and the recess 119 of the connecting member 113 are fixed to one another and thus, two inductance coils are fixed to one another so that their axes coincide.

The connecting members 111 and 113 may be applied to an inductance coil device having a pair of electroconductive wires which have a circular shape in cross section. In this case, the inductance coil device does not have the advantage in that the coil inductance device does not become so large, but does have the advantage that two inductance coils are fixed to one another so that their axes coincide.

Fig. 14 is a schematic section view of an inductance coil device 131 according to a sixth embodiment of the present invention. The inductance coil device 131 is composed of a pair of inductance coils 133 and 135. Each inductance coil 133 (135) comprises an electroconductive wire 137 (139) which has an ellipse shape in cross section. Accordingly, the inductance coil device 131 has the same advantage as the above embodiments in that the coil inductance device 131 is not so large. The electroconductive wire 137 is coiled densely and the electroconductive wire 139 is coiled less densely. The difference between coil pitches of the electroconductive wires 137 and 139 is necessary for transformers which have a plurality of coiled electroconductive wires having a difference, for example in the number of turns, in its width of the wire, and so on. Each inductance coil 133 (135) comprises a insulating board 141 (143) and a magnetic material member 145 (147). The coiled electroconductive wire 137 (139) and the magnetic material member 145 (147) are fixed to the insulating board 141 (143) with adhesives (not shown).

Fig. 15, Fig. 16, Fig. 17 and Fig. 18 are schematic views showing processes for coiling electroconductive wire less densely, for example for the purpose of manufacturing the inductance coil device 131 shown in Fig. 14. A turntable 151 has a groove 153 corresponding to a coil, as shown in Fig. 15. An electroconductive wire 155 having a ellipse shape in cross section is inserted into the groove 153 and is coiled, in such direction that the smaller width of the electroconductive wire 155 in cross section is parallel to the surface of the turntable 151, as shown in Fig. 16. The inserting step is done while the turntable 151 is rotating. The wider width of the electroconductive wire 155 is larger than the depth of the groove 153 and thus, the electroconductive wire 155 protrudes from the groove 153 beyond the surface of the turntable 151. The groove 153 has through holes 157 in the bottom thereof and a vacuum pump 159 is connected with each through hole 157 through a vacuum pipe 161 for attracting the electroconductive wire 155 to the bottom of the groove and thus, for preventing the electroconductive wire 155 from slipping out from the groove 153. After this, a step of attaching a insulating board 163 with adhesives 165 to the electroconductive wire 155 on the turntable 151 is performed, as shown in Fig. 17. The adhesives 165 contacts the electroconductive wire 155. But the adhesives 165 does not contact and not spoil the surface of the turntable 151, because the electroconductive wire 155 protrudes from the groove 153. After the adhesives 165 sets, the insulating board 163 and the electroconductive wire 155 are pulled up from the turntable 151, as shown in Fig. 18. The inductance coil 135 is made in such manner as described above.

A coil which is applicable to the inductance coil device 131 may be manufactured in a manner shown in Fig. 19. Fig. 19 is a schematic sectional view showing a process for coiling less densely an electroconductive wire. A turntable 171 of Fig. 19 is different from the turntable 151 of Fig. 15 to Fig. 18 in minor structured details, that the turntable 171 does not have through holes which are provided for attracting an electroconductive wire 173, but it has a through hole 175 for inserting one end portion 177 of the electroconductive wire 173. The through hole 175 fixes the one end portion 177 of the electroconductive wire 173 and prevents the electroconductive wire 173 from running out from the groove 179. The electroconductive wire 173 is discharged from a nozzle 181 of a wire stocker (not shown) and is put into a groove 179.

The present invention is not limited to the above embodiments. A coiled electroconductive member may be obtained by cutting a rolled electroconductive board in a direction which is perpendicular to the axis of rolling the electroconductive board, instead of coiling an electroconductive wire.

The coiled shapes of the electroconductive wires are circular in plane view, but they may be rectangular.

In summary, it will be seen that the present invention overcomes the disadvantages of the prior art and provides a small sized inductance coil and coil device. Many changes and modifications in the above described embodiments can thus be carried out without departing from the scope of the present invention. Therefore, the appended claims should be construed to include all such modifications.

Claims

1. An inductance coil (11), comprising:
   a coiled electroconductive member (15) having a wide dimension and a narrow dimension in directions intersecting one another in cross section, and being coiled around a coiling axis so that the direction of the wide dimension of said coiled electroconductive member (15) is parallel to the coiling axis of said coiled electroconductive member (15) and that an outline of said coiled electroconductive member (15) is formed in a plane.

2. An inductance coil (11) according to claim 1, **characterized** by an extended portion (21) extending integrally from said coiled electroconductive member (15) at one end thereof, said extended portion (21) having a wide di-

mension and a narrow dimension in directions intersecting one another in cross section and being positioned so that the direction of the narrow dimension of said extended portion (21) is parallel to the coiling axis of said coiled electroconductive member (15).

3. An inductance coil (11) according to claim 1 or 2, **characterized** in that, said coiled electroconductive member (15) is coiled so that the surfaces of said coiled electroconductive member (15) facing one another are fixed to one another with adhesives.

4. An inductance coil (11) according to any preceeding claims, **characterized** by a sheet (13) for fixing said coiled electroconductive member (15) thereto.

5. An inductance coil device (41), comprising:
a plurality of inductance coils (43, 45) which are stacked so that the coiling axes of said inductance coils (43, 45) are coincident, each of said inductance coils (43, 45) comprising a coiled electroconductive member (47, 49) having a wide dimension and a narrow dimension in directions intersecting one another in cross section and being coiled around the respective coiling axis so that the direction of the wide dimension of said coiled electroconductive member (47, 49) is parallel to said coiling axis, with said coiled electroconductive member (47, 49) having an inner end portion (53, 55) at an end thereof near said coiling axis and having an outline formed in a plane; and
connecting means connected with said inner end portions (53, 55) of said coiled electroconductive members (47, 49) and located at the center of said coiled electroconductive members (47, 49) for electrically connecting said inductance coils (43, 45).

6. An inductance coil device (41) according to claim 5, **characterized** in that, said connecting means comprises extended portions extending integrally from each inner end portion (53, 55) of said coiled electroconductive member (47, 49), each extended portion having a wide dimension and a narrow dimension in directions intersecting one another in cross section and being positioned so that the direction of the narrow dimension of each inner end portion (53, 55) is parallel to said coiling axis of each coiled electroconductive member (47, 49) and so that said extended portions are in contact with one another.

7. An inductance coil device (61) according to claim 5, **characterized** by a sheet (63) for fixing said coiled electroconductive members (47, 49) to both sides thereof, said connecting means (53, 55, 65) comprising extended portions extending integrally from each inner end portion (53, 55) of said coiled electroconductive member (47, 49), each extended portion having a wide dimension and a narrow dimension in directions intersecting one another in cross section and being positioned so that the direction of the narrow dimension of each inner end portion (53, 55) is parallel to said coiling axis of each coiled electroconductive member (47, 49).

8. An inductance coil device (81) according to any of claims 5 to 7, **characterized** in that, said connecting means comprises electroconductive connecting members (87, 89) connected with said inner end portions (99, 101) of said coiled electroconductive members (95, 97) and connected to one another, and located at the center of said coiled electroconductive members (95, 97).

9. A manufacturing method for an inductance coil (131), comprising:
coiling an electroconductive member (155) having a wide dimension and a narrow dimension in directions intersecting one another in cross section so that the direction of the wide dimension of said electroconductive member (155) is parallel to a coiling axis of said electroconductive member (155) and that an outline of said electroconductive member (155) is formed in a plane.

10. A manufacturing method according to claim 9, **characterized** by preparing a mount board having a groove (153) formed into a scroll form according to a coil form; and
putting said electroconductive member (155) into said groove (153), whereby said electroconductive member (155) is coiled.

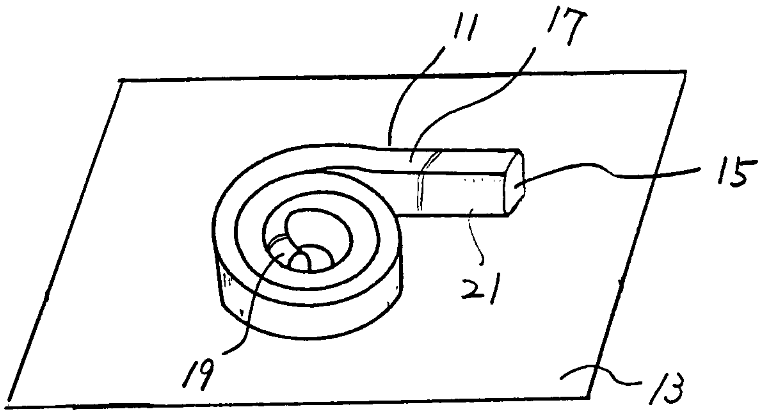

Fig. 1

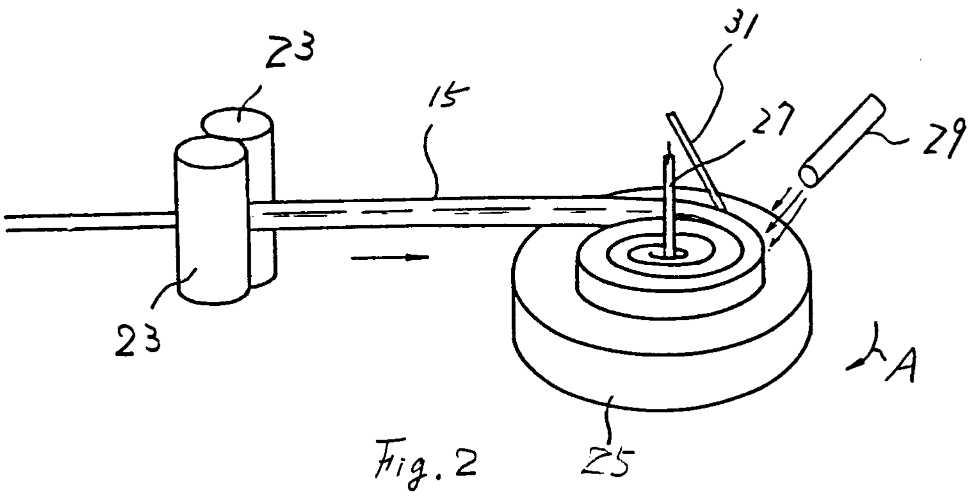

Fig. 2

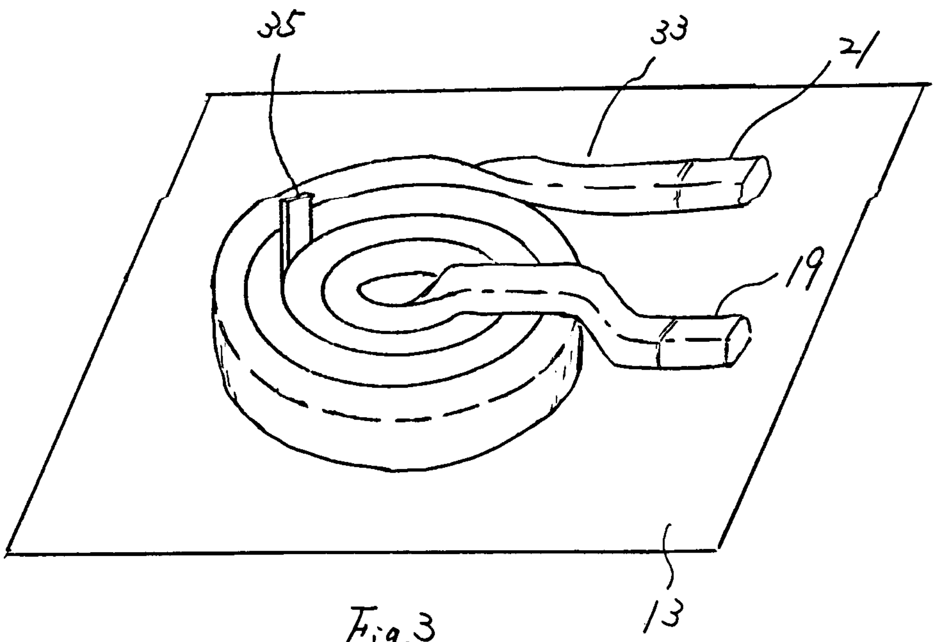

Fig. 3

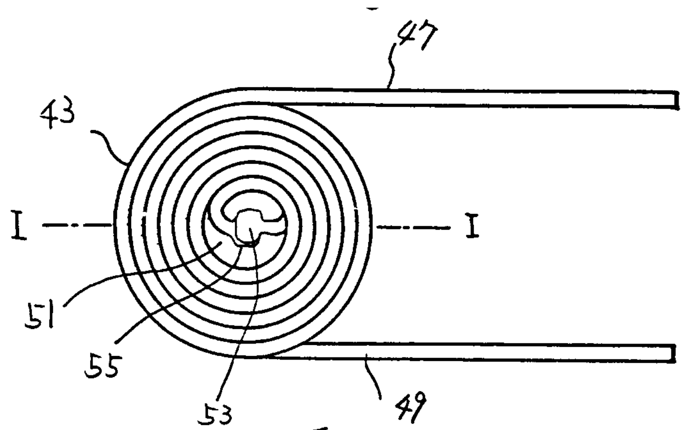

Fig. 4

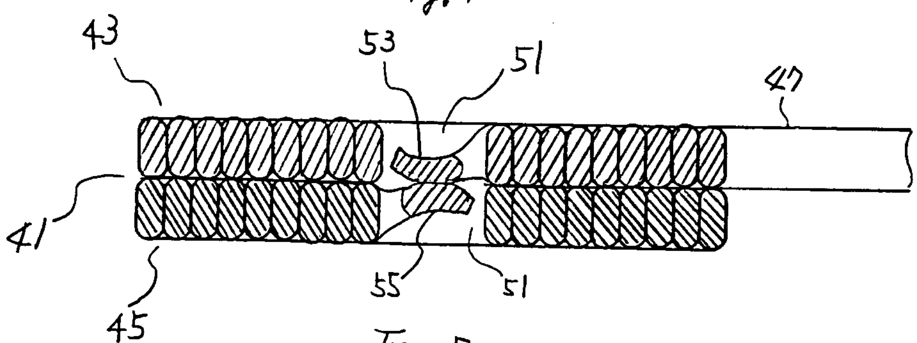

Fig. 5

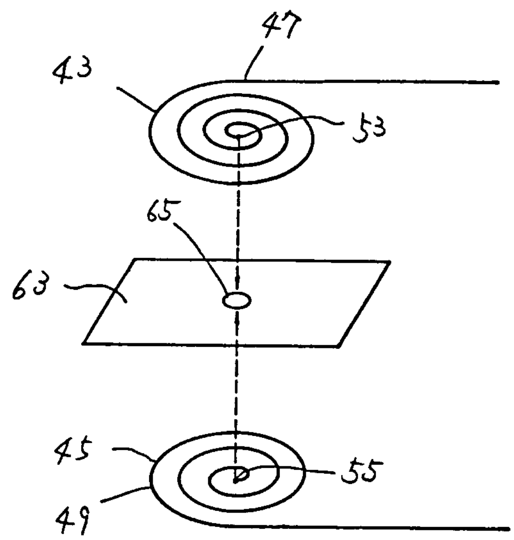

Fig. 6

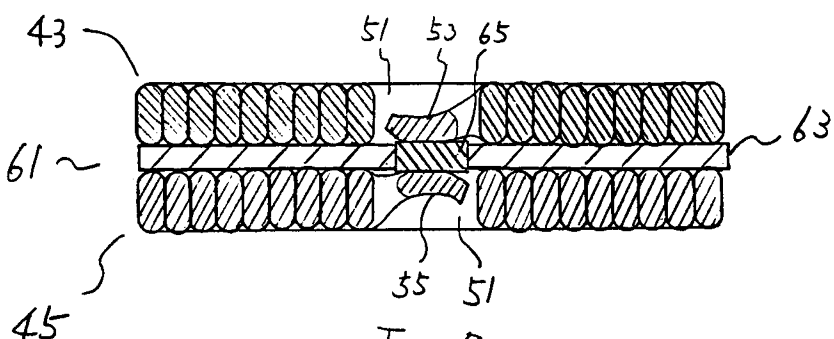

Fig. 7

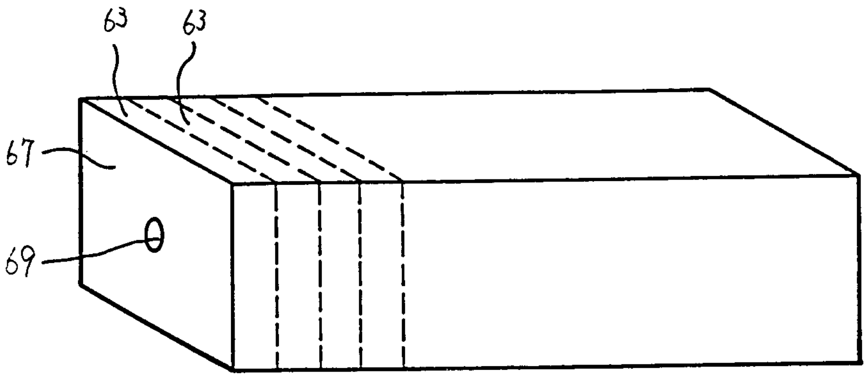

Fig. 8

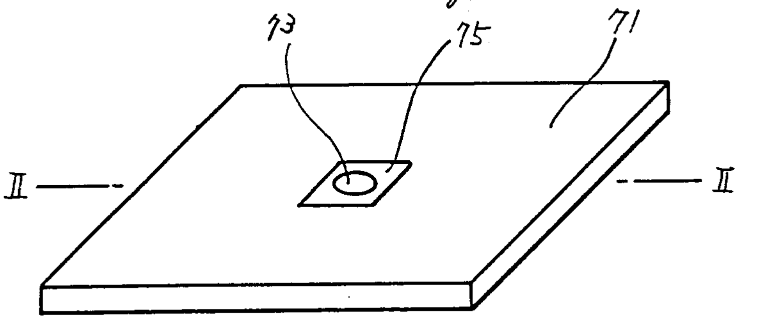

Fig. 9

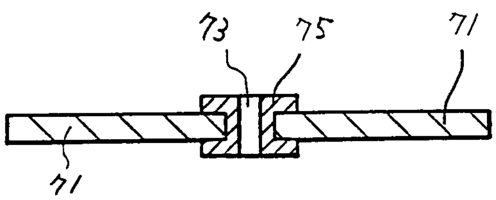

Fig. 10

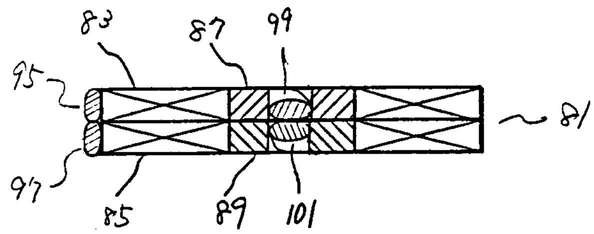

Fig. 12

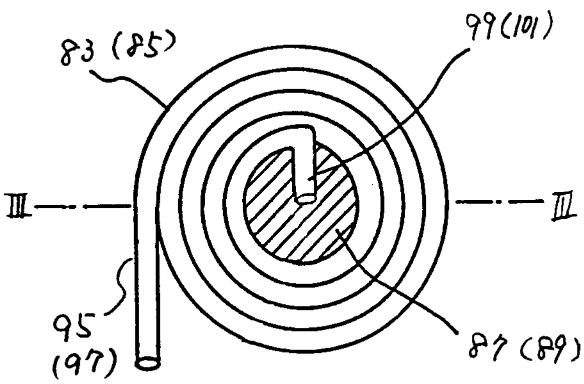

Fig. 11

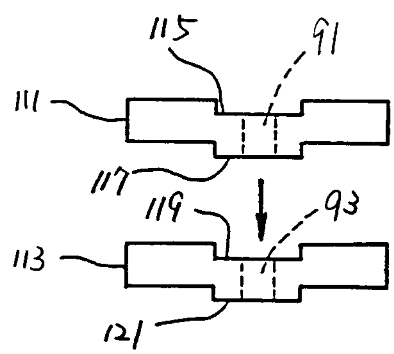

Fig. 13

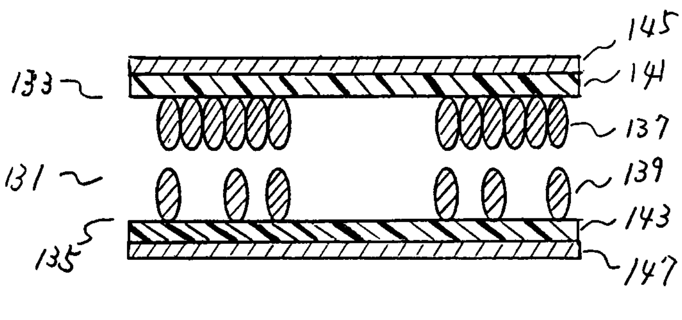

Fig. 14

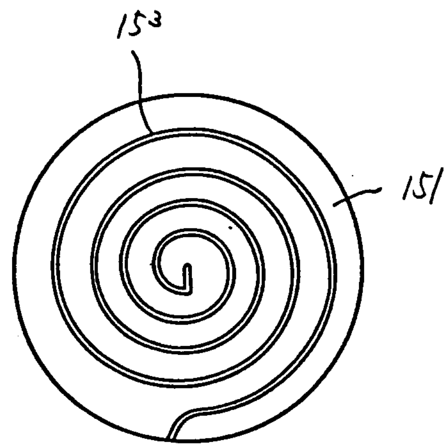

Fig. 15

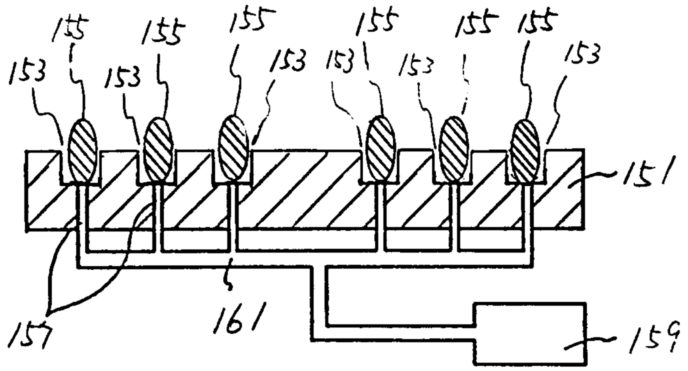

Fig. 16

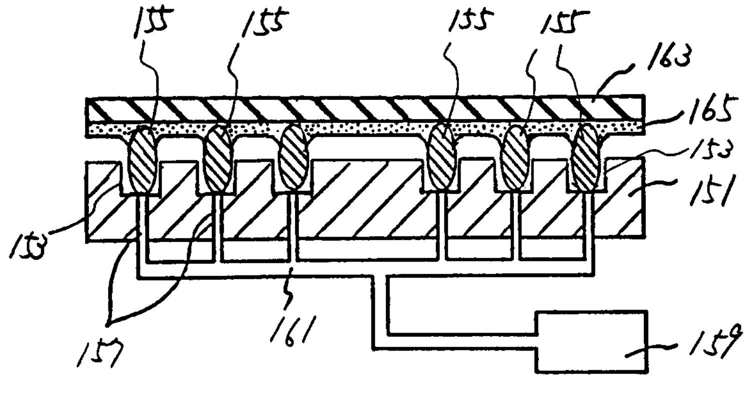

Fig. 17

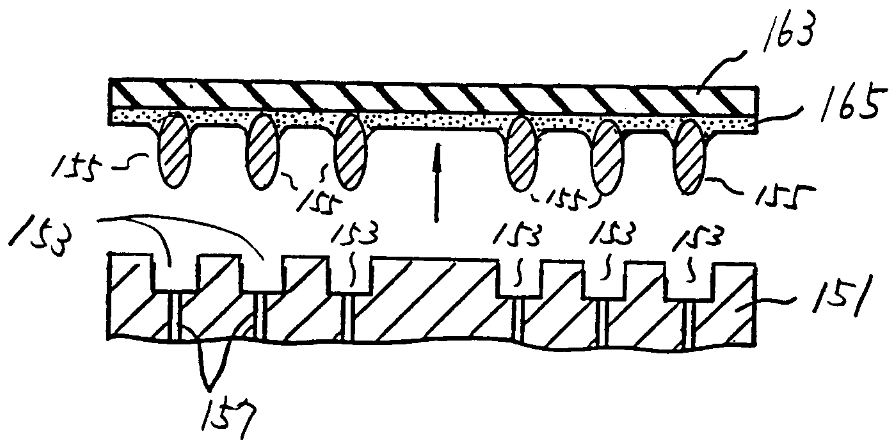
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Fig. 18

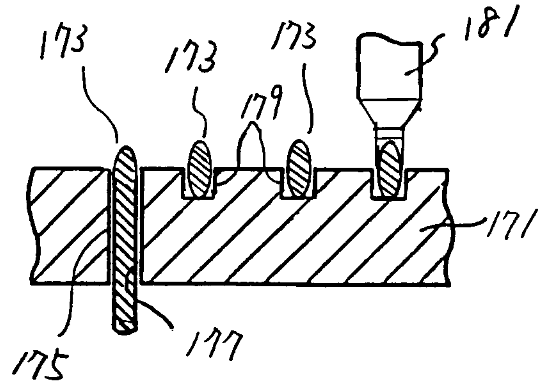
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Fig. 19