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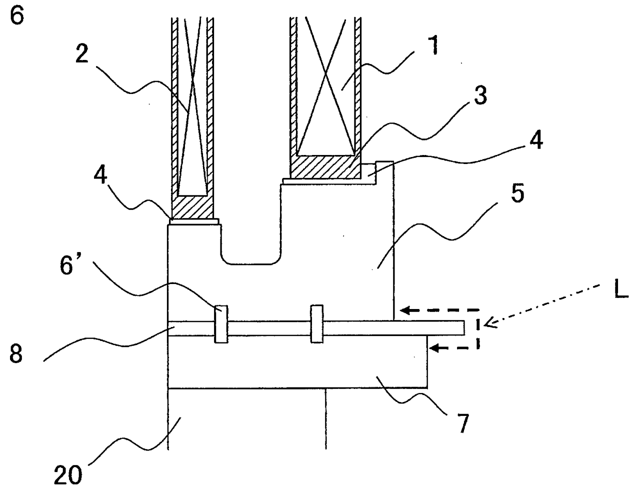
(54) MOLDED TRANSFORMER

(57) A molded transformer according to one embodiment of the present invention has a primary coil, and a secondary coil that is disposed inside the primary coil in a state in which a predetermined space is provided between them, wherein the primary and secondary coils are supported by a plurality of support structures. The plurality of support structures are provided between the ends of the primary and secondary coils and a frame, and each of the support structures comprises an insulator block and a wide insulating plate having a wider surface area than the bottom surface area of the insulator block. A top surface of the insulator block is abutted to the ends of the primary and secondary coils, and the wide insulating plate is disposed between the bottom surface of the insulator block and the frame.

FIG. 6



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Description

[Technical Field]

[0001] The present invention relates to a molded transformer.

[Background Art]

[0002] Patent Literature 1 is a document disclosing one example of the background art of the present technical field. Patent Literature 1 discloses a molded transformer adopting a configuration where a high voltage coil (primary coil) and a low voltage coil (secondary coil) which are both resin molded in a cylindrical shape are fixed to a frame of the transformer via insulating spacers.

[0003] In general, molded transformers are installed and operated in an electric room which is maintained so that outside air does not enter directly. However, expansion of application range of molded transformers is expected. Therefore, in the future, molded transformers may be installed in a particular environment where there is much dust, moisture, salt content and so on, which has not been assumed as installation location of molded transformers. The operation under such environment still requires an equivalent level of reliability as the operation under the environment maintained so that outside air does not enter directly.

[0004] In an environment exposed to a large amount of dust, moisture, salt content and so on, there is a need to consider measures against corrosion caused by tracking phenomenon and the like. Specifically, corrosion resistance of rubber portions of insulating spacers is deteriorated if contaminants such as dust, moisture and salt are adhered thereto, and concentration of electric field is caused. As a result, corrosion of the rubber portion progresses, the insulation resistance is deteriorated, by which the tracking phenomenon progresses along the insulator block, and dielectric breakdown may be caused.

[0005] In order to improve the insulation property of the transformer, it is necessary to ensure a large creepage distance of insulation between the coil and the metal other than the coil (distance along a surface of an insulating member disposed between the coil and metal other than the coil). For example, Patent Literature 2 discloses an art of ensuring a creepage distance of insulation in an oil-immersed transformer, wherein an insulating member disposed between a coil and a coil pressing metal fixture disposed in an outer circumference of the coil is formed to be larger than a length in an axial direction of the coil, and vertically protruding from both end surface positions of the coil.

[Citation List]

[Patent Literature]

[0006]

[PTL 1] Japanese Unexamined Patent Application Publication No. 2000-252138

[PTL 2] Japanese Unexamined Patent Application Publication No. 2009-283686

[Summary of Invention]

[Technical Problem]

[0007] The method disclosed in Patent Literature 2 is a method that ensures the insulation property between the coil and the metal positioned on the outer side of the coil, by arranging an insulating member having a length longer than the length in the axial direction of the coil. On the other hand, in a molded transformer as taught in Patent Literature 1, it is necessary to ensure the creepage distance of insulation between the coil and the frame positioned at upper and lower ends of the coil. Therefore, even if the method taught in Patent Literature 2 is applied to the molded transformer, that is, to provide an insulator at the outer circumference of the coil, and to form the insulator with a length longer than the length in the axial direction of the coil, it is not possible to elongate the creepage distance of insulation between the coil and the frame positioned at upper end lower ends of the coil.

[0008] The object of the present invention is to provide a method for ensuring an appropriate insulation property in a molded transformer.

[Solution to Problem]

[0009] According to one aspect of the present invention, a molded transformer includes a cylindrical primary coil, a cylindrical secondary coil disposed inside the primary coil in a state in which a predetermined space is provided between them, an upper frame, and a lower frame, wherein a plurality of support structures support the primary and secondary coils. A plurality of support structures are respectively provided between upper and lower end portions of the primary and secondary coils and the frame, and the support structures respectively include an insulator block, and a wide insulating plate having an area wider than a bottom surface area of the insulator block. The insulator block is abutted against end portions of the primary and secondary coils, and a wide insulating plate is disposed between the insulator block and the frame.

[Advantageous Effects of Invention]

[0010] According to the present invention, the creepage distance of insulation of the insulator block portion can be extended, and the reliability of the molded transformer can be improved.

[Brief Description of Drawings]

[0011]

[FIG. 1]
FIG. 1 is a front view of a molded transformer according to a first embodiment.
[FIG. 2]
FIG. 2 is a side view of the molded transformer according to the first embodiment.
[FIG. 3]
FIG. 3 is a cross-sectional view of transformer coils according to the first embodiment, and a cross-sectional view of a support structure supporting the coils.
[FIG. 4]
FIG. 4 is a perspective view of the support structure according to the first embodiment.
[FIG. 5]
FIG. 5 is a cross-sectional view of the support structure positioned at an upper end portion of the transformer coils according to the first embodiment.
[FIG. 6]
FIG. 6 is a cross-sectional view of the transformer coils and a cross-sectional view of a support structure supporting the same according to a second embodiment.
[FIG. 7]
FIG. 7 is a perspective view of the support structure according to the second embodiment.
[FIG. 8]
FIG. 8 is a view illustrating a shape of a wide insulating plate in a state where a support structure according to a modified example of the second embodiment is disposed at a lower end of the coil.
[FIG. 9]
FIG. 9 is a cross-sectional view of a transformer coil according to a third embodiment, and a cross-sectional view of a support structure supporting the same.
[FIG. 10]
FIG. 10 is a perspective view of the support structure according to the third embodiment.
[FIG. 11]
FIG. 11 is a cross-sectional view of a state where a buffer material is disposed below the wide insulating plate.
[FIG. 12]
FIG. 12 is a cross-sectional view of a secondary coil according to a fourth embodiment.
[FIG. 13]
FIG. 13 is a cross-sectional view of a transformer coil according to a fifth embodiment, and a cross-sectional view of a support structure supporting the same.
[FIG. 14]
FIG. 14 is a perspective view of a support structure according to a fifth embodiment.
[FIG. 15]
FIG. 15 is a structural drawing of the support structure according to the fifth embodiment.
[FIG. 16]
FIG. 16 is a structural drawing of a support structure according to a sixth embodiment.

[Description of Embodiments]

[0012] Hereafter, a transformer according to embodiments of the present invention will be described with reference to the drawings. The present invention is not restricted to the embodiments described below.

First Embodiment

[0013] Now, a first embodiment of the present invention will be described with reference to the drawings. FIG. 1 is a front view of a molded transformer 100 according to the first embodiment, and FIG. 2 is a side view of the molded transformer 100.

[0014] According to the molded transformer 100 of the first embodiment, primary coils 1 and secondary coils 2 both having tubular shapes, such as cylindrical shapes, are supported via a plurality of insulator blocks 5 and metal fittings 7 on a metal frame 20. The frame 20 includes a frame 20a positioned at a lower portion of the molded transformer 100 and a frame 20b positioned at an upper portion of the molded transformer 100. In the following description, in a case where the frames 20a and 20b are referred to without distinguishing the frames, they are referred to as "the frame 20". Further according to the present specification, the insulator block 5, the metal fitting 7 and the frame 20 are referred to as support structures.

[0015] FIG. 3 illustrates a cross-section of coils (the primary coil 1 and the secondary coil 2) and the support structure positioned at a lower end of the coils in the molded transformer 100. Further, FIG. 4 is a perspective view of the support structure. The primary coil 1 and the secondary coil 2 are respectively molded by resin 3, and are disposed coaxially in a radial direction. In FIG. 3, the left side corresponds to a center direction of the cylinder, and the right side corresponds to an outer circumference direction of the cylinder. The primary coil 1 and the secondary coil 2 are respectively molded by resin 3 (refer to FIG. 3). The secondary coil 2 is disposed coaxially at an inner side of the primary coil 1, and a space 11 (refer to FIG. 3) is provided between the primary coil 1 and the secondary coil 2. An iron core 13 is provided inside the secondary coil 2. In the molded transformer according to the first embodiment, the primary coil 1 is a high voltage coil, and the secondary coil 2 is a low voltage coil.

[0016] The insulator block 5 has a first support portion 5a configured to support the primary coil 1 and a second support portion 5b configured to support the secondary coil 2 disposed on a top surface thereof. The insulator block 5 is formed of an insulator such as a laminated glass plate. Further, a buffer material 4 such as silicon rubber is inserted between the primary coil 1 and the insulator block 5, and between the secondary coil 2 and the insulator block 5. A plurality of metal fittings 7 are mounted on the frame 20a of the molded transformer 100 on which the insulator blocks 5 are to be fixed, and the insulator blocks 5 are disposed on the metal fittings 7 placed on the frame 20 of the transformer. Further, the insulator blocks 5 and the metal fittings 7 are fixed via position retaining pins 6, so as to prevent dislocation of the insulator block 5.

[0017] FIG. 3 is a cross-sectional view illustrating one of the support structures positioned at the lower end portion of the primary coil 1 and the secondary coil 2 of the molded transformer 100 according to the first embodiment, and it should be noted that the upper end portion of the primary coil 1 and the secondary coil 2 also has an approximately vertically symmetric configuration. FIG. 5 illustrates a cross-sectional view of a support structure positioned at the upper end portion of the primary coil 1 and the secondary coil 2 of the molded transformer 100 according to the first embodiment. In this case, the insulator block 5 is used upside down as the direction illustrated in FIG. 3. That is, the first support portion 5a is disposed in contact with an upper end of the primary coil 1, and the second support portion 5b is disposed in contact with an upper end of the secondary coil 2. The insulator block 5 positioned on the upper end of the primary coil 1 and the secondary coil 2 is connected by bolts 15 to the metal fitting 7 and the frame 20b disposed at the upper side thereof.

[0018] Based on a field analysis performed by the present inventors using FIGs. 3 and 4 as the analysis system, it has been discovered that an electric field is applied to a corner portion of the buffer material 4. In an environment in which a molded transformer is usually disposed, such as the environment of an electric room maintained so that outside air does not enter the room directly, corrosion resistance will not be deteriorated even in a molded transformer adopting the conventional configuration. However, in a case where the molded transformer is disposed under a particular environment where there is much dust, moisture, salt content and so on, the electric field is increased by the influence of dust, moisture, salt and the like adhered to the silicon rubber portion, and partial discharge may be caused, deteriorating the corrosion resistance of the surface of the silicon rubber. Discharge corrosion that has occurred in the silicon rubber gradually advances into the insulator block 5, and finally results in dielectric breakdown.

[0019] Since the time up to the occurrence of dielectric breakdown is elongated as the distance between the primary coil 1 and the metal fitting 7 of the transformer increases, the configuration can be improved by increasing the height of the insulator block 5 and thereby increasing a creepage distance of insulation. Therefore, it is preferable to ensure a certain level of height of the insulator block 5. As an example, the height from a bottom portion of the insulator block 5 to a top surface of the first support portion 5a should be set to approximately 10 cm.

[0020] According to the transformer of the first embodiment, the primary coil 1 is a high voltage coil, and the secondary coil 2 is a low voltage coil. Therefore, it is important to further increase the creepage distance of insulation between the primary coil 1 and the frame 20 (or the metal fitting 7). Thus, the height of the first support portion 5a is set higher than the height of the second support portion 5b.

[0021] Further, a dent is provided between the first support portion 5a and the second support portion 5b of the insulator block 5. Thereby, the creepage distance of insulation between the primary coil and the secondary coil can be increased. It is important to perform cleaning and inspection of a molded transformer periodically when it is placed under a particular environment where there is much dust, moisture, salt content and so on,. According to some type of molded transformer, a configuration is adopted where an insulator film is independently disposed in the space 11 between the primary and secondary coils, but if such film is disposed in the space 11, to check the state of the secondary coil will be difficult. According to the present configuration, the states of a contact portion 4a between the primary coil 1 and the buffer material 4 and a contact portion 4b between the secondary coil 2 and the buffer material 4 can be visually checked easily, and ease of maintenance such as cleaning can be enhanced.

Second Embodiment

[0022] Next, a second embodiment of the present invention will be described with reference to FIGs. 6 and 7. A configuration of a molded transformer according to the second embodiment is similar to the molded transformer according to the first embodiment, except for the configuration of a support structure. Therefore, the support structure will mainly be described in the following description. FIG. 6 is a cross-sectional view illustrating one of the support structures positioned at a lower end portion of a primary coil 1 and a secondary coil 2 of a molded transformer according to the second embodiment. In a support structure according to the second embodiment, a wide insulating plate 8, which is a flat plate having an area wider than a bottom surface area of an insulator block portion 5 and the metal fitting 7, is disposed at a lower portion of the insulator block portion 5, in addition to the configuration described with reference to the first embodiment. Further, similar to the first embodiment, the support structure positioned on an upper end of the primary coil 1 and the secondary coil 2 is configured substantially symmetrically as FIG. 6. However, the wide insulating plate 8 is not provided between the insulator block 5 and the metal fitting 7. In the following description, the support structure positioned at the lower end portion of the coils will mainly be described.

[0023] In order to prevent dislocation of the insulator block 5 and the wide insulating plate 8, the insulator block 5 and the wide insulating plate 8 are fixed via position retaining pins 6' to the metal fitting 7. The wide insulating plate 8 is provided to extend the creepage distance of insulation between the coils and the metal fitting 7 or the frame 20. Therefore, the wide insulating plate 8 being used at least has a greater width (length in the circumference direction) and length (length in the radial direction) than the insulator block 5 and/or the metal fitting 7.

[0024] The wide insulating plate 8 is not formed integrally with the insulator block 5, and the plate is formed as an independent component, so that a variety of materials can be used to form the wide insulating plate 8, as long as the material is an insulator. For example, a laminated glass plate and the like used in the insulator block portion 5 can be adopted, or a member formed of a material that differs from the material of the insulator block portion 5 can also be adopted.

[0025] By adopting the configuration where the wide insulating plate 8 is inserted, the creepage distance of insulation from the coil to the metal fitting 7 (or the frame 20) is extended. As the creepage distance of insulation from the coils to the metal fitting increases, the time until dielectric breakdown occurs is elongated. In a state where the wide insulating plate 8 is disposed, as illustrated in FIG. 7, surface distance of the wide insulating plate 8 is added to the height of the insulator block 5 as the creepage distance of insulation (a section L illustrated by a dotted line in FIG. 6 is the creepage distance of insulation). Therefore, the time until dielectric breakdown occurs is elongated.

[0026] Since the configuration allows the wide insulating plate 8 and the insulator block 5 to be separated, the insulator block 5 and the wide insulating plate 8 can be replaced independently. Further, the insulator block 5 can be applied easily to transformers of various sizes. In a state where the wide insulating plate 8 is integrated with the insulator block 5, the wide insulating plate 8 may interfere with other structures in a case where the insulator block 5 is disposed in a small-sized transformer. By preparing a plurality of wide insulating plates 8 of various sizes, and selecting an appropriate wide insulating plate 8 among the different sized plates 8 in response to the size of the transformer in which the insulator block is to be disposed, the insulator block 5 can be applied in common to transformers of various sizes, and the manufacturing costs of the insulator block 5 can be cut down.

Modified Example

[0027] A modified example of a support structure of a molded transformer according to the second embodiment will be described with reference to FIG. 8. The second embodiment has illustrated a configuration example in which a plate having a flat surface is used as the wide insulating plate 8. However, the shape of the wide insulating plate 8 is not restricted to a plate having a flat surface. The modified example illustrates a case where a wide insulating plate 8 with an inclined shape, that is, where ends of the wide insulating plate 8 are formed lower than the center portion of the plate, is adopted in the support structure.

[0028] FIG. 8 illustrates an example of a configuration of a wide insulating plate 8' provided with an inclination. FIG. 8 is a configuration diagram of a state in which the insulator block 5, the metal fitting 7 and the wide insulating plate 8' are viewed from the outer side of the transformer toward the center portion, in a state where the insulator block 5 is disposed at a lower end of the coils. Since the outer sides of the wide insulating plate 8' are formed lower than the center portion, water drops and the like are prevented from accumulating on the surface of the wide insulating plate 8'. The shape of the wide insulating plate 8' is not restricted to the example illustrated in FIG. 8. Various contours can be utilized, as long as the configuration adopts end portions disposed lower than the center portion and water drops attached to the top surface are prevented from accumulating on the surface. For example, a wide insulating plate having a trapezoidal shape can be utilized.

[0029] In a state where an inclination is provided to the wide insulating plate 8, the wide insulating plate 8 arranged at a lower end portion of the coils is disposed so that ends of the wide insulating plate 8' are lower than the center portion, as illustrated in FIG. 8.

[0030] If the wide insulating plate 8 and the insulator block 5 are molded integrally (hereinafter, the integrally molded wide insulating plate 8 and insulator block 5 is referred to as a "wide insulator block"), it is necessary to make a wide insulator block to be disposed at the lower end portion and a wide insulator block to be disposed at the upper end portion separately. The wide insulator block to be disposed at the lower end portion adopts a configuration where end portions of the wide insulating plate portion are lowered than the center portion when disposed at the lower end portion, as illustrated in FIG. 8. If the same block is disposed as it is at the upper end portion, the end portions of the wide insulating plate portion will be curved upward, and water drops and the like will be accumulated, so that it is not preferable. Therefore, the wide insulator block disposed at the upper end portion must adopt a configuration different from the wide insulator block disposed at the lower end portion (for example, as an insulator block not having a wide insulating plate portion).

[0031] If the wide insulating plate and the insulator block are formed as independent components, as according to the second embodiment and the present modified example, it becomes possible to prevent water drops and the like from accumulating on the surface of the insulator block 5 by disposing only the insulator block at the upper end portion without providing the wide insulating plate. Therefore, the same insulator block can be used in both the upper end portion and the lower end portion, and there is no need to independently create an insulator block to be disposed at the lower end portion and an insulator block to be disposed at the upper end portion.

[0032] An example has been described above where a wide insulating plate is not provided at the upper end portion, but it is also possible to provide the wide insulating plate on the upper end portion. In that case, the wide insulating plate 8' should be disposed in a same direction as the plate disposed at the lower end portion. That is to say, the wide insulating plate 8' should be disposed so that the outer portions are placed lower than the center portion. According to this configuration, water drops and the like are prevented from being accumulated near the insulator block provided at the upper end portion, similar to the case where the wide insulating plate 8' is disposed at the lower end portion.

Third Embodiment

[0033] Next, a third embodiment of the present invention will be described with reference to FIGs. 9 and 10. A configuration of a molded transformer according to the third embodiment is similar to the configuration of the molded transformer according to the first embodiment, except for the configuration of a support structure. FIG. 9 is a cross-sectional view of coils (the primary coil 1 and the secondary coil 2) and a support structure (the insulator block 5, the metal fitting 7 and the frame 20) supporting the coils in a molded transformer according to the third embodiment. FIG. 10 is a perspective view of the support structure.

[0034] According to the molded transformer of the first embodiment, the buffer material 4 is disposed between the coils and the insulator block 5. On the other hand, according to the molded transformer of the third embodiment, the buffer material 4 is disposed below the insulator block 5, and the primary and secondary coils 1 and 2 are directly supported by the insulator block 5. The other points are the same as the transformer according to the first embodiment.

[0035] The silicon rubber used as the buffer material 4 has a lower relative dielectric constant compared to the resin 3 molding the coils or the insulator block 5 composed of laminated glass plates and the like, and dielectric breakdown tends to occur. Therefore, according to the molded transformer of the third embodiment, the buffer material 4 is disposed at a distant location from the coils, so that concentration of the electric field is reduced, and dielectric breakdown is less likely to occur.

[0036] Further, the above configuration was described with reference to the configuration illustrated in FIG. 3, that is, a configuration without a wide insulating plate 8, but it is also possible to adopt the method according to the third embodiment to the configuration of the transformer according to the second embodiment. FIG. 11 illustrates a configuration example thereof. FIG. 11 adopts a configuration in which the second and third embodiments are combined, where the wide insulating plate 8 is disposed below the insulator block 5 such as the laminated glass plate, and the buffer material 4 such as silicon rubber is provided between the wide insulating plate 8 and the metal fitting 7. According to this configuration, the creepage distance of insulation between the coils and the metal fitting 7 can be extended, and concentration of electric field to the buffer material 4 can be relieved.

[0037] As another embodiment, the buffer material 4 can be provided between the insulator block 5 and the wide insulating plate 8.

Fourth Embodiment

[0038] Now, a fourth embodiment of the present invention will be described with reference to FIG. 12.

[0039] FIG. 12 is a cross-sectional view of a secondary coil 2 of a molded transformer according to a fourth embodiment. The configuration of the molded transformer according to the fourth embodiment is similar to the molded transformers according to the first, second or third embodiments, except for the point that an insulating film composed of an insulating paper 9 and an insulating tape 10 is disposed on an outer circumference portion of the secondary coil 2.

[0040] The insulating paper 9 and the insulating tape 10 are adhered to the outer circumference portion of the secondary coil 2, by which pollution resistance and pressure resistance of the transformer can be improved. Further, since insulation property is enhanced by this configuration, the space between the primary coil 1 and the secondary coil 2, such as the space 11 in FIG. 3, can be narrowed. In that case, the diameter of the primary coil 1 can be downsized, so that the whole transformer can be downsized.

[0041] Maintenance is important during the use of the molded transformer under a particular environment where there is much dust, moisture, salt content and so on. As described in the first embodiment, the method in which the insulator film is disposed in the space 11 between the primary and secondary coils 1 and 2 also improves the insulation property, reduces the insulation distance between coils, and enables the transformer to be downsized. However, cleaning is also important during use of the molded transformer under a particular environment where there is much dust, moisture, salt content and so on. It is difficult to perform cleaning of the secondary coil if an insulator is disposed in the space portion, but the present configuration enables to realize both downsizing of the transformer and improvement of ease of maintenance.

Fifth Embodiment

[0042] Next, a configuration of a molded transformer according to a fifth embodiment will be described. FIG. 13 is a cross-sectional view of a transformer coil (primary coil 1 and secondary coil 2) of the molded transformer and a support structure supporting the same according to the fifth embodiment. FIG. 14 is a perspective view of the support structure according to the fifth embodiment, and FIG. 15 is a structural drawing of the support structure according to the fifth embodiment.

[0043] According to the molded transformer of the second embodiment, as illustrated in FIG. 6, the wide insulating plate 8 is disposed between the insulator block 5 and the metal fitting 7 of the transformer, and configured to ensure the creepage distance of insulation L. On the other hand, according to the molded transformer of the fifth embodiment, as illustrated in FIG. 13, wide insulating plates 8a and 8b are respectively disposed at upper and lower portions of the insulator block 5, with the aim to further extend the creepage distance of insulation. The other points of the molded transformer according to the fifth embodiment are the same as the molded transformers of the first to fourth embodiments.

[0044] However, the wide insulating plates 8a and 8b are not configured to be directly molded onto the insulator block 5 by machining operation or the like. As illustrated in FIG. 15, grooves into which the wide insulating plates 8a and 8b are to be fit are formed on the insulator block 5. By fitting the wide insulating plates 8a and 8b into the grooves, the support structure as illustrated in FIG. 14 is formed.

[0045] In a case where a gap occurs between the respective wide insulating plates 8a and 8b and the grooves at the engagement portions between the insulator block and the wide insulating plates 8a and 8b, the gaps are filled using silicon, resin with an insulation property, and so on. Of course, it is also possible to prevent gaps from occurring between the grooves provided on the insulator block 5 and the wide insulating plates 8a and 8b, by forming accurate engagement dimensions through machine processing. However, in a case where a tracking phenomenon occurs, if the gaps are filled for example by silicon or resin with insulation property, the formation of an electric path passing the grooves formed on the insulating block 5 can be prevented more easily. According to the present configuration, if an electric path is formed to the insulator block 5 and the wide insulating plates 8a and 8b by tracking or the like, the insulation property can be easily recovered by replacing the wide insulating plates 8a and 8b. As for the insulator block 5, the insulation property can be recovered by polishing the surface of the formed electric path using a file or the like, or by applying an insulating coating, a varnish, and so on.

[0046] The present embodiment has illustrated an example in which two wide insulating plates are disposed on the insulator block 5, but it is also possible to dispose the wide insulating plate to only one area. For example, it is possible to dispose only the wide insulating plate 8b on the block.

Sixth Embodiment

[0047] FIG. 16 is a structural drawing of a support structure for a molded transformer according to a sixth embodiment. The configuration of the molded transformer according to the sixth embodiment is similar to the configuration of the molded transformer according to the first to fifth embodiments, except for the point (configuration of the support structure) described below.

[0048] The fifth embodiment has illustrated an example where the creepage distance of insulation is extended by fitting wide insulating plates 8a and 8b to the insulator block 5 from one direction. According to the molded transformer of the sixth embodiment, as illustrated in FIG. 16, a groove is formed to cover a whole periphery in the circumference direction of the insulator block 5. Thereafter, wide insulating plates 8c and 8d are inserted to the formed groove. At this time, the wide insulating plates 8c and 8d are disposed so that the insulator block 5 is sandwiched between the wide insulating plates 8c and 8d. The gaps occurred at the engagement portion between the insulator block 5 and the wide insulating plates 8c and 8d can be filled using silicon, resin with insulation property and so on, similar to the fifth embodiment.

[0049] The present embodiments have been illustrated above. The present invention is not restricted to the embodiments described above, and can include various modifications. For example, in the respective embodiments described above, an example has been described of the case where the coils are cylindrical, but the shape of the coils is not restricted to a cylinder. For example, the shape of the coils can be a rectangle. The embodiments described above have been illustrated in detail to help understand the present invention, and the present invention is not restricted to a configuration provided with all the components described in the description.

[0050] For example, the respective embodiments described above illustrate an example where the coils are cylindrical, but the shape of the coils is not restricted to a cylinder. It can be rectangular, for example. Further, the first support portion and the second support portion of the insulator block can be formed as independent structures. Moreover, other components can be added to, removed from or replace a portion of the configuration of the respective embodiments.

[Reference Signs List]

[0051]

1: Primary coil
2: Secondary coil
3: Resin
4: Buffer material such as silicon rubber
5: Insulator block
6: Position retaining pin
7: Metal fitting of transformer
8 (8a, 8b, 8c, 8d): Wide insulating plate
9: Insulating paper
10: Insulating tape
11: Space
13: Iron core
20: Frame

Claims

1. A molded transformer comprising a primary coil, a

secondary coil disposed inside the primary coil, a frame, and a plurality of support structures supporting the primary and secondary coils; wherein the secondary coil is disposed in a state in which a predetermined space is provided between the primary coil and the secondary coil,
the support structures respectively comprise an insulator block, and a wide insulating plate having an area wider than a bottom surface area of the insulator block, the support structures respectively provided between end portions of the primary and second coils and the frame,
a first support portion supporting the end portion of the primary coil and a second support portion supporting the end portion of the secondary coil are provided on a top surface of the insulator block, and
the wide insulating plate is disposed between a bottom surface of the insulator block and the frame.

2. The molded transformer according to claim 1, wherein the insulator block, the wide insulating plate and a metal fitting mounted to the frame are fixed by a position retaining pin.

3. The molded transformer according to claim 1 or claim 2, wherein the insulator block comprises a groove, and the wide insulating plate is inserted to the groove.

4. The molded transformer according to any one of claims 1 through 3,
wherein a height of the first support portion is higher than a height of the second support portion.

5. The molded transformer according to any one of claims 1 through 4,
wherein a dent is provided between the first support portion and the second support portion.

6. The molded transformer according to any one of claims 1 through 5,
wherein the plurality of support structures are provided between lower end portions of the primary and secondary coils and the frame,
the wide insulating plate comprises an inclination provided thereon, and
an end portion of the wide insulating plate provided at the lower end portions of the primary and secondary coils is positioned lower than a center portion of the wide insulating plate.

7. The molded transformer according to any one of claims 1 through 6,
wherein the plurality of support structures are provided between upper end portions of the primary and secondary coils and the frame positioned above the upper end portions of the primary and secondary coils,
an inclination is provided on the wide insulating plate, and
an end portion of the wide insulating plate provided at the upper end portions of the primary and secondary coils is positioned lower than the center portion of the wide insulating plate.

8. The molded transformer according to any one of claims 1 through 7,
wherein a buffer material is disposed between end portions of the primary and secondary coils and the insulator block.

9. The molded transformer according to any one of claims 1 through 8,
wherein the buffer material is disposed between the insulator block and the frame.

10. The molded transformer according to any one of claims 1 through 9,
wherein an insulating film is disposed on an outer circumference of the secondary coil.

FIG. 1

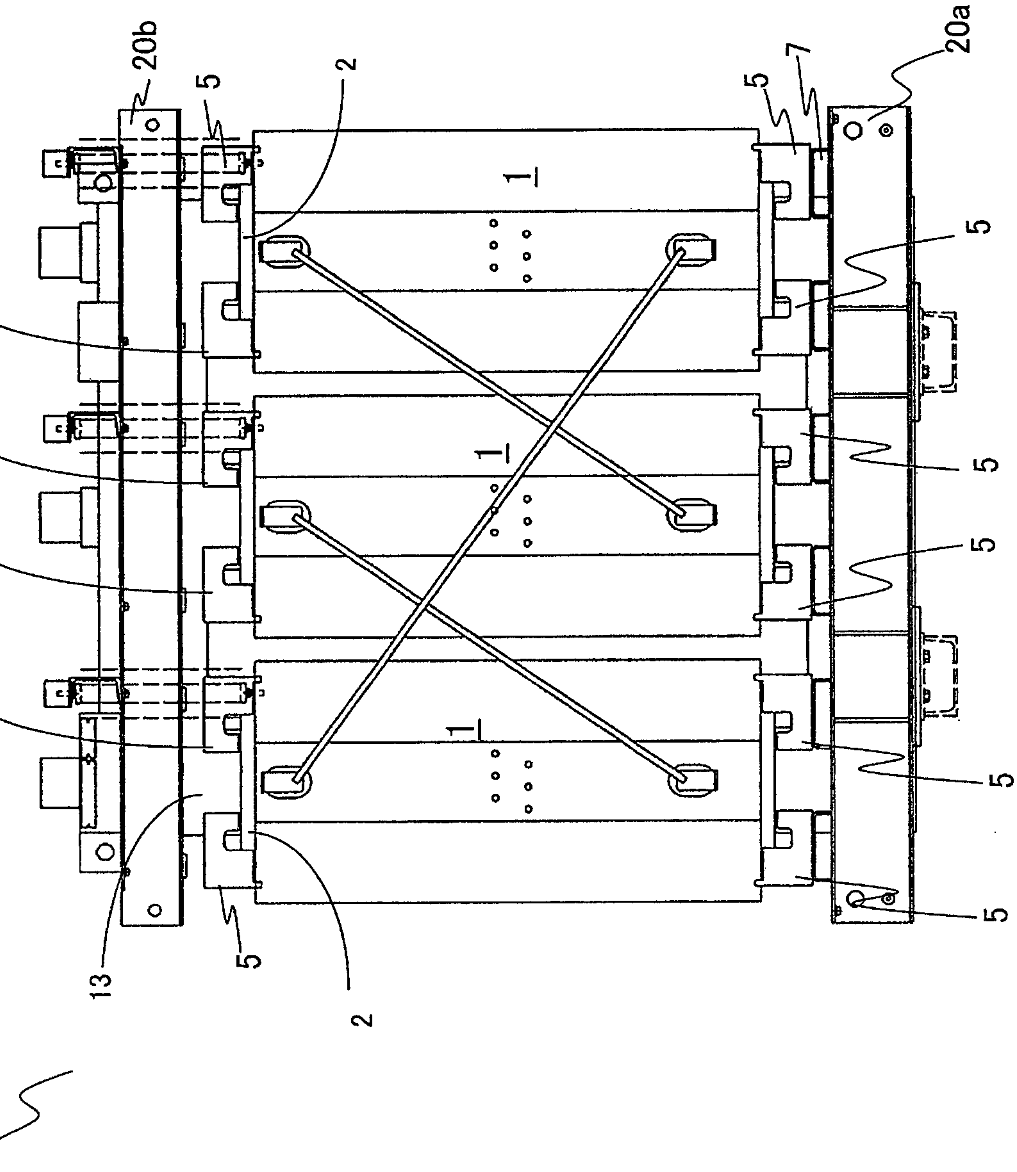


FIG. 2

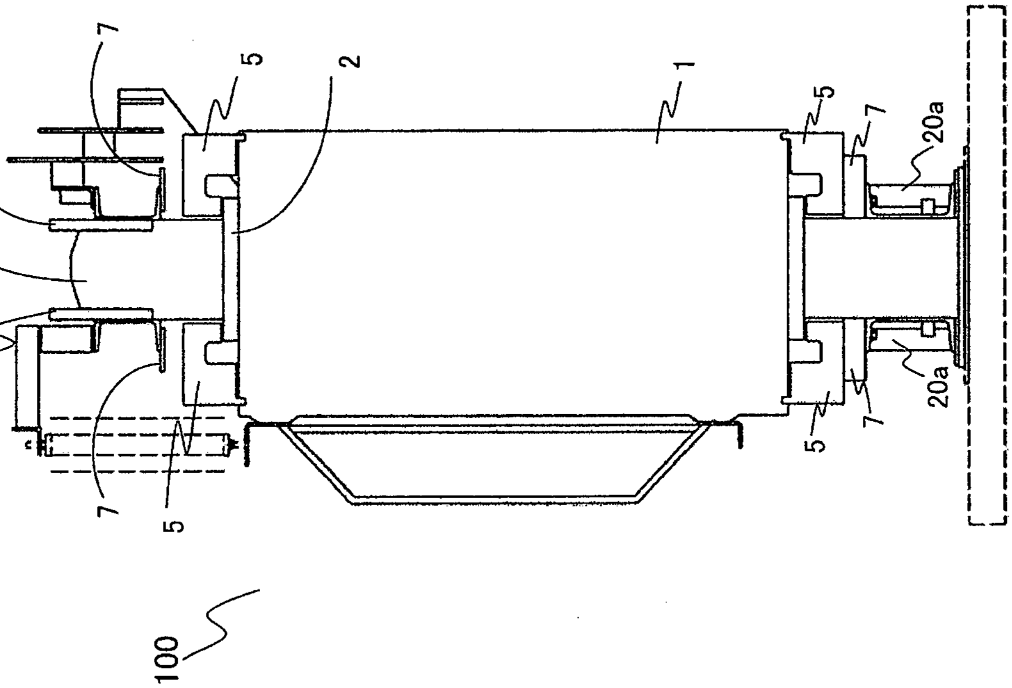


FIG. 3

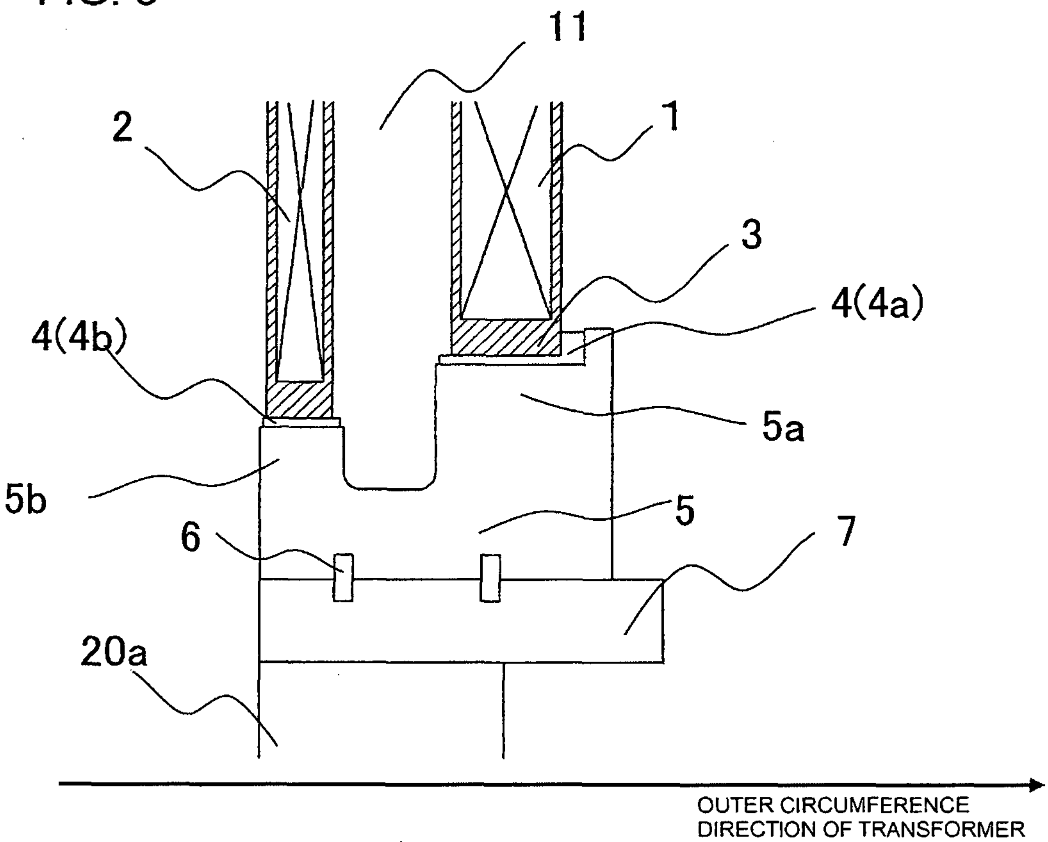

11
2
1
3
4(4a)
4(4b)
5a
5b
5
6
7
20a
OUTER CIRCUMFERENCE
DIRECTION OF TRANSFORMER

FIG. 4

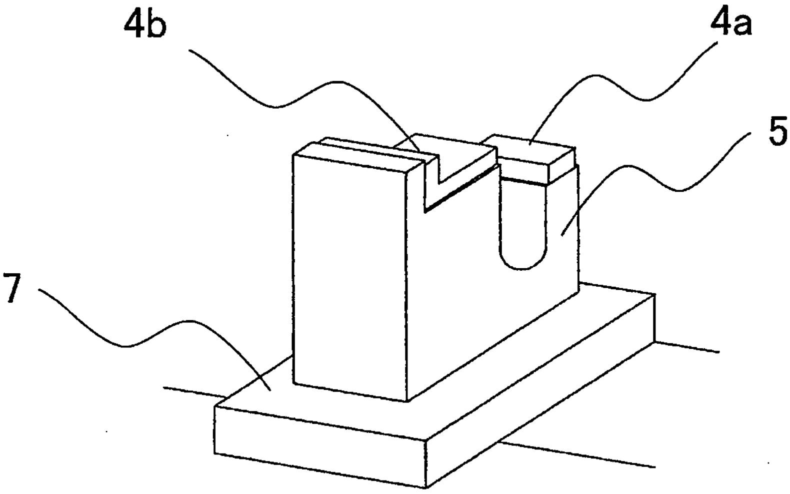


FIG. 5

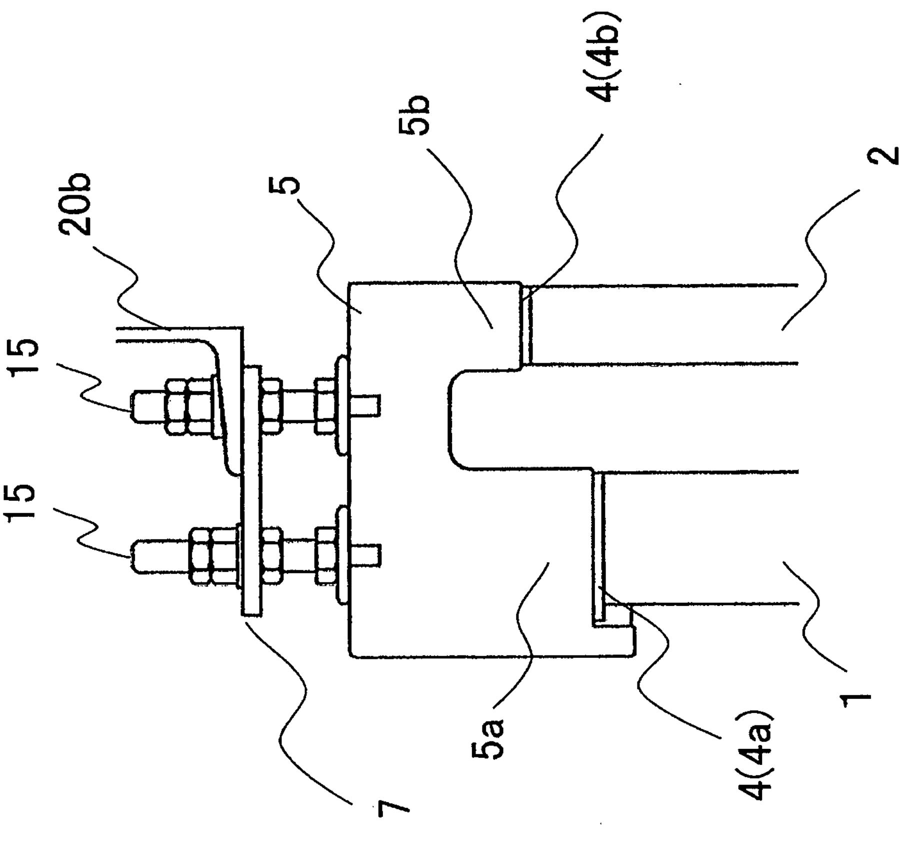


FIG. 6

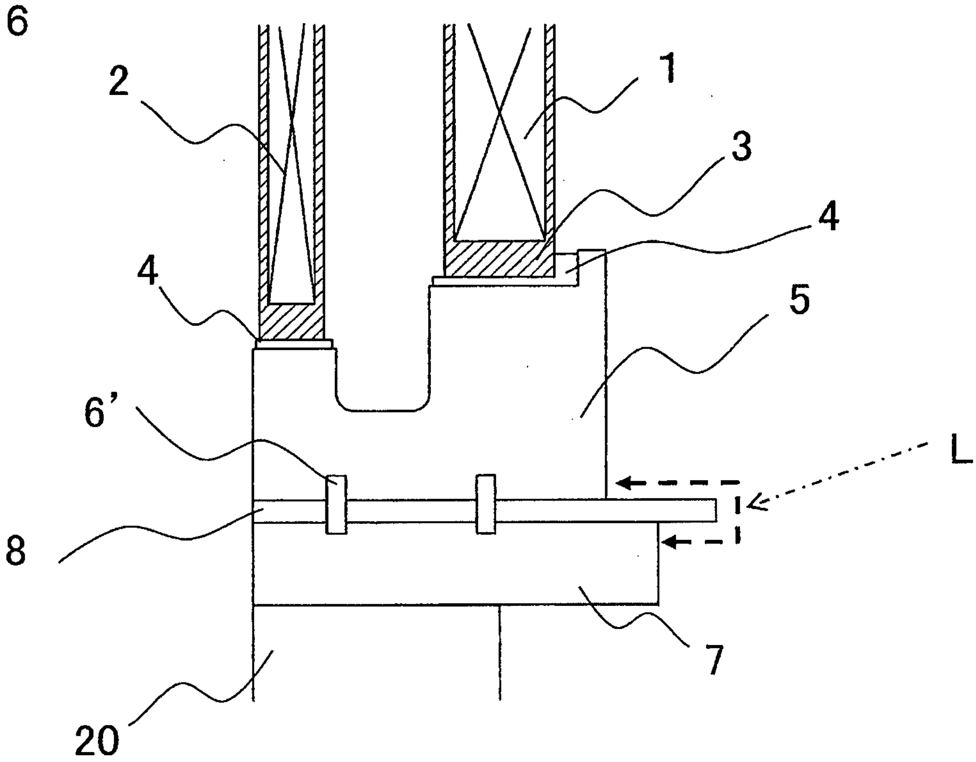


FIG. 7

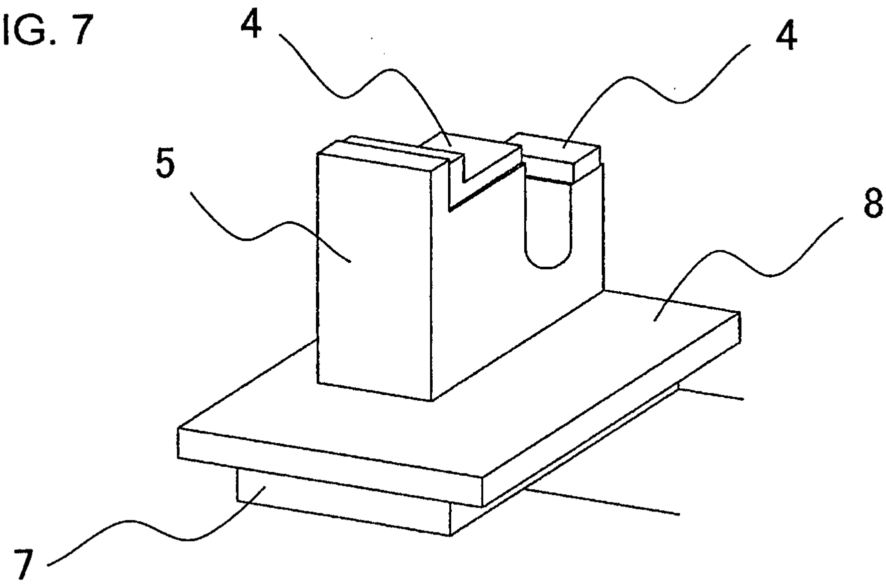


FIG. 8

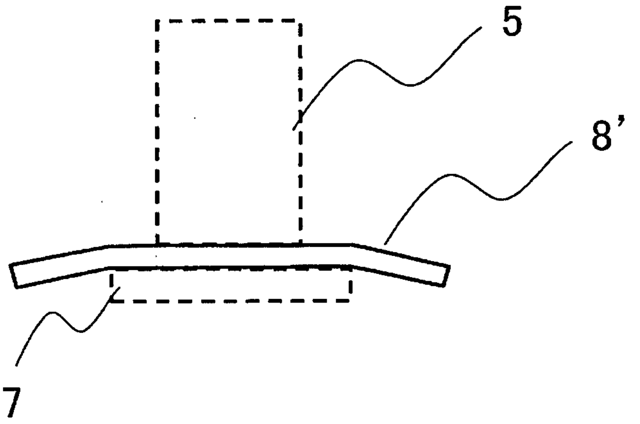


FIG. 9

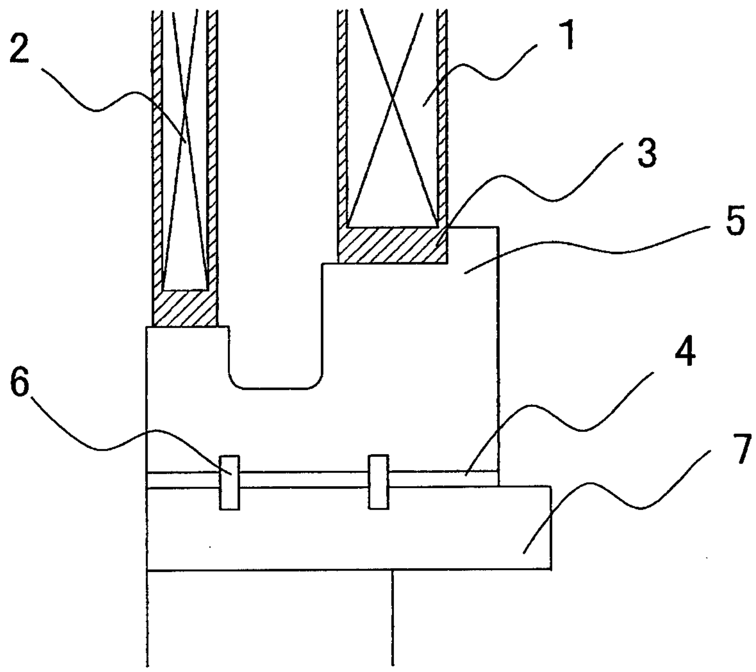


FIG. 10

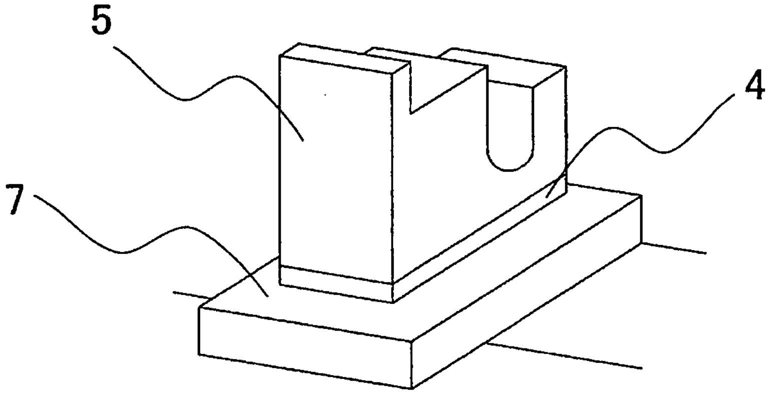


FIG. 11

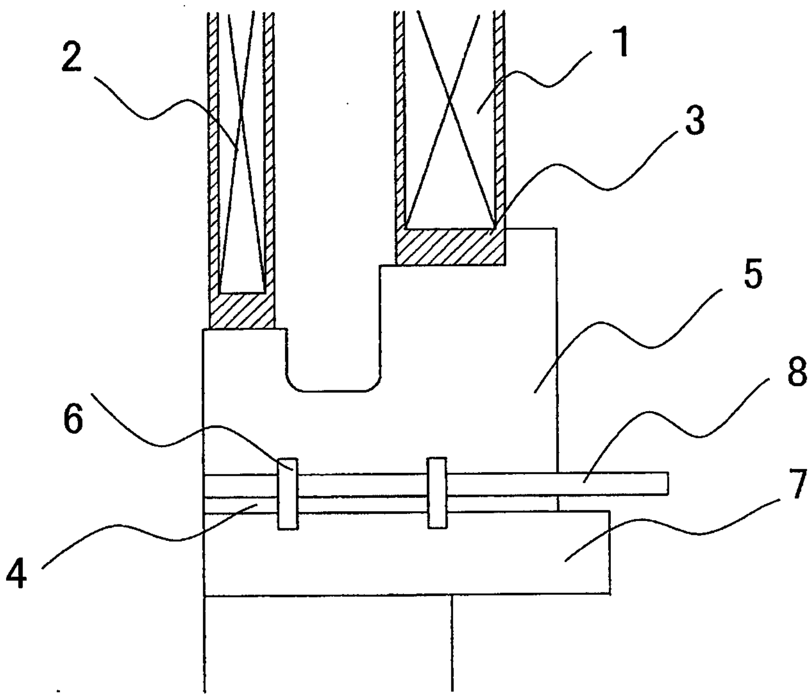


FIG. 12

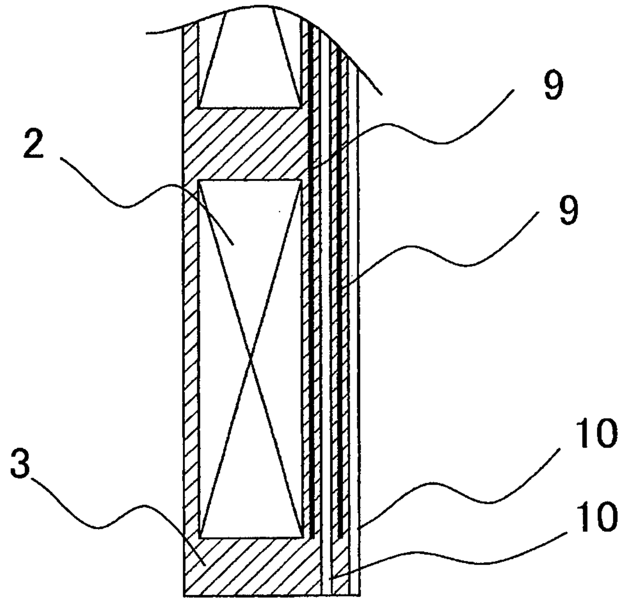


FIG. 13

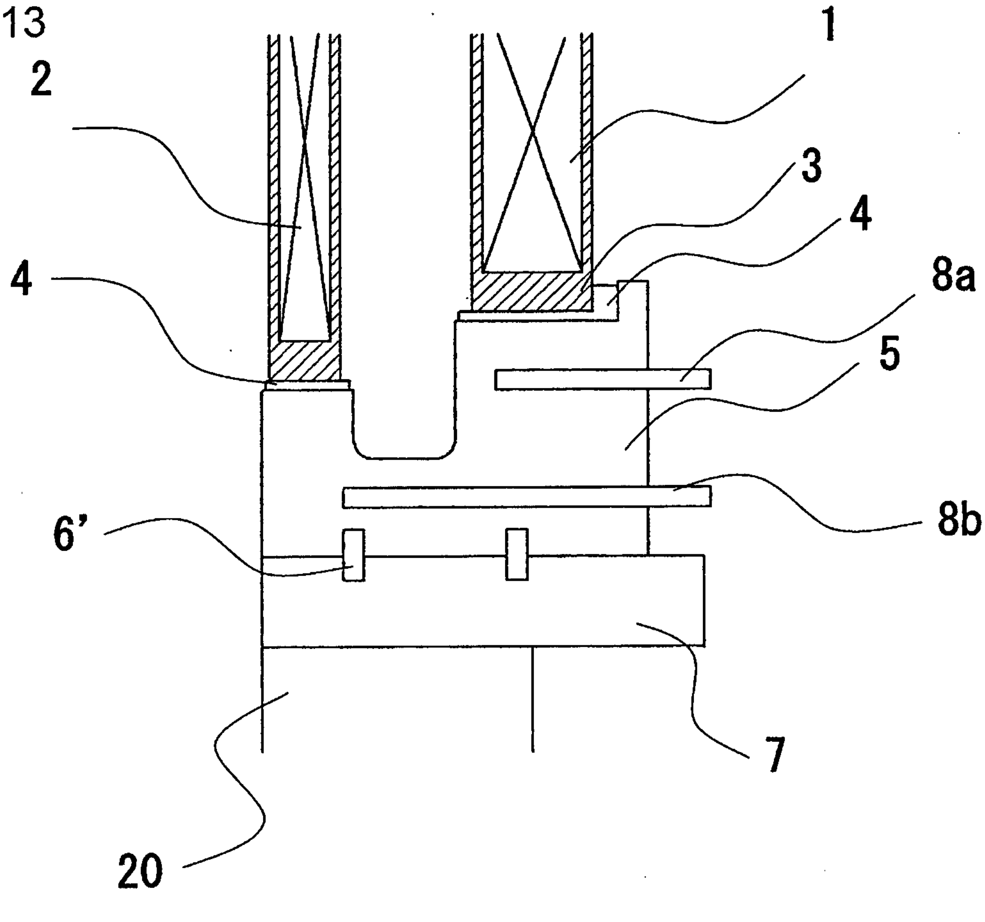


FIG. 14

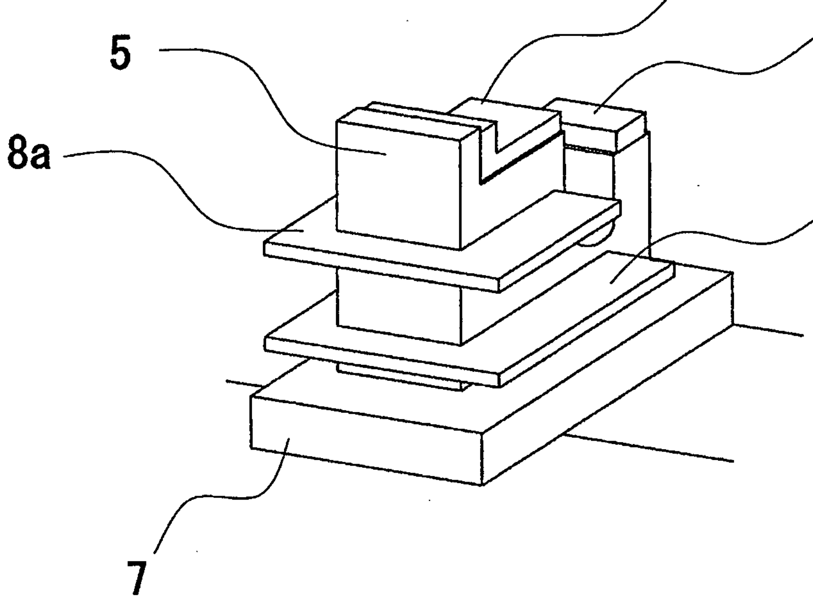


FIG. 15

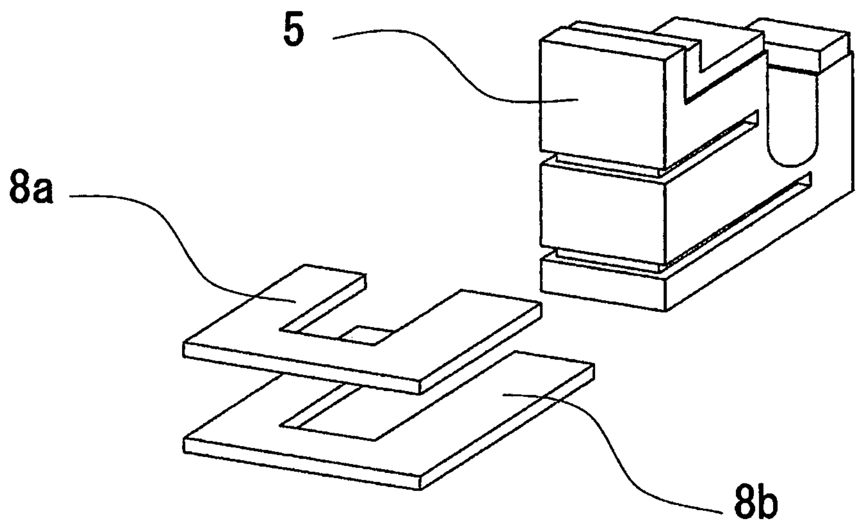
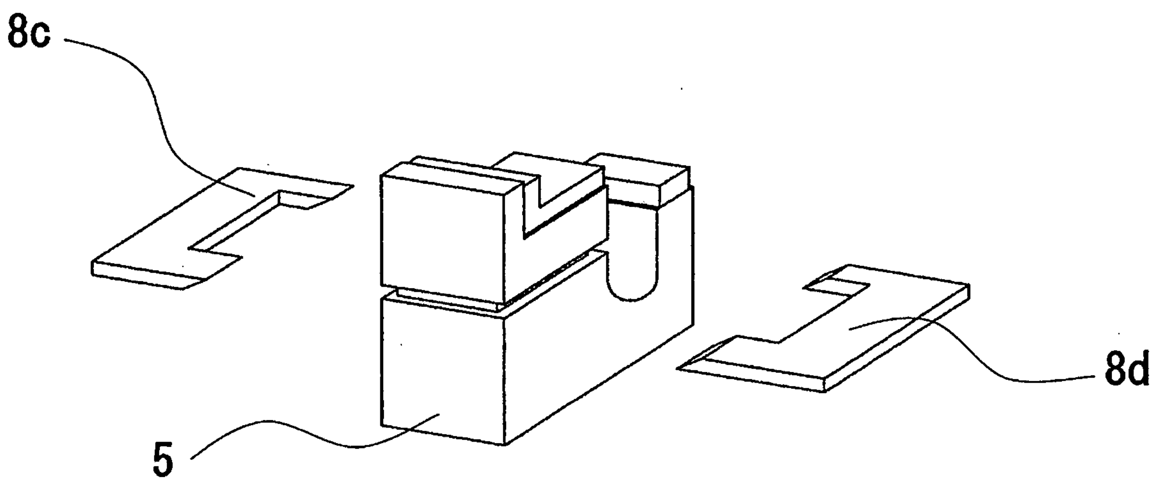


FIG. 16



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/069640

A. CLASSIFICATION OF SUBJECT MATTER
H01F27/32(2006.01)i, *H01F27/30*(2006.01)i, *H01F30/00*(2006.01)i, *H01F30/12*(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)
H01F27/32, H01F27/30, H01F30/00, H01F30/12

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	1996-2015
Kokai Jitsuyo Shinan Koho	1971-2015	Toroku Jitsuyo Shinan Koho	1994-2015

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.
Y A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 144049/1977(Laid-open No. 70014/1979) (Hitachi, Ltd.), 18 May 1979 (18.05.1979), entire text; all drawings (Family: none)	1-5,8-10 6-7
Y	JP 60-15304 Y2 (Toshiba Corp.), 14 May 1985 (14.05.1985), column 1, line 26 to column 2, line 13; fig. 1 (Family: none)	1-5,8-10

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 September 2015 (11.09.15)	29 September 2015 (29.09.15)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/069640

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 7-17129 Y2 (Fuji Electric Co., Ltd.), 19 April 1995 (19.04.1995), column 4, lines 1 to 6; fig. 3 (Family: none)	1-5,8-10
Y	JP 1-29779 Y2 (Aichi Electric Co., Ltd.), 11 September 1989 (11.09.1989), column 1, line 19 to column 2, line 8; column 3, lines 3 to 22; fig. 1, 4 (Family: none)	1-5,8-10
Y	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 25728/1992(Laid-open No. 85025/1993) (Toto Ltd.), 16 November 1993 (16.11.1993), paragraphs [0017] to [0020], [0031]; fig. 5 to 7 (Family: none)	3
Y	JP 61-51811 A (Hitachi, Ltd.), 14 March 1986 (14.03.1986), page 2, upper right column, line 7 to lower left column, line 18; fig. 1 (Family: none)	10

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Patent documents cited in the description

- JP 2000252138 A **[0006]**
- JP 2009283686 A **[0006]**