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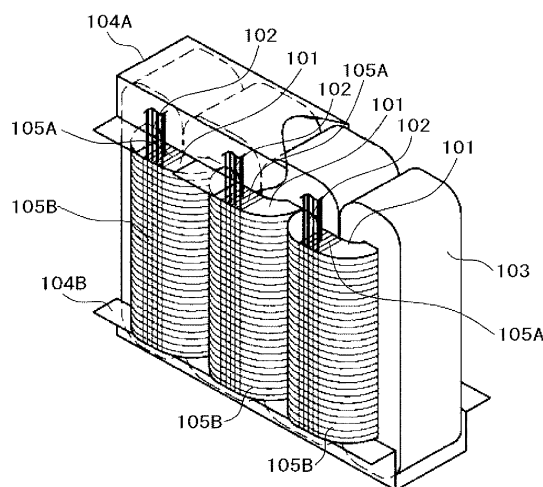
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(54) **OIL-FILLED TRANSFORMER**

(57) The present invention is intended, in view of eliminating the possibility of destroying the insulation of varnished coils, to address the weakening of the mechanical strength in the coil axis direction in time of short circuiting in the manufacturing process of coils without varnishing. The invention relates to an oil-filled transformer mounted with an iron core formed of an amorphous ribbon or a silicon steel sheet and a coil of which both high-voltage and low-voltage windings are formed of flat or round conductor lead wires wound around the iron core, in which a thermosetting resin-impregnated fiber is wound in the coil axis direction around the coil in a tap line wire lead part, and further the thermosetting resin-impregnated fiber is wound in the outermost layer of the coil. As the thermosetting resin-impregnated fiber, a glass binding tape made of epoxy resin is used.

FIG. 1A



Description

Technical Field

[0001] The present invention relates to an oil-filled transformer, and more particularly to a coil.

Background Art

[0002] Recently, an oil-filled transformer for use in off-shore floating wind power generation plants having cylindrical coils formed of flat or round conductor lead wires as high-voltage (primary side) and low-voltage (secondary side) windings has been developed.

[0003] Flat conductor lead wire-made cylindrical coils constituting the high-voltage (primary side) and low-voltage (secondary) sides of the transformer are varnished to increase their mechanical strength in time of short circuiting. However, a transformer for use in offshore floating wind power plants would suffer stresses on coil end faces caused by sea surface oscillation, which might destroy insulation of the coils.

[0004] Whereas available iron cores for transformers include the amorphous iron core and the silicon steel sheet core, the core and coil assembling phase of the manufacturing process of transformers using amorphous iron cores includes a step of turning the coil sideways, and this might damage insulating paper in varnished coils. Furthermore, large-capacity transformers would have heavier coils and iron cores, and the surface of the insulating paper is fixed with varnish, involving the risk that the paper in the coil might become cracked to cause destruction of insulation.

[0005] Also, in an oil-filled transformer having cylindrical coils configured of flat conductor lead wires on both high-voltage (primary) and low-voltage (secondary) side windings, the mechanical force working on the coils in time of short circuiting occurs not only between the high-voltage and low-voltage side windings but also in the coil axis direction on account of a deviation between the center heights of the high-voltage and low-voltage side windings.

[0006] A conventional oil-filled transformer suppresses the mechanical force working on the coils in time of short circuiting by aligning the center heights of the high-voltage and low-voltage side windings in the coil axis direction, varnishing the coils, and suppressing them with upper and lower metal clamps.

[0007] The rising positions of tap lines are especially susceptible to the deviation in the center heights of coils and accordingly, the mechanical force working in the axial direction in time of short circuiting increases.

[0008] Furthermore, since the upper and lower metal clamps have notches to avert tap lines, thus making it impossible to suppress the mechanical force working in the coil axis direction, it has been difficult to manufacture coils for oil-filled transformers without fixing the lead lines by varnishing.

[0009] Patent Literature 1 (Japanese Unexamined Patent Application Publication No. Sho 61-51811) discloses a resin mold coil for a transformer having such coils that eliminates deformation by the tare weight of coils in the manufacturing process, thereby enhancing the mechanical strength working in the coil axis direction in time of short circuiting.

Citation List

Patent Literature

[0010] Patent Literature 1: Japanese Unexamined Patent Application Publication No. Sho 61-51811

Summary of Invention

Problems that the Invention is to Solve

[0011] Patent Literature 1 cited above concerns a technique regarding resin mold coils by which coils for oil-filled transformers are fixed with resin, but does not disclose anything about enhancing the mechanical strength working on the coils for oil-filled transformers in time of short circuiting without varnishing.

[0012] The present invention is intended, in view of eliminating the possibility of destroying the insulation of varnished coils, to address the weakening of the mechanical strength in the coil axis direction in time of short circuiting in the manufacturing process of coils without varnishing.

Means for Solving the Problems

[0013] To solve the problem noted above, one or another of the configurations disclosed in the Claims is used. Whereas the present application includes a plurality of means to solve the problem, one example is an oil-filled transformer mounted with an iron core formed of an amorphous ribbon or a silicon steel sheet and a coil of which both high-voltage and low-voltage windings are formed of flat or round conductor lead wires wound around the iron core, wherein a thermosetting resin-impregnated fiber is wound in the coil axis direction around the coil in a tap line wire lead part, and further the thermosetting resin-impregnated fiber is wound in the outermost layer of the coil. Further, the thermosetting resin-impregnated fiber is a glass binding tape using epoxy resin.

Advantageous Effects of Invention

[0014] According to the present invention, an oil-filled transformer having cylindrical coils configured of flat or round conductor lead wires on both high-voltage and low-voltage windings can secure sufficient mechanical strength in the coil axis direction in time of short circuiting without varnishing. Furthermore, the dispensability of

varnishing contributes to increased reliability of large-capacity transformers using amorphous ribbons because of the absence of the risk of destruction of insulation by the tare weights of coils or iron cores, and highly efficient transformers significantly improved in non-load losses for wind power generation or the like can be made available.

Brief Description of Drawings

[0015]

Fig. 1A shows a perspective view of the coil iron core assembly of an oil-filled transformer, which is a first embodiment of the present invention;
 Fig. 1B shows an expanded perspective view of a partially notched part of the coil iron core assembly of Fig. 1A;
 Fig. 1C shows a perspective view of an upper clamp of the coil iron core assembly;
 Fig. 1D shows a perspective view of a lower clamp of the coil iron core assembly;
 Fig. 2A shows a perspective view of the coil iron core assembly of an oil-filled transformer, which is a second embodiment of the present invention;
 Fig. 2B shows an expanded perspective view of a partially notched part of the coil iron core assembly of Fig. 2A;
 Fig. 3A shows a perspective view of the coil iron core assembly of an oil-filled transformer, which is a third embodiment of the present invention;
 Fig. 3B shows an expanded perspective view of a partially notched part of the coil iron core assembly of Fig. 3A;
 Fig. 4 shows a perspective view of a thermosetting resin-impregnated fiber wound around a tap of a coil and its partially expanded perspective view;
 Fig. 5 shows a perspective view of a thermosetting resin-impregnated fiber wound around each layer of a coil and its partially expanded perspective view;
 Fig. 6 shows a perspective view of a configuration in which a thermosetting resin-impregnated fiber is wound around each layer of a coil in two or more turns;
 Fig. 7 shows a perspective view of a configuration in which a thermosetting resin-impregnated fiber is wound around positions where a strong electromagnetic force works in time of short circuiting at the beginning and end of coil winding;
 Fig. 8 shows a perspective view of a configuration of a method by which a thermosetting resin-impregnated fiber is wound around a coil; and
 Fig. 9 shows a perspective view of an oil-filled transformer housing a coil iron core assembly.

Description of Embodiments

[0016] Exemplary embodiments of the present inven-

tion will be described in detail below with reference to the drawings.

(First Embodiment)

[0017] A first embodiment of the present invention will be described with reference to Figs. 1A to 1D. Fig. 1A shows a perspective view of a coil iron core assembly to be housed in an oil-filled transformer; Fig. 1B, a perspective view of partially notched part of the coil iron core assembly of Fig. 1A; Fig. 1C, an upper clamp; and Fig. 1D, a lower clamp.

[0018] In the drawings, 101 denotes a coil; 102, a tap line wire lead part; 103, an iron core; 104A, an upper clamp; 104B, a lower clamp; and 105A and 105B, thermosetting resin-impregnated fibers.

[0019] Further, Fig. 1A shows the inner part of a coil iron core assembly for use in a three-phase five-leg wound iron core transformer, in which the thermosetting resin-impregnated fiber 105A is wound in the coil axis direction around the tap line wire lead part 102 of the coil 101, and further the thermosetting resin-impregnated fiber 105B is wound in the horizontal direction around the outermost circumference of the coil 101. It also shows the coil iron core assembly of the oil-filled transformer, the assembly including a five-leg wound iron core 103 formed of an amorphous ribbon or a silicon steel sheet, the coil 101 in which both the high-voltage (primary side) and the low-voltage (secondary side) windings are formed of flat or round conductor lead wires, and the upper clamp 104A and the lower clamp 104B which press the coil 101 by clamping in the axial direction.

[0020] The upper clamp 104A has a configuration having a flange formed by bending a plate in a U shape and disposing it on a side in the lengthwise direction as shown in Fig. 1C, and a notch to stay away from the position of the tap line wire lead part 102 of the coil 101 is formed in this flange part.

[0021] Although the upper clamp 104A is supposed here to be formed in a U shape, it may instead be shaped as a rectangular box.

[0022] Similarly, as the configuration of the lower clamp 104B in Fig. 1D shows, a plate is bent in a U shape to form a flange on a side in the lengthwise direction, and a notch is formed in this flange part in a position matching the tap line wire lead part of the coil 101.

[0023] The coil 101 is formed of the thermosetting resin-impregnated fiber 105A wound around the tap line wire lead part 102, which cannot be mechanically pressed in the coil axis direction, in the coil axis direction in the notched position of the upper clamp 104A, and the thermosetting resin-impregnated fiber 105B is also wound around in the horizontal direction of the outermost layer of the coil 101.

[0024] Where an amorphous ribbon is used for the iron core 103, since a thin ribbon of about 20 μm , unlike a silicon steel sheet, is stacked between the iron core 103 and the coil 101 in the coil axis direction as shown in the

partially expanded perspective view of Fig. 1B, the amorphous iron core is susceptible to deformation, and the thermosetting resin-impregnated fiber 105A is wound around in the coil axis direction 101 at portions where the iron core 103 overlaps on the coil 101.

[0025] Next, a description of thermosetting resin-impregnated fiber will be given. A commonly used thermosetting resin-impregnated fiber is a glass binding tape, which is a binding tape made of epoxy resin, and its advantages include high strength of the hardened product resulting from its heat treatment, excellent adhesiveness and high resistance to heat. The base material is glass tape, featuring high tensile strength. The resin is usually hardened by heating at 150°C for 15 hours.

(Second Embodiment)

[0026] Now, a second embodiment of the present invention will be described with reference to Figs. 2A and 2B. Figs. 2A and 2B show perspective views of a coil iron core assembly that uses a three-phase tripod iron core and in which a thermosetting resin-impregnated fiber 205A is wound around in the vicinity of the tap part 202 of a coil 201 in the coil axis direction, and further a thermosetting resin-impregnated fiber 205B is wound around in the horizontal direction in the outermost layer of the coil 201.

[0027] In Fig. 2A, 201 denotes a coil; 202, a tap line wire lead part; 203, an iron core; 203A, an outer iron core; 203B, an inner iron core; 204A, an upper clamp; 204B, a lower clamp; 205A, a thermosetting resin-impregnated fiber wound around in the coil axis direction, and 205B, a thermosetting resin-impregnated fiber wound around in the outermost layer of the coil.

[0028] Fig. 2 further shows the coil iron core assembly of an oil-filled transformer including the coil 201 in which both the high-voltage (primary side) and the low-voltage (secondary side) windings are formed of flat or round conductor lead wires wound around the tripod iron core 203 formed of an amorphous ribbon or a silicon steel sheet, and an upper clamp 204A and a lower clamp 204B that clamp and press the coil 201 in the axial direction.

[0029] The coil 201 is formed by further winding, in a position where the upper clamp 204A is notched, the thermosetting resin-impregnated fiber 205A wound in the coil axis direction of the tap line wire lead part 202 permitting no mechanical pressing in the coil axis direction and, also in the horizontal direction around the outermost circumference of the coil 201, the thermosetting resin-impregnated fiber 205B is wound around. Further, where an amorphous ribbon is used for the iron core 203, since the amorphous ribbon thinner than a silicon steel sheet is stacked between the iron core 203 and the coil 201 in the axial direction of the coil 201 as shown in Fig. 2B, the amorphous iron core is susceptible to deformation, and therefore the thermosetting resin-impregnated fiber 205A is wound around in the axial direction of the coil 201 where the iron core 203 overlaps the coil 201 as well.

(Third Embodiment)

[0030] Next, Embodiment 3 of the present invention will be described with reference to Figs. 3A and 3B. Fig. 3A shows a perspective view of the coil iron core assembly of an oil-filled transformer. The coil iron core assembly uses a three-phase tripod laminated iron core, winds a thermosetting resin-impregnated fiber 305A in the coil axis direction in the vicinity of a tap part 302 of a coil 301, and further winds a thermosetting resin-impregnated fiber 305B in the horizontal direction around the outermost circumference of the coil 301.

[0031] In Figs. 3A and 3B, 301 denotes the coil; 302, a tap line wire lead part; 303, an laminated iron core; 304A, an upper clamp; 304B, a lower clamp; 305A, the thermosetting resin-impregnated fiber in the vicinity of the tap part 302; and 305B, the thermosetting resin-impregnated fiber in the horizontal direction around the outermost circumference of the coil.

[0032] Fig. 3 shows the coil 301 in which both the high-voltage (primary side) and the low-voltage (secondary side) windings are formed of flat or round conductor lead wires is wound around the tripod laminated iron core 303 formed of a silicon steel sheet and the coil iron core assembly of the oil-filled transformer from the upper clamp 304A and the lower clamp 304B clamping pressing in the coil axis direction.

[0033] Further, the coil 301 is formed by winding, in a position where the upper clamp 304A is notched, the thermosetting resin-impregnated fiber 305A wound in the coil axis direction of the tap line wire lead part 302 permitting no mechanical pressing in the coil axis direction and, also in the horizontal direction around the outermost circumference of the coil 301, the thermosetting resin-impregnated fiber 305B is wound around.

(Fourth Embodiment)

[0034] Next, a case where a thermosetting resin-impregnated fiber is wound around a coil in the vicinity of a tap part will be described with reference to Fig. 4.

[0035] In Fig. 4, Fig. 4(a) shows a perspective view of a thermosetting resin-impregnated fiber 405A wound around in the coil axis direction in the vicinity of a tap part 402 of a coil 401; Fig. 4(b), a thermosetting resin-impregnated fiber tape 405A; Fig. 4(c), a partially expanded perspective view of the tap part 402 of the coil 401; and Fig. 4(d), a partially expanded perspective view of Fig. 4(c).

[0036] In Fig. 4(a), 401 denotes the coil; 402A, a primary side tap terminal; 402B, a secondary side tap terminal; and 405A, the thermosetting resin-impregnated fiber. In the respective vicinities of the primary side tap and the secondary side tap part of the coil 401, the thermosetting resin-impregnated fiber 405A is collectively wound in the coil axis direction.

[0037] In Fig. 4(b), 402C denotes a position in which a tap terminal is to be arranged, and 405B, positions in which the thermosetting resin-impregnated fiber tape

405A is rounded and arranged on edges of cooling ducts 406 and the tape is expanded and pasted within the coil.

[0038] In Fig. 4(c), the thermosetting resin-impregnated fiber tape 405A to be wound around the tap part 402 of the coil 401 in the coil axis direction is wound on the flank of the coil 401 in an expanded shape with the adhesive part of the tape pasted; on an end face in the upper part of the coil 401, it takes on a shape 405B in which the tape of the thermosetting resin-impregnated fiber tape 405A is rounded; and inside the coil 401 it is pasted onto the inner flank face in an expanded shape and wound.

[0039] The thermosetting resin-impregnated fiber tape 405A takes on the round shape 405B on an end face of the coil 401 in order to prevent blocking of the cooling ducts 406 arranged in the coil.

[0040] The cooling ducts in the coil have spaces continuous from one end to the other of the coil. It is a hole for cooling the heat generated from the coil in the oil channel where insulating oil in the transformer passes.

[0041] Therefore, these cooling ducts are so formed as not to be blocked. Incidentally, if the thermosetting resin-impregnated fiber tape 405A is pasted in an expanded shape to a coil end face, air may be locked in the tape because its surface is rough and not completely flat.

[0042] If an iron core is fitted in a state in which air is locked in the thermosetting resin-impregnated fiber tape 405A, the coil iron core assembly is placed in the oil-filled transformer, the space is filled with insulating oil and the transformer is operated, the insulation may be destroyed by air in the vicinity of the coil.

[0043] Therefore, the configuration should be such that no coil can be locked in the oil end face.

(Fifth Embodiment)

[0044] Next, a configuration in which a thermosetting resin-impregnated fiber tape is wound layer by layer of the oil will be described with reference to Fig. 5.

[0045] In Fig. 5, Fig. 5(a) shows a perspective view of the thermosetting resin-impregnated fiber tape 505A is wound in a first layer, while Figs. 5(b) and 5(c) show partially expanded perspective views of the tape 505A wound around the tap part of the coil 501.

[0046] In Fig. 5(a), 501 denotes the coil; 502, a tap terminal; and 505A, a thermosetting resin-impregnated fiber. The thermosetting resin-impregnated fiber tape 505A is collectively wound in the first layer of the coil 501 in the coil axis direction. The position of the coil where the thermosetting resin-impregnated fiber 505A is wound also is the position where the tap part is disposed.

[0047] Referring to Fig. 5(b), the tape 505A is wound in the coil axis direction in the position where the tap part of the coil 501 is disposed. The tape is pasted in an expanded state on the flank side of the coil 501, on its end face side and further on the inner flank side of the coil.

[0048] In Fig. 5(c), 506 denotes cooling ducts. The

thermosetting resin-impregnated fiber tape 505A is pasted layer by layer of the coil, and arranged by passing it through the cooling ducts 506 arrayed at equal intervals, bending and pasting it.

(Sixth Embodiment)

[0049] Next, a configuration in which a thermosetting resin-impregnated fiber is wound in part of two or more turns wound layer by layer of the coil will be described with reference to Fig. 6.

[0050] Fig. 6 shows a perspective view of a configuration in which a thermosetting resin-impregnated fiber tape 605A is wound around each layer of a coil 601 in two or more turns (collectively in five turns in the illustrated case).

[0051] In Fig. 6, 601 denotes the coil; 602B, a tap terminal; and 605A, the thermosetting resin-impregnated fiber. Here is shown a configuration in which five turns 610 of the tape 605A in the tap part are collectively wound in a single layer of the coil. On the outer face of the coil, the thermosetting resin-impregnated fiber tape is pasted in an expanded state and wound, and on the end face of the coil, the tape is pasted, with the inner flank also pasted in an expanded state and wound.

[0052] Then, around the outer circumference of the one coil layer shown in Fig. 6, a second coil layer is wound, and in the tap part five turns of the thermosetting resin-impregnated fiber tape 605A are collectively pasted and wound in the second coil layer like the first coil layer. This process is repeated to manufacture the whole coil.

[0053] Referring to Fig. 6, in the vicinity of the tap part of the coil 601, because of the presence of a tap line wire lead part, no pressing by the upper clamp and the lower clamp is possible, and accordingly the configuration is such that the thermosetting resin-impregnated fiber tape 605A is wound for a few turns of coil in the vicinity of the tap part.

(Seventh Embodiment)

[0054] Next, a configuration in which a thermosetting resin-impregnated fiber tape is wound in a position where the electromagnetic mechanical force is great in time of short circuiting at the beginning and end of coil winding will be described with reference to Fig. 7.

[0055] The left-hand part of Fig. 7 shows a perspective view of the beginning phase of coil winding, and the right-hand part, a perspective view of the ending phase of coil winding. In Fig. 7, 701 denotes a coil; 702A, a primary side tap terminal; 702B, a secondary side tap terminal; and 705A, a thermosetting resin-impregnated fiber. In the position where the tap part is arranged, the thermosetting resin-impregnated fiber tape 705A is wound partially.

[0056] In the left-hand part of Fig. 7, the tap terminal 702B is the secondary side tap terminal, while 702A denotes the primary side tap terminal. At the secondary

side tap terminal, a few turns of the coil beginning to be wound in the vicinity of the tap are put together, and the thermosetting resin-impregnated fiber tape 705A is wound layer by layer.

[0057] As illustrated, five turns of the coil are collectively wound.

[0058] The right-hand part of Fig. 7 shows the secondary side tap terminal, where a few (five in the illustration) turns of the coil are collectively wound in the vicinity of the tap at the winding end, with the thermosetting resin-impregnated fiber tape 705A put together and wound layer by layer.

(Eighth Embodiment)

[0059] Next, a method of winding the thermosetting resin-impregnated fiber into a coil will be described with reference to Fig. 8. Fig. 8 shows a partially expanded +perspective view of a coil of the method at a step where a thermosetting resin-impregnated fiber tape is wound.

[0060] In Fig. 8, Fig. 8(a) is a perspective view of cooling ducts arranged; Fig. 8(b), a perspective view of segments of a tape placed between the cooling ducts; Fig. 8(c), a perspective view of flat or round lead wires wound in a horizontal direction in a state in which the tape segments are erected; Fig. 8(d), a perspective view of cooling ducts arranged over insulating paper wound on the coil surface; and Fig. 8(e), a perspective view of a configuration in which a thermosetting resin-impregnated fiber tape in an erect state is bent.

[0061] In Figs. 8(a) to 8(e), 810 denotes insulators; 820, rectangular materials; 830, spaces formed by the rectangular materials 820; and 805A, a thermosetting resin-impregnated fiber tape.

[0062] Referring to Fig. 8(a), a cylindrical shape to serve as the base is formed of the insulators 810 within the coil, and the rectangular materials 820, which may be oil-resistant lumber or the like, are arranged at equal intervals on the outer circumference of the cylindrical base.

[0063] The spaces are formed by these adjoining rectangular materials 820, and insulating oil is passed through these spaces 830 to enable the spaces to serve as the cooling ducts 830 for cooling the coil.

[0064] Next, as shown in Fig. 8(b), the thermosetting resin-impregnated fiber tape 805A is pasted to the insulators 810 in the spaces of the rectangular materials 820. Since the tape 805A is folded when it is pasted, one side part of the tape should be kept as it is.

[0065] Then, as shown in Fig. 8(c), a coil 801 is wound in a horizontal direction to form a first layer. A flat or round lead wire is used as the coil and, as shown in Fig. 8(d), a sheet-shaped insulator 811 is wound around the coil 801, and over it the rectangular materials 820 are further arranged at equal intervals.

[0066] Further, the spaces 830 are formed between the rectangular materials 820 arranged at equal intervals to serve as the cooling ducts 830.

[0067] Next, as shown in Fig. 8(e), the parts of the thermosetting resin-impregnated fiber tape 805A to be folded in being pasted into the spaces 830, formed of the rectangular materials 820, are pasted.

[0068] In this way, the configuration is such that the coil 801 is sandwiched between parts of the thermosetting resin-impregnated fiber tape 805A.

[0069] The whole coil is assembled by repeating the manufacturing steps illustrated in Figs. 8(a) to 8(e).

[0070] Now, the oil-filled transformer housing the coil iron core assembly according to the present invention will be described. Fig. 9 shows a perspective view of the oil-filled transformer housing the coil iron core assembly. In Fig. 9, 900 denotes a tank of an oil-filled transformer body; 910, cooling ribs disposed around the tank; and 920, weld lines fixed to the upper and lower ends of the wavy ribs to strengthen and preventing deformation of the wavy ribs 910; 930, a high-voltage (primary side) terminal, which connects a high voltage supplied from a power plant and is connected to the tap line wire lead parts 102, 202 and 302; and 940, a low-voltage (secondary side) terminal for supplying a voltage generally lowered by the transformer to loads connected to the tap line wire lead parts 402B, 502B and 602B.

[0071] To add, the present invention is not limited to the embodiments described above, and includes various modifications. For instance, these embodiments are described in detail to help understand the present invention, but they are not limited to embodiments including all the constituent elements described for each. It is also possible to replace part of the configuration of one embodiment to part of another, or to add an element or elements of the configuration of one embodiment to that of another. Further, it is possible to add to, delete from or substitute some element for the configuration of each embodiment.

[0072] For instance, adjoining coils can be fixed by winding with a thermosetting resin-impregnated fiber, and the rounds of thermosetting resin-impregnated fiber winding can be increased or reduced partly.

List of Reference Signs

[0073]

101, 201, 301, 401, 501, 601, 701, 801: Coil
102, 202, 302: Tap line wire lead part
103, 203, 303: Iron core
104A, 204A, 304A: Upper clamp
104B, 204B, 304B: Lower clamp
105A, 205A, 305A, 405A, 505A, 605a, 705A, 805A: Thermosetting resin-impregnated fiber
105B, 205B, 305B: Thermosetting resin-impregnated fiber around outermost circumference of coil
405B: Thermosetting resin-impregnated fiber tape which takes on the round shape
406: Cooling duct
402C: Tap terminal
810: Insulator

820: Rectangular material
 830: Space formed of rectangular materials 820
 900: Tank of oil-filled transformer body
 910: Cooling ribs disposed around tank
 920: Weld lines fixed to the upper and lower ends of the wavy ribs 5
 930: High-voltage (primary side) terminal
 940: Low-voltage (secondary side) terminal

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Claims

1. An oil-filled transformer mounted with an iron core formed of an amorphous ribbon or a silicon steel sheet and a coil of which both high-voltage and low-voltage windings are formed of flat or round conductor lead wires wound around the iron core, wherein a thermosetting resin-impregnated fiber is wound in the coil axis direction around the coil in a tap line wire lead part, and further the thermosetting resin-impregnated fiber is wound in the outermost layer of the coil. 15 20
2. The oil-filled transformer according to Claim 1, wherein the thermosetting resin-impregnated fiber is a glass binding tape using epoxy resin. 25
3. The oil-filled transformer according to Claim 1, wherein the thermosetting resin-impregnated fiber is wound around in the coil axis direction where the iron core overlaps on the coil between the coil and the iron core. 30
4. The oil-filled transformer according to Claim 1 or 3, wherein the thermosetting resin-impregnated fiber is collectively wound for the coil in the coil axis direction. 35
5. The oil-filled transformer according to Claim 1 or 3, wherein the thermosetting resin-impregnated fiber is wound in the axial direction around each layer of the coil. 40
6. The oil-filled transformer according to Claim 1, 2 or 4, wherein the thermosetting resin-impregnated fiber is wound in the coil axis direction around each layer of a coil in two or more turns only in a part in the vicinity of the coil end face. 45
7. The oil-filled transformer according to Claim 1 or 2, wherein the thermosetting resin-impregnated fiber is wound in the coil axis direction at the respective beginning and ending of the high-voltage and low-voltage windings where the electromagnetic mechanical force is great in time of short circuiting. 50 55

FIG. 1A

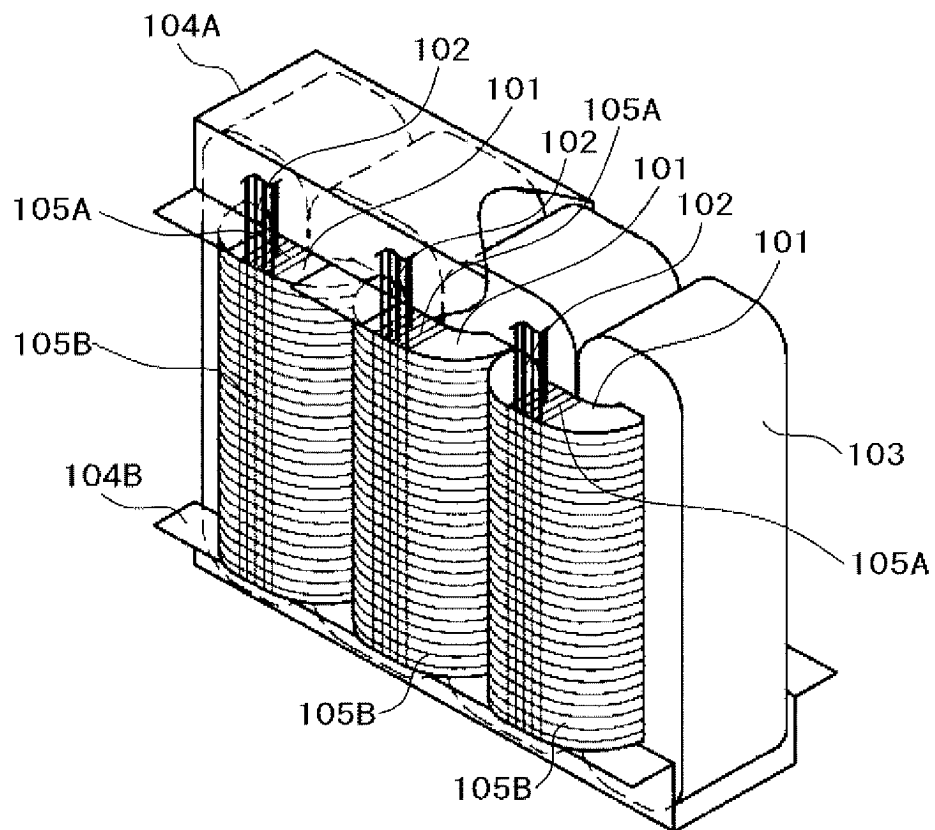


FIG. 1B

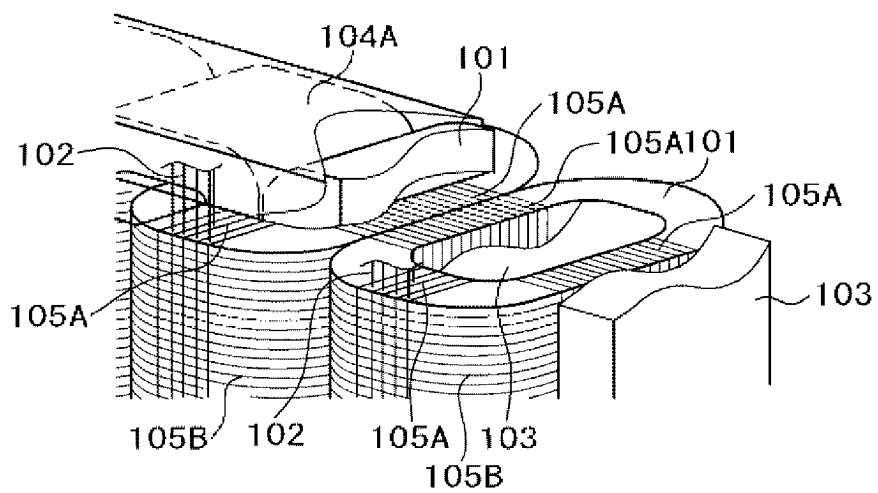


FIG. 1C

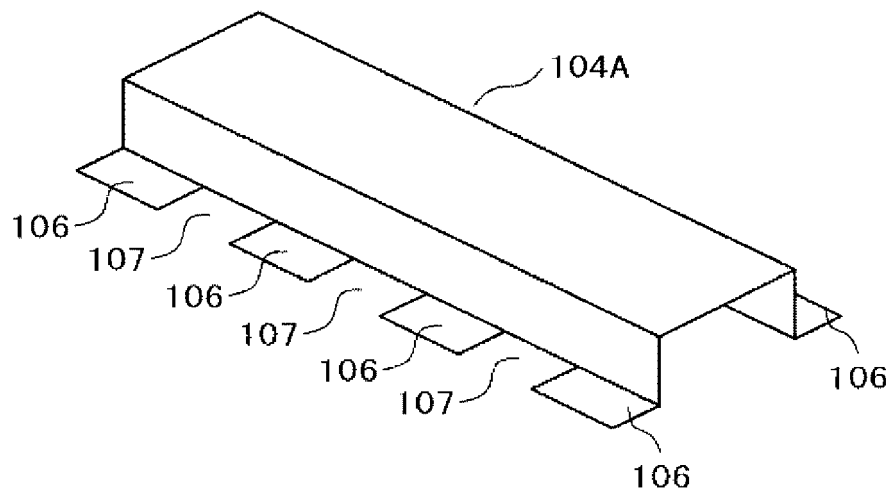


FIG. 1D

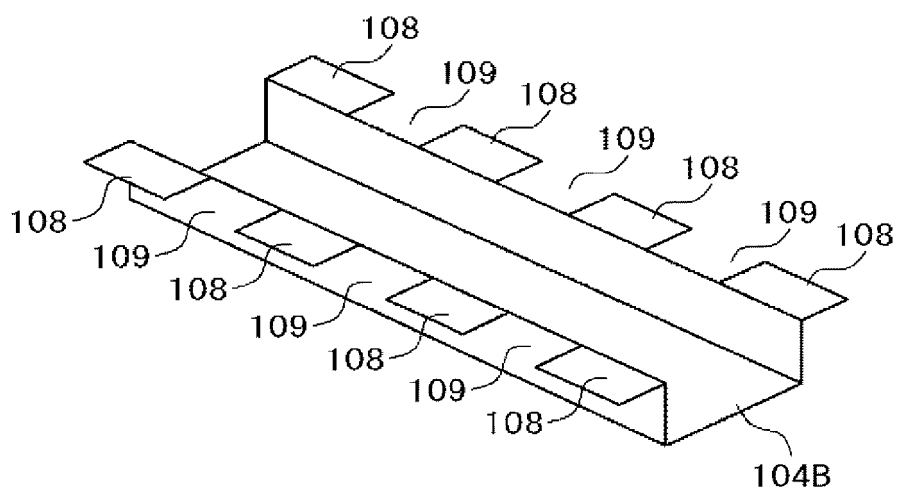


FIG. 2A

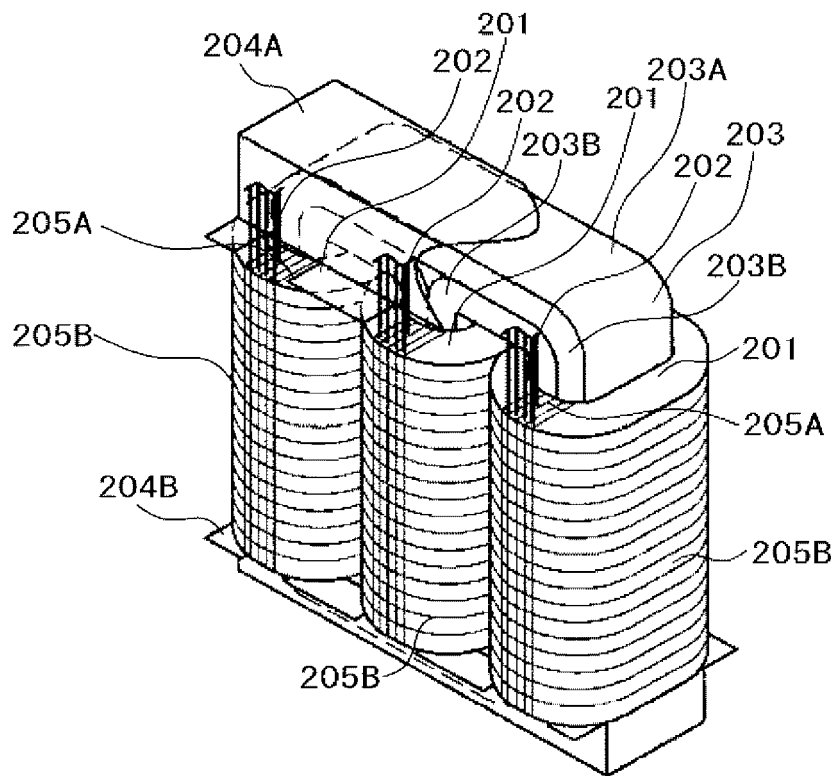


FIG. 2B

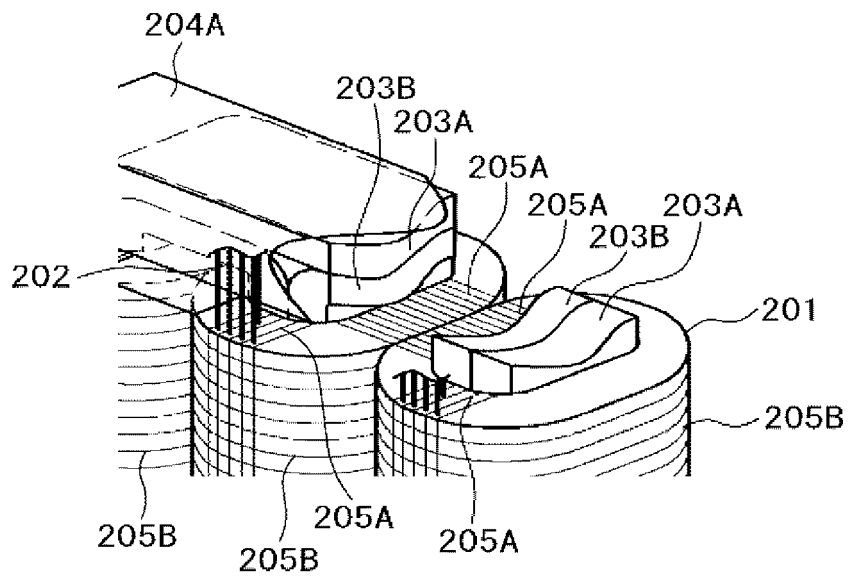


FIG. 3A

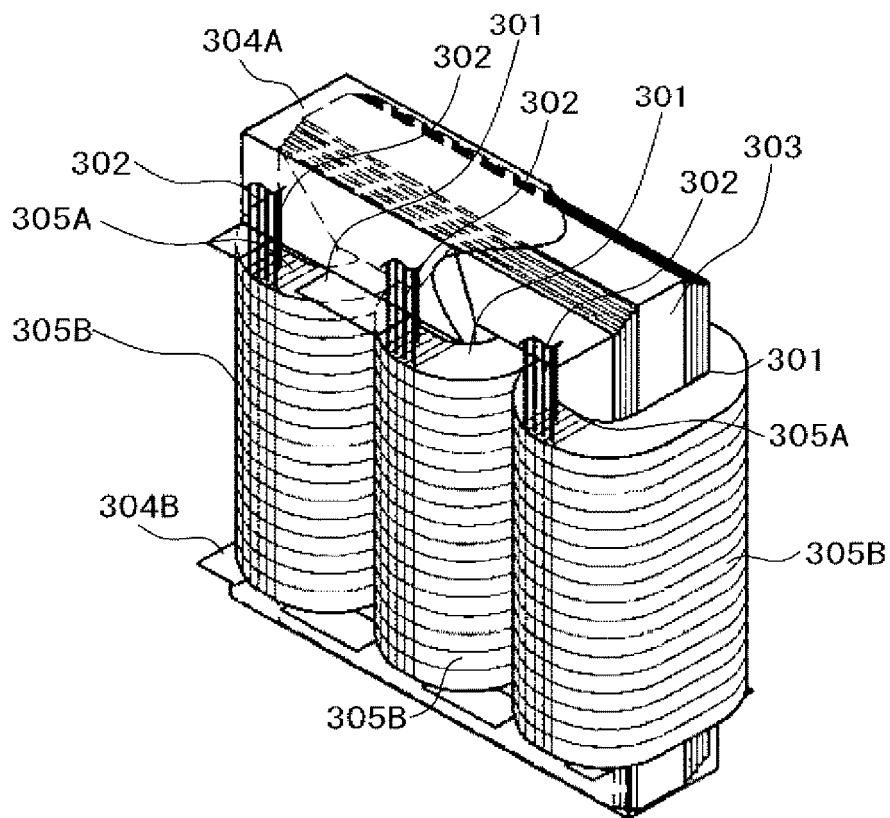


FIG. 3B

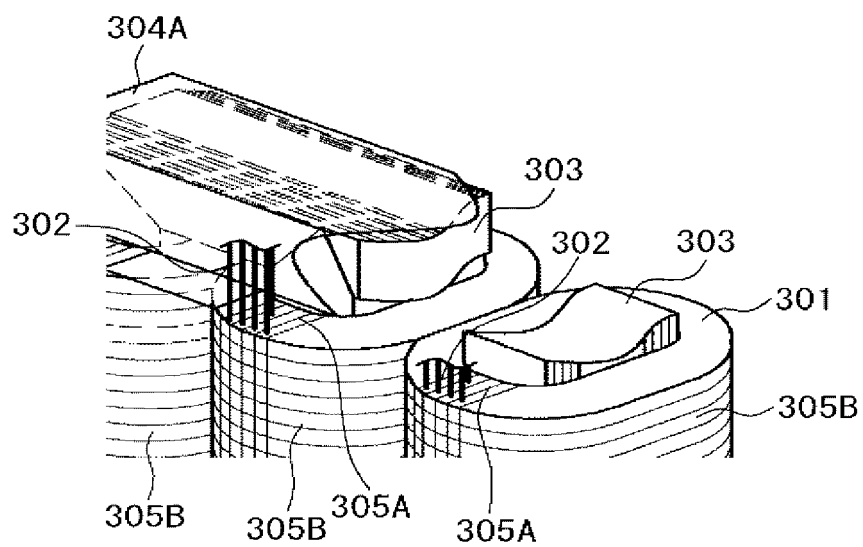


FIG. 4

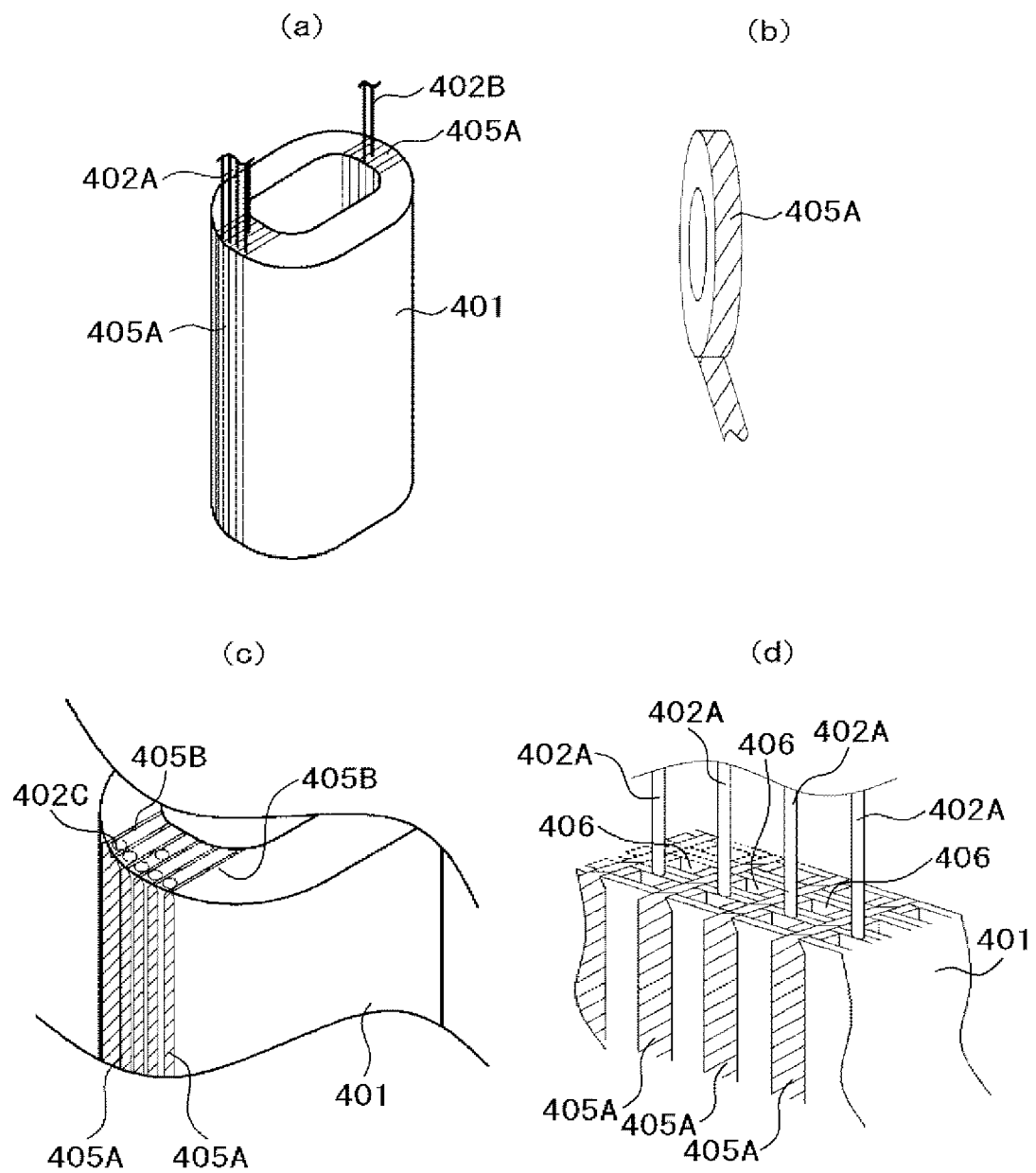


FIG. 5

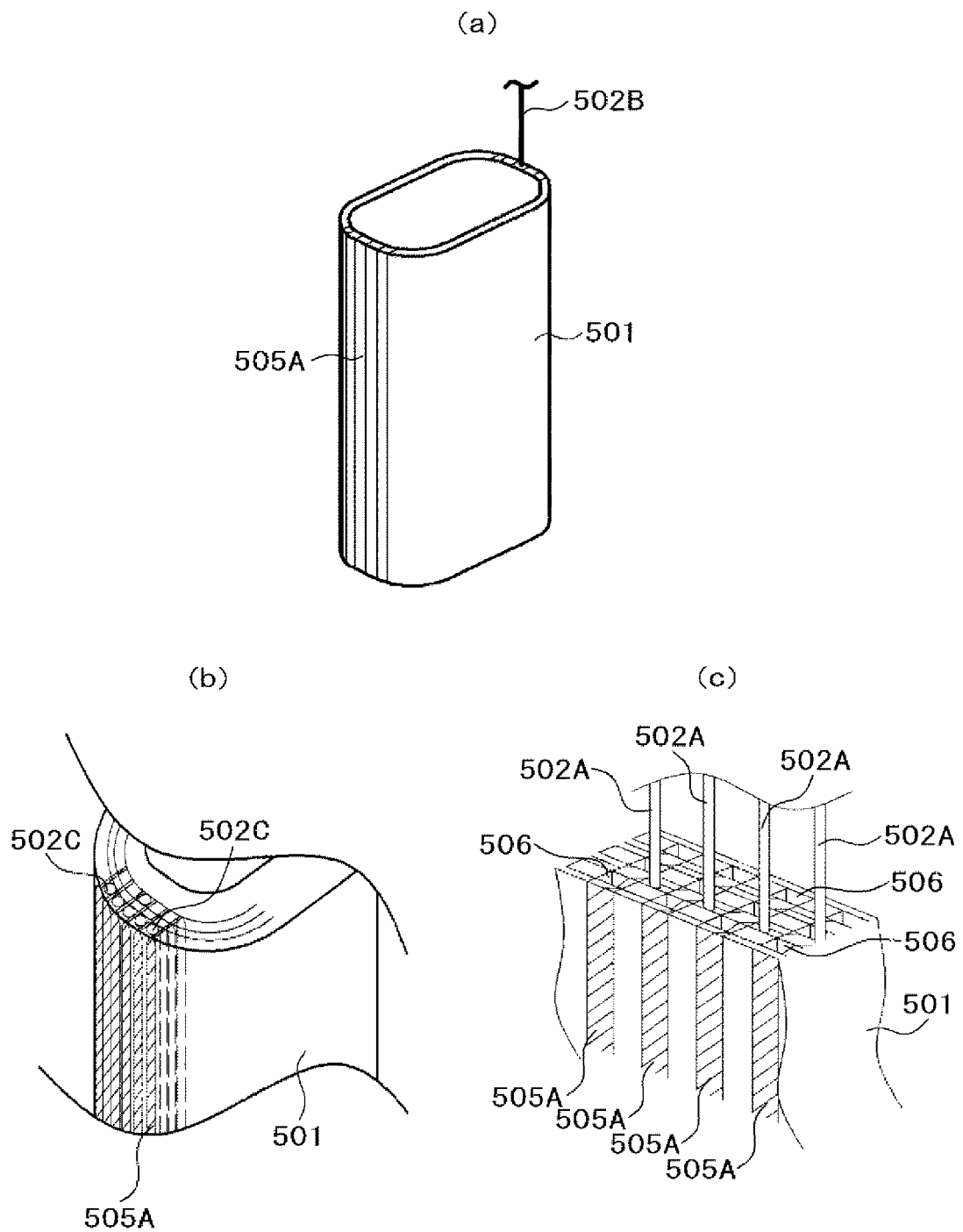


FIG. 6

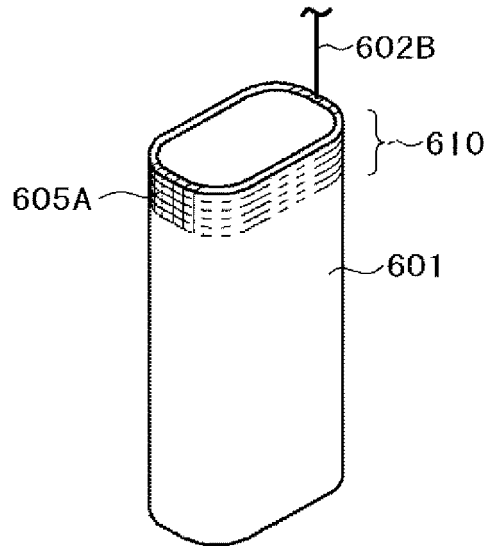


FIG. 7

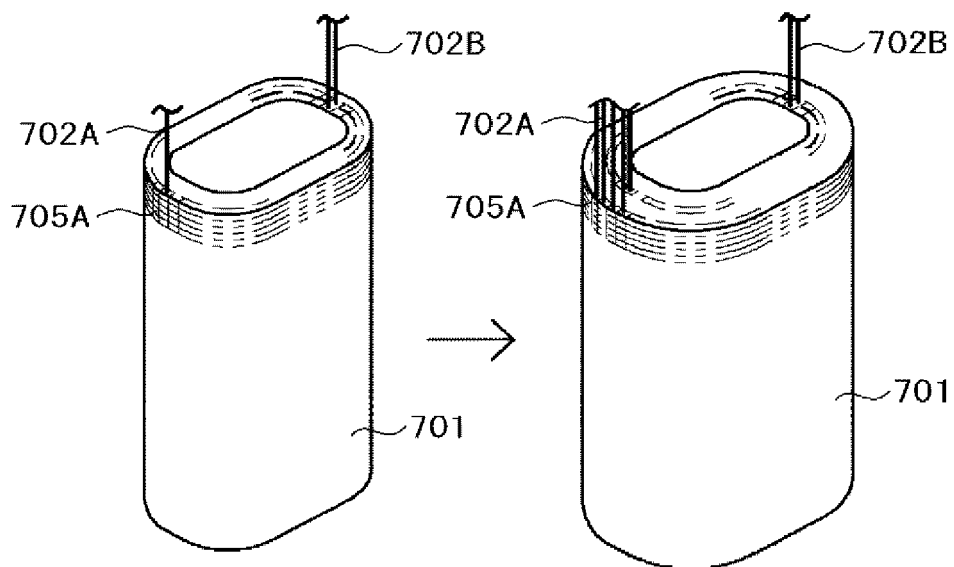


FIG. 8

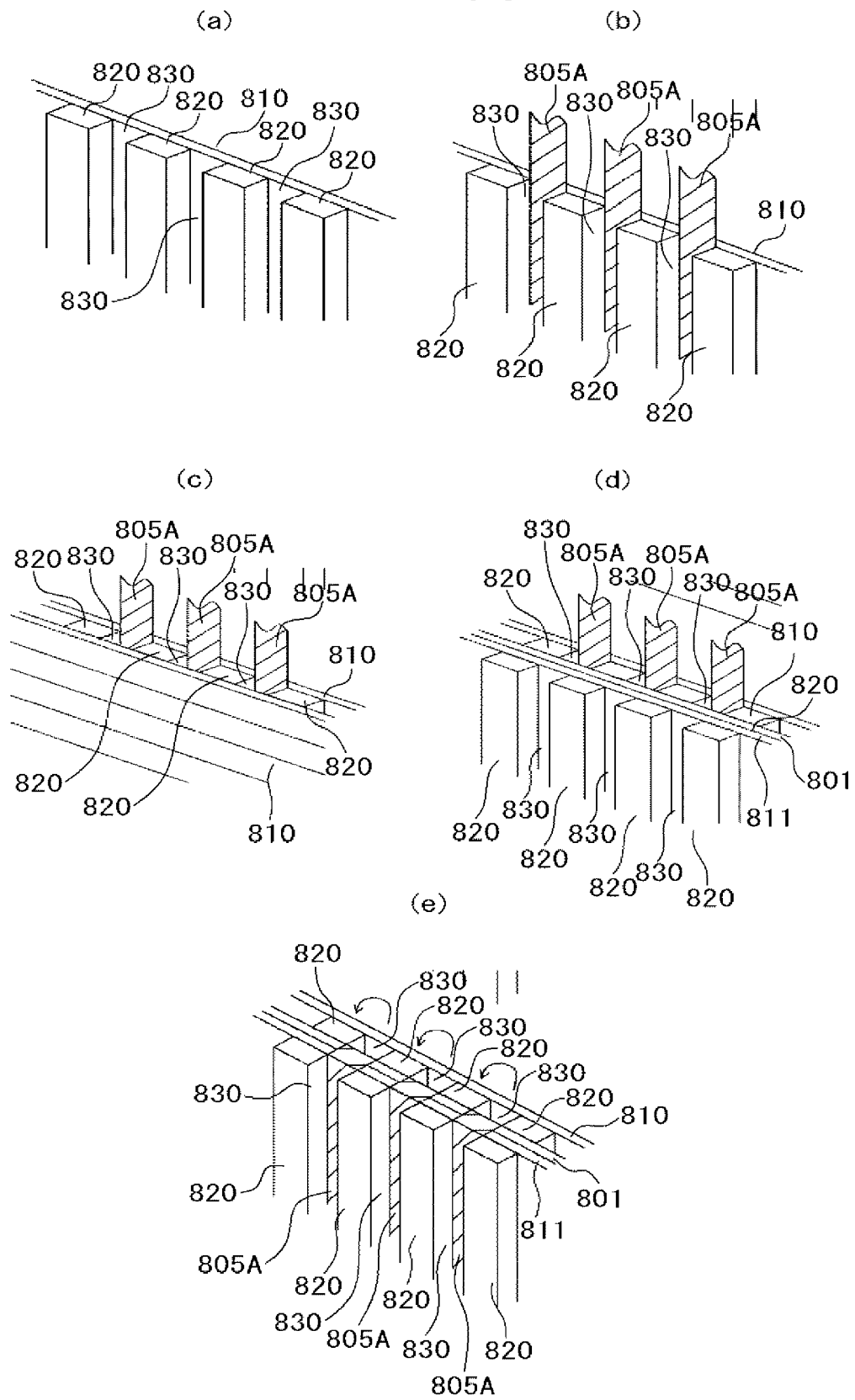
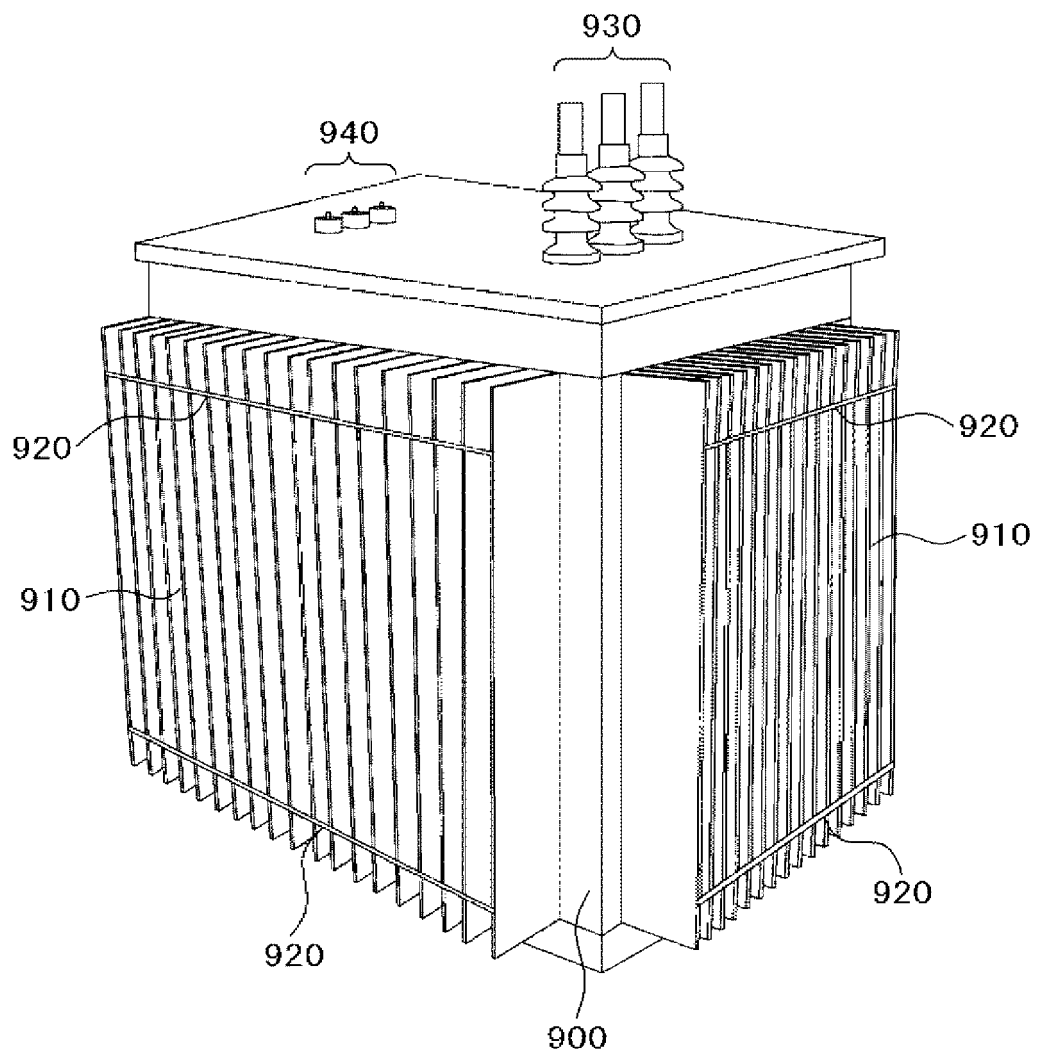


FIG. 9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2013/055744

A. CLASSIFICATION OF SUBJECT MATTER

H01F27/30(2006.01)i, H01F5/04(2006.01)i, H01F27/28(2006.01)i, H01F27/32(2006.01)i, H01F30/00(2006.01)i, H01F30/12(2006.01)i, H01F41/12(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01F27/30, H01F5/04, H01F27/28, H01F27/32, H01F30/00, H01F30/12, H01F41/12

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2013

Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 162465/1977(Laid-open No. 88543/1979) (Ikeda Electric Co., Ltd.), 22 June 1979 (22.06.1979), page 1, line 17 to page 2, line 1; fig. 4 (Family: none)	1-7
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 26250/1976(Laid-open No. 118952/1977) (Mitsubishi Electric Corp.), 09 September 1977 (09.09.1977), page 3, line 3 to page 6, line 16; fig. 2 to 7 (Family: none)	1-7

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

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Date of the actual completion of the international search
15 March, 2013 (15.03.13)Date of mailing of the international search report
26 March, 2013 (26.03.13)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2013/055744

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 50843/1981 (Laid-open No. 163722/1982) (Hitachi, Ltd.), 15 October 1982 (15.10.1982), page 1, line 12 to page 5, line 8; fig. 1 to 10 (Family: none)	1-7
A	JP 1-207913 A (The Kansai Electric Power Co., Inc.), 21 August 1989 (21.08.1989), page 2, lower left column, lines 1 to 17; fig. 1 (Family: none)	1-7
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 118227/1975 (Laid-open No. 31815/1977) (Tamura Corp.), 05 March 1977 (05.03.1977), page 2, line 9 to page 3, line 16; fig. 1 to 4 (Family: none)	1-7

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP SHO6151811 A [0009] [0010]