



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
19.11.2008 Bulletin 2008/47

(51) Int Cl.:
H02B 13/02 (2006.01) H01C 7/10 (2006.01)
H01C 7/12 (2006.01)

(21) Application number: **07713544.0**

(86) International application number:
PCT/JP2007/000162

(22) Date of filing: **02.03.2007**

(87) International publication number:
WO 2007/102274 (13.09.2007 Gazette 2007/37)

(84) Designated Contracting States:
CH DE LI

(30) Priority: **08.03.2006 JP 2006062266**

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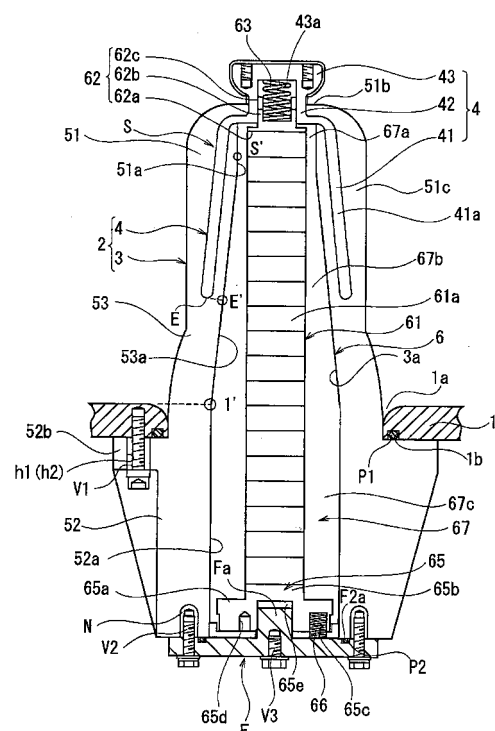
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(54) **ARRESTER**

(57) A interfacial pressure between an insertion hole of a bushing and a molded rubber is ensured and a generation of a gap is prevented. The bushing (2) of this invention is provided with an insertion hole (3a) for housing a molded arrester elements stack (6), and a tapered insertion hole (53a) which extends conically from a high-voltage side toward a low-voltage side of the bushing (2) is provided in a region where an electric field of the aforementioned insertion hole (3a) concentrates. The molded arrester elements stack (6) is provided with the molded rubber (67) comprising silicone rubber or the like integrally molded around the outer circumference of an arrester elements stack (61), and the molded rubber (67) is provided with a conically-shaped portion (67b) to be able to be fitted in the tapered inner surface of the tapered insertion hole (53a).

Fig.1



Description

TECHNICAL FIELD

[0001] The present invention relates to an arrester which is provided with a stack (hereinafter called "arrester elements stack") of plurality of nonlinear resistance element (hereinafter called "arrester element") containing a zinc oxide as the main component. In particular, the present invention relates to the arrester which is able to ensure an interfacial pressure between an insertion hole of a bushing and a molded rubber including the arrester element stack, and to prevent the generation of gap.

BACKGROUND ART

[0002] In general, in gas insulated switchgear installed in a power plant or a substation and so on, an arrester is arranged to protect electric equipments such as switchgears or transformers from abnormal voltage which invades through the power cable line when the thunderbolt and so on occurs.

[0003] Heretofore, as the arrester of this type, as shown in Fig.4, the arrester that the arrester elements stack 100 is attached vertically on the bottom 110a of the tank 110 filling insulation gas, and which is supported through the insulation supporting tube 120 is known (for example, refer to non-patent document No.1). Or as shown in Fig.5, the arrester that the bushing 220 is attached to the inner wall of the equipment case 210 hermetically, and that the arrester elements stack 230 is provided removably in this bushing 220 is known (for example, refer to patent document No.1). In Fig.4, the numeral 140 shows an eccentric shield of high-voltage side, the numeral 150 shows an insulation spacer, the numeral 160 shows an instrumentation box and the numeral 170 shows an adsorbent.

[0004] However, in the former arrester, it is necessary to set large-scale shield 130 on a high-voltage side of the arrester elements stack 100 in order to equalize the voltage distribution of the arrester element which constitutes the arrester elements stack 100. Therefore, there is a difficult point that the equipment itself becomes large. And, when the withstand voltage test of the gas insulated switchgear (hereinafter called "GIS") having the arrester elements stack 100 is performed, because the arrester elements stack 100 must be separated from the main circuit conductor (not shown in the drawing), it is necessary to arrange the separating device (not shown in the drawing). Therefore, there is a difficult point that the structure of the equipment becomes complex.

[0005] On the one hand, in the latter arrester, because it is not necessary to arrange the separating device, the structure of the equipment becomes simple. And, when the withstand voltage test of the GIS is performed, it is not necessary to perform the operation of collecting or filling insulation gas of the inside of the equipment case 210. However, because the equipment case 210 as an

earthed electrode exists in an outer circumference of a portion of the arrester elements stack 230, it is difficult to equalize the voltage distribution of the arrester element 230a. Therefore, there is a difficult point that its application is restricted to the power cable line for the medium voltage of approximately 22/33kV.

[0006] For this reason, previously, as shown in Fig.6, the present inventors developed the arrester (hereinafter called "gas tank type arrester in GIS") which is provided with the bushing 320 and the molded arrester elements stack 340, and filed (Patent application number 2004-357915). The bushing 320 is hermetically installed to the opened section 310 of the equipment case 300 which houses the electric equipment, and comprises the epoxy resin. The molded arrester elements stack 340 is removably installed into the insertion hole 330 of the bushing 320 from the outside of the equipment case 300.

[0007] Here, the molded arrester elements stack 340 consists of the arrester elements stack 350 which stacks plurality of the arrester element 350a and the molded rubber 360 comprising the silicone rubber which is arranged at the outer circumference of the aforementioned arrester elements stack 350. And, the bushing 320 which houses the molded rubber 360 is provided with an upper-end-closed cylindrical portion (hereinafter called "cylindrical portion for tip") 321 having the insertion hole (hereinafter called "insertion hole for tip") 321a to house a column-shaped tip 340a of the molded arrester elements stack 340, a cylindrical portion (hereinafter called "cylindrical portion for back-end") 322 having the insertion hole (hereinafter called "insertion hole for back-end") 322a to house a column-shaped back-end 340b of the molded arrester elements stack 340, and a cylindrical portion (hereinafter called "cylindrical portion for intermediate section") 323 having the tapered insertion hole (hereinafter called "tapered insertion hole") 323a to house a conically-shaped portion 340c which is arranged in the intermediate section of the molded arrester elements stack 340.

[0008] According to the gas tank type arrester in GIS of such composition, because the whole of the molded arrester elements stack 340 is housed in the inside of the insertion hole 330 of the bushing 320, it is applicable to the power line of the voltage rank higher than the conventional arrester. And, because the molded rubber 360 is pressured toward the tip of the bushing 320, the interfacial pressure between the tapered inner surface of the tapered insertion hole 323a of the bushing 320 and the tapered outer surface of the conically-shaped portion 340c which constitutes the molded rubber 360 is ensured, therefore, it is possible to prevent the dielectric breakdown in the interface.

[0009] More concretely, a spring 370 is arranged at the back-end portion of the molded arrester elements stack 340 and the spring 370 is compressed to an axial direction by a sealing cover 390 arranged at the back-end portion of the bushing 320. Therefore, the tapered outer surface of the conically-shaped portion 340c which

constitutes the molded rubber 360 is pressured to the tapered inner surface of the tapered insertion hole 323a of the bushing 320. Consequently, the insulating performance of the interface between the tapered outer surface of the conically-shaped portion 340c of the molded rubber 360 and the tapered inner surface of the tapered insertion hole 323a of the bushing 320 is ensured.

[0010] On the one hand, an imperceptible gap tends to be made in a neighborhood of a consecutively-installed portion P between the conically-shaped portion 340c of the molded rubber 360 and the tip 340a of the molded rubber 360. Therefore, in the gas tank type arrester in GIS of such composition, a triple junction on which the bushing 320 (epoxy resin), air (the imperceptible gap in the neighborhood of the consecutively-installed portion P) and the molded rubber 360 (silicone rubber) abut is not shielded completely by a high voltage shielding electrode 380. Consequently, as shown in Fig.7 and Fig.8, because an electric field goes around toward the triple junction P side, there was a difficult point that a partial discharge occurs in the air (gap) of the aforementioned triple junction.

[0011] Non-patent document No.1: The Institute of Electrical Engineers of Japan, Technical Report, No.851, 7(Fig.2.10) Patent document No.1: Japanese Patent Publication No.Hei01-232681(Fig.1)

DISCLOSURE OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0012] This invention was performed to solve the aforementioned difficult points. This invention has a purpose to provide the arrester which can inhibit the occurrence of the partial discharge in the interface by ensuring the interfacial pressure between the insertion hole of the bushing and the molded rubber and preventing the generation of the gap.

MEANS FOR SOLVING THE PROBLEMS

[0013] The arrester as the first feature of this invention, in an opened section of an equipment case which houses electrical equipments, is provided with a bushing installed to cover the opened section hermetically, and a molded arrester elements stack installed in an insertion hole of the bushing removably from outside of the equipment case. The molded arrester elements stack has an arrester elements stack comprising a layer stack of plurality of arrester elements, and a molded rubber provided around outer circumference of the arrester elements stack. An outer circumference of tip of the arrester elements stack is covered by a high voltage shielding electrode, and a tapered inner surface which extends conically from a high-voltage side toward a low-voltage side of the bushing is provided in a region where an electric field of the insertion hole of the bushing concentrates, and a tapered outer surface which fits in the tapered inner surface is

provided in the molded rubber.

[0014] The arrester as the second feature of this invention, in an opened section of an equipment case which houses electrical equipments, is provided with a bushing installed to cover the opened section hermetically, and a molded arrester elements stack installed in an insertion hole of the bushing removably from outside of the equipment case. The molded arrester elements stack has an arrester elements stack comprising a layer stack of plurality of arrester elements, and a molded rubber provided around outer circumference of the arrester elements stack. An outer circumference of tip of the arrester elements stack is covered by a high voltage shielding electrode, and a tapered inner surface which extends conically from a high-voltage side toward a low-voltage side of the bushing is provided in an insertion hole of the bushing for the section from a portion corresponding to a neighborhood of an end portion of the low-voltage direction of the high voltage shielding electrode to a portion corresponding to a neighborhood of the high-voltage side surface of the equipment case, and a tapered outer surface which fits in the tapered inner surface is provided in the molded rubber.

[0015] The arrester as the third feature of this invention, in an opened section of an equipment case which houses electrical equipments, is provided with a bushing installed to cover the opened section hermetically, and a molded arrester elements stack installed in an insertion hole of the bushing removably from outside of the equipment case. The molded arrester elements stack has an arrester elements stack comprising a layer stack of plurality of arrester elements, and a molded rubber provided around outer circumference of the arrester elements stack. An outer circumference of tip of the arrester elements stack is covered by a high voltage shielding electrode, and a tapered inner surface which extends conically from a high-voltage side toward a low-voltage side of the bushing is provided in an insertion hole of the bushing for the section from a portion corresponding to an intermediate section of the high voltage shielding electrode to a portion corresponding to a neighborhood of the high-voltage side surface of the equipment case, and a tapered outer surface which fits in the tapered inner surface is provided in the molded rubber.

[0016] The arrester as the fourth feature of this invention, in an opened section of an equipment case which houses electrical equipments, is provided with a bushing installed to cover the opened section hermetically, and a molded arrester elements stack installed in an insertion hole of the bushing removably from outside of the equipment case. The molded arrester elements stack has an arrester elements stack comprising a layer stack of plurality of arrester elements, and a molded rubber provided around outer circumference of the arrester elements stack. An outer circumference of tip of the arrester elements stack is covered by a high voltage shielding electrode, and a tapered inner surface which extends conically from a high-voltage side toward a low-voltage side

of the bushing is provided in an insertion hole of the bushing for the section from a portion corresponding to a top of the high voltage shielding electrode to a portion corresponding to a neighborhood of the high-voltage side surface of the equipment case, and a tapered outer surface which fits in the tapered inner surface is provided in the molded rubber.

[0017] The arrester as the fifth feature of this invention, in an opened section of an equipment case which houses electrical equipments, is provided with a bushing installed to cover the opened section hermetically, and a molded arrester elements stack installed in an insertion hole of the bushing removably from outside of the equipment case. The molded arrester elements stack has an arrester elements stack comprising a layer stack of plurality of arrester elements, and a molded rubber provided around outer circumference of the arrester elements stack. An outer circumference of tip of the arrester elements stack is covered by a high voltage shielding electrode, and a tapered inner surface which extends conically from a high-voltage side toward a low-voltage side of the bushing is provided in an insertion hole of the bushing for the section from a tip of the bushing to a back-end of the bushing, and a tapered outer surface which fits in the tapered inner surface is provided in the molded rubber.

[0018] In the sixth feature of this invention according to any one of the arrester of the first to fifth features, the molded arrester elements stack is provided with the arrester elements stack comprising a layer stack of plurality of the arrester elements containing zinc oxide as the main component, a joint conductor abutted on the high-voltage side of the arrester elements stack, and a pressure metal fitting abutted on the low-voltage side of the arrester elements stack.

[0019] In the seventh feature of this invention according to any one of the arrester of the first to sixth features, the back-end of the molded arrester elements stack is led to the outside of the equipment case through the opened section of the equipment case.

[0020] In the eighth feature of this invention according to any one of the arrester of the first to seventh features, the back-end of the bushing is formed by an insulated cylindrical component, and the cylindrical component is led to the outside of the equipment case through the opened section of the equipment case.

[0021] In the ninth feature of this invention according to any one of the arrester of the first to eighth features, the bushing is formed by a rigid plastic resin.

EFFECT OF THE INVENTION

[0022] According to the arrester from first feature to ninth feature of this invention, there are following effects.

[0023] First, because the molded arrester elements stack is removably installed to the bushing which is hermetically arranged at the opened section of the equipment case from the outside of the equipment case, it is not necessary to arrange the separation device as hith-

erto known gas insulated type arrester. Therefore, the simplification of the structure of the equipment is possible. And, the operation of collecting or filling the insulating gas of the inside of the equipment case can not be required when changing the arrester elements.

[0024] Second, because the outer circumference of the tip of the molded arrester elements stack is covered by the high voltage shielding electrode, the equalization of the voltage distribution of the arrester elements is possible, and consequently, it is possible to provide the arrester which can apply to the high-voltage power cable line of the 66/77kV class.

[0025] Third, because a part of the molded arrester elements stack is led to the outside of the equipment case, the miniaturization of the equipment can be attempted.

[0026] Fourth, because the back-end of the bushing is led to the outside of the equipment case hermetically, the simplification, the downsizing, and the weight-saving of the structure of the equipment can be attempted.

[0027] Fifth, because the tapered portion is arranged at the portion where the electric field of the insertion hole of the bushing concentrates, the interfacial pressure between the insertion hole of the bushing and the molded rubber can be ensured, and the generation of the gap can be prevented, and consequently, the occurrence of the partial discharge in the interface portion can be inhibited.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028]

[Fig.1] A partial sectional view of the arrester in the first embodiment of this invention.

[Fig.2] An equipotential distribution drawing of the arrester in the first embodiment of this invention.

[Fig.3] A partial sectional view of the arrester in the second embodiment of this invention.

[Fig.4] A partial sectional view of the arrester in the prior art.

[Fig.5] A partial sectional view of the arrester in the prior art.

[Fig.6] A partial sectional view of the arrester in the prior art.

[Fig.7] An equipotential distribution drawing whose interval of equipotential line in the neighborhood of the high voltage shielding electrode shown in Fig. 6 is 5kV/mm.

[Fig.8] An equipotential distribution drawing whose interval of equipotential line in the neighborhood of the triple junction shown in Fig. 6 is 1kV/mm.

BEST MODE FOR CARRYING OUT THE INVENTION

[0029] Hereinafter, the preferred modes of embodiment which applied the arrester of this invention are explained with reference to the drawings. In the following

explanation, "tip" of the bushing, the molded arrester elements stack, the arrester elements stack and the high voltage shielding electrode means the end portion of the high-voltage side of the bushing, the molded arrester elements stack, the arrester elements stack and the high voltage shielding electrode respectively, and these correspond to the upper direction in the drawings. Furthermore, "back-end" of the bushing, the molded arrester elements stack, the arrester elements stack and the high voltage shielding electrode means the opposite end portion of the tip, and these correspond to the lower direction in the drawings.

[Embodiment 1]

[0030] Fig.1 is the partial sectional view which shows one example of the arrester of the 66/77kV class of this invention.

[0031] In this drawing, the electrical equipment having the arrester of this invention is provided with the equipment case 1 which houses the electrical equipment (not shown in the drawing) such as the switch hermetically. And for example, the insulating gas such as SF_6 gas is filled in the equipment case 1. In addition, the opened section 1a is provided at the bottom of the equipment case 1. And in this opened section 1a, the bushing 2 is arranged to make the tip of the bushing 2 itself locate in the inside of the equipment case 1 and to cover the opened section 1a in the intermediate section of the bushing 2 itself hermetically. And the after-mentioned molded arrester elements stack 6 is removably installed in this bushing 2.

[0032] The bushing 2 is provided with a hard and insulated bushing body 3 comprising such as a molded body which is formed by the epoxy resin and the high-voltage shielding electrode 4 embedded in the bushing body 3 concentrically at the tip of the bushing body 3.

[0033] The bushing body 3 is provided with an insertion hole 3a to house the molded arrester elements stack 6, and a tapered inner surface which extends conically from a high-voltage side toward a low-voltage side of the bushing 2 is formed in a region where an electric field of the aforementioned insertion hole 3a concentrates. Concretely, the bushing body 3 is provided with an upper-end-closed cylindrical portion (hereinafter called "cylindrical portion for tip") 51 which has an insertion hole (hereinafter called "insertion hole for tip") 51a to house a tip (the length of about one-tenth of the whole of the molded arrester elements stack 6) of the molded arrester elements stack 6, a cylindrical portion (hereinafter called "cylindrical portion for back-end") 52 which has an insertion hole (hereinafter called "insertion hole for back-end") 52a to house a back-end (the length of about two-fifth of the whole of the molded arrester elements stack 6) of the molded arrester elements stack 6, and a cylindrical portion (hereinafter called "cylindrical portion for intermediate section") 53 which has an insertion hole (hereinafter called "tapered insertion hole") 53a as a tapered inner

surface to house an intermediate section (the length of about one-half of the whole of the molded arrester elements stack 6) except the tip and the back-end of the molded arrester elements stack 6. And, a hexagonal plate-like mounting flange 52b is continuously provided so as to protrude to a perpendicular direction for an axis line of the bushing 2 in an outer circumference of an upper position of the cylindrical portion for back-end 52. Here, the diameter of the insertion hole for back-end 52a is larger than the diameter of the insertion hole for tip 51a, in addition, the tapered insertion hole 53a has the tapered inner surface which extends conically from the high-voltage side (tip) toward a low-voltage side (back-end) of the bushing 2, and the insertion hole for tip 51a is communicated with the insertion hole for back-end 52a through this conically-shaped tapered inner surface. The outer diameter of the mounting flange 52b is larger than the diameter of the opened section 1a of the equipment case 1. And, the bolt insertion holes h1, h2, - are arranged respectively in the neighborhood of each corner parts of the mounting flange 52b.

[0034] The high-voltage shielding electrode 4 is provided with a bell shaped shielding body 41 which is embedded in the cylindrical portion for tip 51 concentrically from the closed portion 51b across the back-end of the cylindrical portion for tip 51, and the tubular portion (hereinafter called "joint conductor insertion portion") 42 which protrudes to the upper direction of the closed portion 51b in the center of the horizontal portion of the shielding body 41, and a main circuit connection terminal 43 which is formed continuously in the upper portion of the joint conductor insertion portion 42 and is connected to the main circuit conductor (not shown in the drawing). Here, a side wall portion 41a of the shielding body 41 is formed so as to extend conically from the tip toward the back-end, and the length of the axial direction is the length of about one-third of whole of the bushing body 3. Therefore, the almost intermediate section of the tapered insertion hole 53a is located at the portion E' which corresponds to the end portion E of the low-voltage direction of the side wall portion 41a of the shielding body 41.

[0035] The joint conductor insertion portion 42 has the function as the insertion hole of an after-mentioned joint conductor 62 of the molded arrester elements stack 6, and the main circuit connection terminal 43 which is provided at the tip of the joint conductor insertion portion 42 has also the function as the stopper of an after-mentioned coiled spring 63 of the molded arrester elements stack 6.

[0036] According to the high-voltage shielding electrode 4 of such composition, the main circuit connection terminal 43 protrudes from the closed portion 51b of the cylindrical portion for tip 51 to the upper direction, and the side wall portion 41a is embedded concentrically in the tip of cylindrical portion 51 so that it is located in the side wall portion 51c of the cylindrical portion for tip 51.

[0037] According to the bushing 2 of such composition, because the cylindrical portion for tip 51 and the cylindrical portion for intermediate section 53 of the bushing 2

are located in the equipment case 1, and the cylindrical portion for back-end 52 is led to the outside of the equipment case 1 through the opened section 1a, the upper surface of the mounting flange 52b can abut on the lower surface of the peripheral part of the opened section 1a of the equipment case 1. Therefore, in the bushing 2 of such composition, by letting an O-ring P1 intervene in the annular concave groove 1b which is arranged in the peripheral part of the opened section 1a of the equipment case 1 and tightening the bolt V1 which is arranged in the bolt insertion hole h1, h2, - of the mounting flange 52b, the bushing 2 can be installed in the opened section 1a of the equipment case 1 hermetically.

[0038] On the one hand, The molded arrester elements stack 6 is provided with the arrester elements stack 61 which stacked plurality of arrester elements 61a containing zinc oxide as the main component, the joint conductor 62 which is arranged at the tip side (high-voltage side) of the arrester elements stack 61, the coiled spring (hereinafter called "high-voltage side spring") 63 which is arranged at the tip side (high-voltage side) of the joint conductor 62, the pressure metal fitting 65 which is arranged at the back-end side (low-voltage side) of the arrester elements stack 61, the coiled spring (hereinafter called "low-voltage side spring") 66 which is arranged at the lower surface side of the pressure metal fitting 65, and the molded rubber 67 comprising such as silicone rubber which is molded integrally across the joint conductor 62 and the pressure metal fitting 65 in the outer circumference of the arrester elements stack 61. Here, the outer surface of the molded rubber 67 is formed so that it corresponds to the inner surface of the insertion hole 3a of the bushing 2. Concretely, the column-shaped tip 67a which corresponds to the inner surface of the insertion hole for tip 51a is provided in the tip side (high-voltage side) of the molded rubber 67, and the column-shaped back-end 67c which corresponds to the inner surface of the insertion hole for back-end 52a is provided in the back-end (low-voltage side), and the conically-shaped portion 67b which corresponds to the tapered inner surface of the tapered insertion hole 53a is provided in the intermediate section which is the remaining section except the tip side and the back-end side respectively. The number of arrester elements 61a corresponding to the system voltage is determined in consideration of the predetermined varistor voltage. This embodiment applies to the high voltage power cable line of 66kV.

[0039] The joint conductor 62 is provided with a circular plate portion 62a which is the almost same shape as the arrester element 61a which abuts on the high-voltage side of the arrester elements stack 61 and a cylindrical portion 62b which protrudes toward upper direction in the center portion of the upper surface of this circular plate portion 62a. And an annular concave groove 62c is provided in the outer circumference of the cylindrical portion 62b in order to fit in a tape-shaped electrical contact (multi-contact) which is not shown in the drawing.

[0040] The pressure metal fitting 65 is provided with

an annular component 65a which has slightly smaller diameter than the outside diameter of the back-end side (low-voltage side) of the molded rubber 67. And a plate-shaped pressure portion 65b whose shape is almost same as the arrester element 61a is provided in the center portion of the upper surface of this annular component 65a, and, for example, the twelve concave groove portions 65c are provided so that these are placed along the circumference at regular interval in the neighborhood of the outer edge of the lower surface side. The numeral 65d in the drawing is, for example, four tapped holes which are placed along the circumference at regular interval in the inner periphery of the annular component 65a, and the numeral 65e is the large diameter concave groove portion (hereinafter called "large diameter concave groove portion") which is provided in the center portion of the lower surface side of the annular component 65a.

[0041] In the outer circumference of the arrester elements stack 61 of such composition, in the state of abutting on the lower surface of the circular plate portion 62a of the joint conductor 62 in the tip, and abutting on the pressure portion 65b of the pressure metal fitting 65 in the back-end, the molded rubber 67 comprising such as silicone rubber is provided across the upper surface portion of the circular plate portion 62a of the connected conductor 62 and the outer circumference of the pressure metal fitting 65. And, by this molded rubber 67, the arrester elements stack 61 is integrated together with the joint conductor 62 and the pressure metal fitting 65.

[0042] The numeral F shows the sealing cover which is arranged to the back-end surface of the cylindrical portion for back-end 52 of the bushing 2, and aforementioned sealing cover F is constituted by the circular plate-shaped metal fitting such as aluminum metal fitting. Regarding the sealing cover F, a column-shaped boss portion Fa which is possible to connect by insetting into a large diameter concave groove portion 65e of the pressure metal fitting 65 is provided so as to protrude at the center portion of the upper surface side (face-to-face side to bushing 2) of itself. And, for example eight bolt insertion holes (not shown in the drawing) are provided along the circumference so that they are placed at regular interval at the neighborhood of the outer edge of itself. Further, an annular concave groove (not shown in the drawing) to house an O-ring P2 is provided concentrically with the insertion hole for back-end 52a at the upper surface side. Besides, the annular concave groove (not shown in the drawing) is provided at the outer circumference of the boss portion Fa, and the tape-shaped electrical contact (not shown in the drawing) is fitted in this annular concave groove. The numeral V3 shows the bolt for attaching an earthing conductor (not shown in the drawing).

[0043] Next, the method for installing the molded arrester elements stack 6 removably in the bushing 2 is explained.

[0044] First, the coiled high-voltage side spring 63 of the almost same diameter as the inner diameter of the

cylindrical portion 62b is installed in the inside of the cylindrical portion 62b of the joint conductor 62 so that the upper half portion of the coiled high-voltage side spring 63 protrudes. In this state, the tip (high-voltage side) of the molded arrester elements stack 6 is inserted into the inside of the bushing 2, and is pushed until the tip of the high-voltage side spring 63 abuts on an inner wall surface 43a of the main circuit connection terminal 43. Therefore, an individual piece (not shown in the drawing) which constitutes the electrical contact (multi-contact) which is arranged at the concave groove 62c contacts electrically to the inner peripheral surface of the joint conductor insertion portion 42. Besides, the outer peripheral surface of the tip 67a of the molded rubber 67 abuts on the inner peripheral surface of the insertion hole for tip 51a of the bushing 2, and the outer peripheral surface of the conically-shaped portion 67b of the molded rubber 67 abuts on the inner peripheral surface of the tapered insertion hole 53a of the bushing 2, and the outer peripheral surface of the back-end 67c of the molded rubber 67 abuts on the inner peripheral surface of the insertion hole for back-end 52a.

[0045] Next, the coiled low-voltage side spring 66 of the almost same diameter as the inner diameter of the concave groove portion 65c is installed in the concave groove portion 65c of the pressure metal fitting 65 so that the lower half portion of the coiled low-voltage side spring 66 protrudes, and the O-ring P2 comprising such as fluorine-containing rubber is arranged in a concave groove F2a. In this state, the sealing cover F is abutted on the lower surface of the cylindrical portion for back-end 52 of the bushing 2, and further, the tip of the bolts V2 which is inserted into the bolt insertion holes of the sealing cover F is screwed into an embedded metal fittings N which is embedded to the lower surface of the cylindrical portion for back-end 52. Therefore, the sealing cover F is attached to the lower surface of the cylindrical portion for back-end 52.

[0046] By abutting on and fixing of such the sealing cover F to the lower surface of the cylindrical portion for back-end 52, the insertion hole for back-end 52a of the bushing 2 is sealed by the O-ring P2, and the low-voltage side spring 66 is pressured to the axial direction. Because a predetermined spring force is given to the low-voltage side spring 66, the molded rubber 67 is pressured toward the tip of the bushing 2, and a predetermined interfacial pressure is given to a fitting portion between the inner peripheral surface of the tapered insertion hole 53a of the bushing 2 and the outer peripheral surface of conically-shaped portion 67b of the molded rubber 67.

[0047] Besides, because the molded rubber 67 is pressured toward the tip of the bushing 2, the high-voltage side spring 63 which is arranged at the tip of the molded rubber 67 is pressured to the axial direction, and the predetermined spring force is given to the aforementioned high-voltage side spring 63. Therefore, the predetermined interfacial pressure is given between the arrester element 61a and the joint conductor 62, between the ar-

rester elements 61a, and between the arrester element 61a and the pressure portion 65b. Consequently, these members contact certainty.

[0048] As described above, according to the arrester of such composition, because the whole of the molded arrester elements stack 6 is housed in the inside of the insertion hole 3a of the bushing 2, as described later, it is possible to apply to the higher voltage power line than the hitherto known arrester. Besides, because the molded rubber is pressured toward the tip of the bushing, the interfacial pressure between the inner surface of the tapered insertion hole 53a of the bushing 2 and the outer surface of the conically-shaped portion 67b of the molded rubber 67 is ensured, and the dielectric breakdown of the interface can be prevented. More concretely, because the spring is arranged at the back-end of the molded arrester elements stack and the spring force is given to the aforementioned spring, the molded arrester elements stack can be pressured toward the tip of the bushing. And, because the inner surface of the tapered insertion hole 53a of the bushing 2 and the outer surface of the conically-shaped portion 67b of the molded rubber 67 fit in, the press force of the axial direction can be operated effectively as the interfacial pressure. And further, because the tapered insertion hole 53a (conically-shaped portion 67b) that the surface pressure operates effectively to the inside of the end portion E of the low-voltage direction of the high voltage shielding electrode where the electric field concentrates is arranged, as described later, the occurrence of the partial discharge in the interface portion can be prevented.

[0049] Fig.2 shows the equipotential distribution drawing of the arrester in this embodiment. From this drawing, the tip of the molded arrester elements stack 6 is shielded by the high voltage shielding electrode 4, and the back-end of the molded arrester elements stack 6 is arranged at the outside of the equipment case 1 which is the earthed electrode, further, the electric field of the intermediate section of the molded arrester elements stack 6 is controlled appropriately by adjusting the interval between the high voltage shielding electrode 4 and the equipment case 1 as the earthed electrode. Therefore, the voltage which is distributed by the arrester elements is equalized in the longer direction.

[0050] Here, the influence that the shielding body 41 and the equipment case 1 which is the earthed electrode give to the molded arrester elements stack 6 is explained. First, when the interval between the end portion E of the low voltage direction of the shielding body 41 and the high voltage side surface of the equipment case 1 is short, there is a relation that the electric field in the intermediate section of the molded arrester elements stack 6 becomes dense by the influence of the shielding body 41 and the equipment case 1, and, to the contrary, when the interval of both is long, there is a relation that the electric field in the aforementioned intermediate section becomes coarse. Therefore, in the structure which the interval of both only expands, it is difficult to equalize the voltage

distribution of the arrester element 61a. On this point, in this embodiment, the tip (length of about one-third of the molded arrester elements stack 6) of the molded arrester elements stack 6 and the intermediate section (length of about one-third of the molded arrester elements stack 6) of the molded arrester elements stack 6 are located in the inside of the equipment case 1, and the back-end (length of about one-third of the molded arrester elements stack 6) of the molded arrester elements stack 6 is located at the outside of the equipment case 1. Therefore, the interval between the high-voltage shielding electrode 4 and the equipment case 1 which is the earthed electrode is adjusted appropriately, and it is possible to control the electric field appropriately in the intermediate section of the molded arrester elements stack 6. Consequently, the equalization of the voltage distribution of the arrester element 61a can be attempted.

[0051] As described above, according to the arrester of this invention, because it is possible to install the molded arrester elements stack 6 removably from the outside of the equipment case 1 into the bushing 2 which is attached hermetically at the opened section 1a of the equipment case 1, it is not necessary to arrange the separation device as hitherto known gas insulated type arrester, and it is possible to simplify the structure of the equipment, besides, it is not necessary to perform the operation of collecting or filling the insulation gas of the inside of the equipment case 1 when the exchange of the arrester elements is performed. Further, because the outer circumference of the tip of the molded arrester elements stack 6 is covered by the high voltage shielding electrode 4, the equalization of the voltage distribution of the arrester element 61a can be performed, consequently, it is possible to provide the arrester which can apply to the high voltage power cable line of the 66/77kV class. And, because the back-end side (low-voltage side) of the molded arrester elements stack 6 is led to the outside of the equipment case 1, the miniaturization of the equipment can be attempted. Further, the tapered insertion hole 53a is arranged in the insertion hole 3a of the bushing 2 for the section from the portion S' corresponding to the top S of the high voltage shielding electrode 4, that is, from the portion S' which is located at the high-voltage side (tip side) by looking from the portion E' corresponding to the end portion E of the low-voltage direction of the high voltage shielding electrode 4 to the portion 1' corresponding to the neighborhood of the high-voltage side of the equipment case 1, and the conically-shaped portion 67b which fits in the tapered insertion hole 53a is arranged in the molded rubber 67. Therefore, the interfacial pressure between the insertion hole of the bushing and the molded rubber in the region where the electric field concentrates can be ensured, and the generation of the gap can be prevented, consequently, the occurrence of the partial discharge in the interface of the both portion can be inhibited.

[Embodiment 2]

[0052] Fig. 3 shows the partial sectional view of the arrester in the second embodiment of this invention. In this drawing, the same numerals are given to the portions which are common to Fig.1, and detailed explanation is omitted.

[0053] In Fig.3, in this embodiment, instead of the insertion hole 3a of bushing shown in Fig.1, the tapered insertion hole 53a' which extends conically from the high-voltage side toward the low-voltage side of the bushing for the section from the tip of the bushing 2 to the back-end of the bushing 2 is provided. And, a conically-shaped portion 67b' which fits in the inner surface of the tapered insertion hole 53a' is provided in the molded rubber 67.

[0054] Also in this embodiment as well as aforementioned embodiment, it is not necessary to arrange the separation device, and it is possible to simplify the structure of the equipment. Besides, it is not necessary to perform the operation of collecting or filling the insulating gas of the inside of the equipment case 1 when the exchange of the arrester elements is performed. Further, because the equalization of the voltage distribution of the arrester element 61a can be performed, it is possible to provide the arrester which can apply to the high voltage power cable line of 66/77kV class. And, because a part (low-voltage side) of the molded arrester elements stack 6 is led to the outside of the equipment case 1, the miniaturization of the equipment can be attempted. Besides, the tapered insertion hole 53a' is provided over all region from the tip of bushing to the back-end of bushing, and the conically-shaped portion 67b' of the molded arrester elements stack 6 is constituted so as to fit in the tapered insertion hole 53a'. Therefore, the interfacial pressure of the both can be ensured over the entire length of the molded arrester elements stack 6, and the generation of the gap can be prevented. Consequently, it is possible to provide the arrester which has more superior insulating performance than the aforementioned embodiment.

INDUSTRIAL APPLICABILITY

[0055] In this invention, it is possible to modify or revise the invention within the scope of claims as follows.

[0056] First, in the aforementioned embodiment, although the case that the bushing is installed at the bottom of the equipment case 1 is explained, also it is possible to install the bushing at the side wall of the equipment case 1.

[0057] Second, in the aforementioned embodiment, although the case that the arrester of this invention is applied to the high voltage power cable line of 66/77 kV is explained, also it is possible to apply the arrester of this invention to the power cable line of less than 66 kV or to the high voltage power cable line that exceeds 77 KV.

[0058] Third, in the aforementioned embodiment, in the bushing, although the case that the tapered insertion hole is arranged for the section from the portion corre-

sponding to the top of the high voltage shielding electrode is explained to the portion corresponding to the neighborhood of the high-voltage side of the equipment case, or although the case that the tapered insertion hole which extends conically from the high-voltage side toward the low-voltage side of the bushing is arranged is explained, also it is possible to arrange the tapered insertion hole for the section from the portion corresponding to the neighborhood of the end portion of low-voltage direction of the high voltage shielding electrode to the portion corresponding to the neighborhood of the high-voltage side of the equipment case, or also it is possible to arrange the tapered insertion hole for the section from the portion corresponding to the intermediate section of the high voltage shielding electrode to the portion corresponding to the neighborhood of the high-voltage side surface of the equipment case.

Claims

1. An arrester providing, in an opened section of an equipment case which houses electrical equipments, a bushing installed to cover said opened section hermetically, and a molded arrester elements stack installed in an insertion hole of said bushing removably from outside of said equipment case, wherein said molded arrester elements stack has an arrester elements stack comprising a layer stack of plurality of arrester elements, and a molded rubber provided around outer circumference of said arrester elements stack, **characterized in that:**

an outer circumference of tip of said arrester elements stack is covered by a high voltage shielding electrode,
a tapered inner surface which extends conically from a high-voltage side toward a low-voltage side of said bushing is provided in a region where an electric field of the insertion hole of said bushing concentrates, and
a tapered outer surface which fits in said tapered inner surface is provided in said molded rubber.

2. An arrester providing, in an opened section of an equipment case which houses electrical equipments, a bushing installed to cover said opened section hermetically, and a molded arrester elements stack installed in an insertion hole of said bushing removable from outside of said equipment case, wherein said molded arrester elements stack has an arrester elements stack comprising a layer stack of plurality of arrester elements, and a molded rubber provided around outer circumference of said arrester elements stack, **characterized in that:**

an outer circumference of tip of said arrester elements stack is covered by a high voltage

shielding electrode,
a tapered inner surface which extends conically from a high-voltage side toward a low-voltage side of said bushing is provided in an insertion hole of said bushing for the section from a portion corresponding to a neighborhood of an end portion of the low-voltage direction of said high voltage shielding electrode to a portion corresponding to a neighborhood of the high-voltage side surface of said equipment case, and
a tapered outer surface which fits in said tapered inner surface is provided in said molded rubber.

3. An arrester providing, in an opened section of an equipment case which houses electrical equipments, a bushing installed to cover said opened section hermetically, and a molded arrester elements stack installed in an insertion hole of said bushing removably from outside of said equipment case, wherein said molded arrester elements stack has an arrester elements stack comprising a layer stack of plurality of arrester elements, and a molded rubber provided around outer circumference of said arrester elements stack, **characterized in that:**

an outer circumference of tip of said arrester elements stack is covered by a high voltage shielding electrode,
a tapered inner surface which extends conically from a high-voltage side toward a low-voltage side of said bushing is provided in an insertion hole of said bushing for the section from a portion corresponding to an intermediate section of said high voltage shielding electrode to a portion corresponding to a neighborhood of the high-voltage side surface of said equipment case, and
a tapered outer surface which fits in said tapered inner surface is provided in said molded rubber.

4. An arrester providing, in an opened section of an equipment case which houses electrical equipments, a bushing installed to cover said opened section hermetically, and a molded arrester elements stack installed in an insertion hole of said bushing removably from outside of said equipment case, wherein said molded arrester elements stack has an arrester elements stack comprising a layer stack of plurality of arrester elements, and a molded rubber provided around outer circumference of said arrester elements stack, **characterized in that:**

an outer circumference of tip of said arrester elements stack is covered by a high voltage shielding electrode,
a tapered inner surface which extends conically from a high-voltage side toward a low-voltage side of said bushing is provided in an insertion hole of said bushing for the section from a portion

corresponding to a top of said high voltage shielding electrode to a portion corresponding to a neighborhood of the high-voltage side surface of said equipment case, and a tapered outer surface which fits in said tapered inner surface is provided in said molded rubber.

5. An arrester providing, in an opened section of an equipment case which houses electrical equipments, a bushing installed to cover said opened section hermetically, and a molded arrester elements stack installed in an insertion hole of said bushing removably from outside of said equipment case, wherein said molded arrester elements stack has an arrester elements stack comprising a layer stack of plurality of arrester elements, and a molded rubber provided around outer circumference of said arrester elements stack, **characterized in that:**

an outer circumference of tip of said arrester elements stack is covered by a high voltage shielding electrode, a tapered inner surface which extends conically from a high-voltage side toward a low-voltage side of said bushing is provided in an insertion hole of said bushing for the section from a tip of said bushing to a back-end of said bushing, and a tapered outer surface which fits in said tapered inner surface is provided in said molded rubber.

6. The arrester according to any one of claims 1 to 5, **characterized in that:**

said molded arrester elements stack is provided with the arrester elements stack comprising a layer stack of plurality of the arrester elements containing zinc oxide as the main component, a joint conductor abutted on the high-voltage side of said arrester elements stack, and a pressure metal fitting abutted on the low-voltage side of said arrester elements stack.

7. The arrester according to any one of claims 1 to 6, **characterized in that:**

the back-end of said molded arrester elements stack is led to the outside of said equipment case through the opened section of said equipment case.

8. The arrester according to any one of claims 1 to 7, **characterized in that:**

the back-end of said bushing is formed by an insulated cylindrical component and said cylindrical component is led to the outside of said equipment case through the opened section of said equipment case.

9. The arrester according to any one of claims 1 to 8, **characterized in that:**

said bushing is formed by a rigid plastic resin.

Fig.1

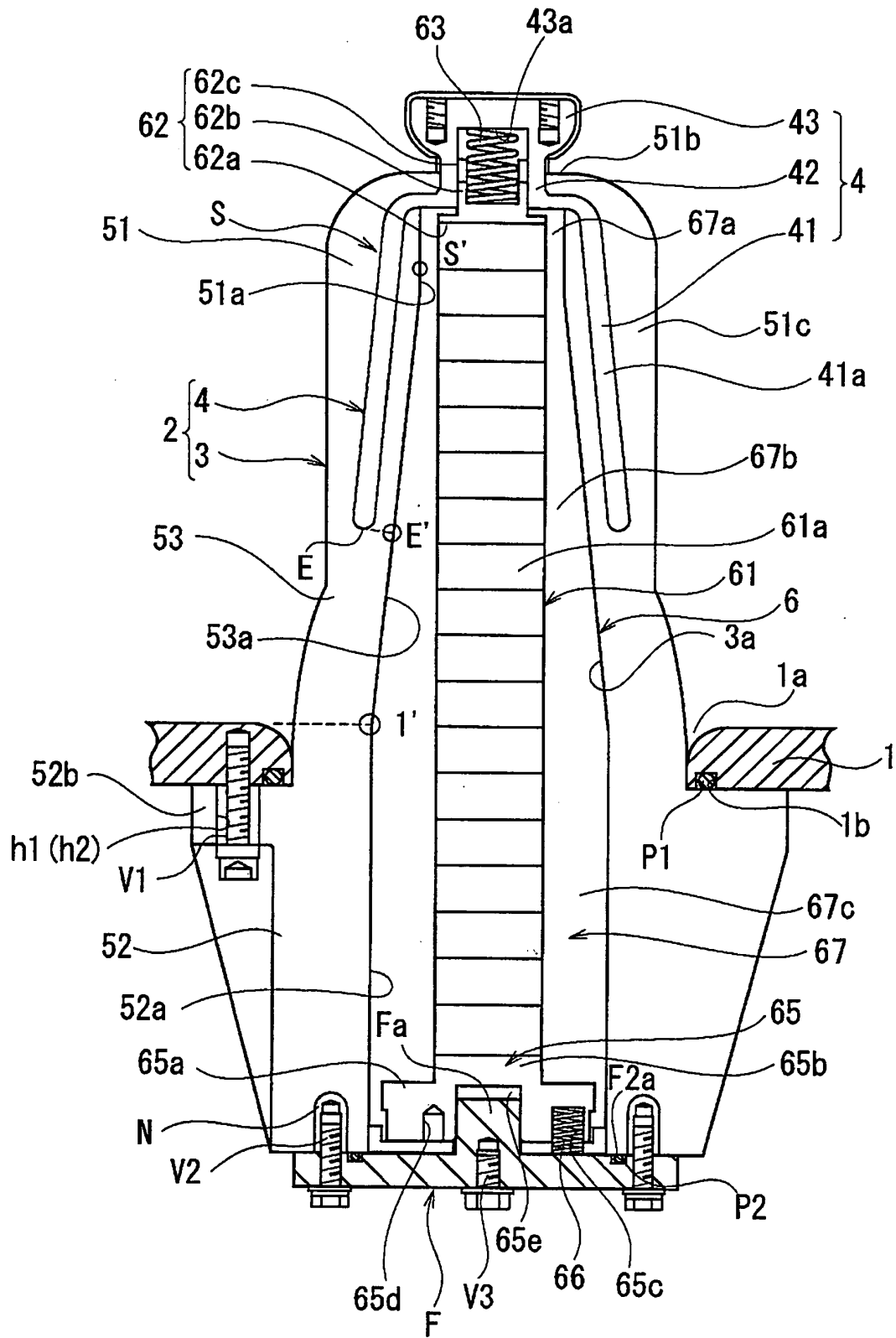


Fig.2

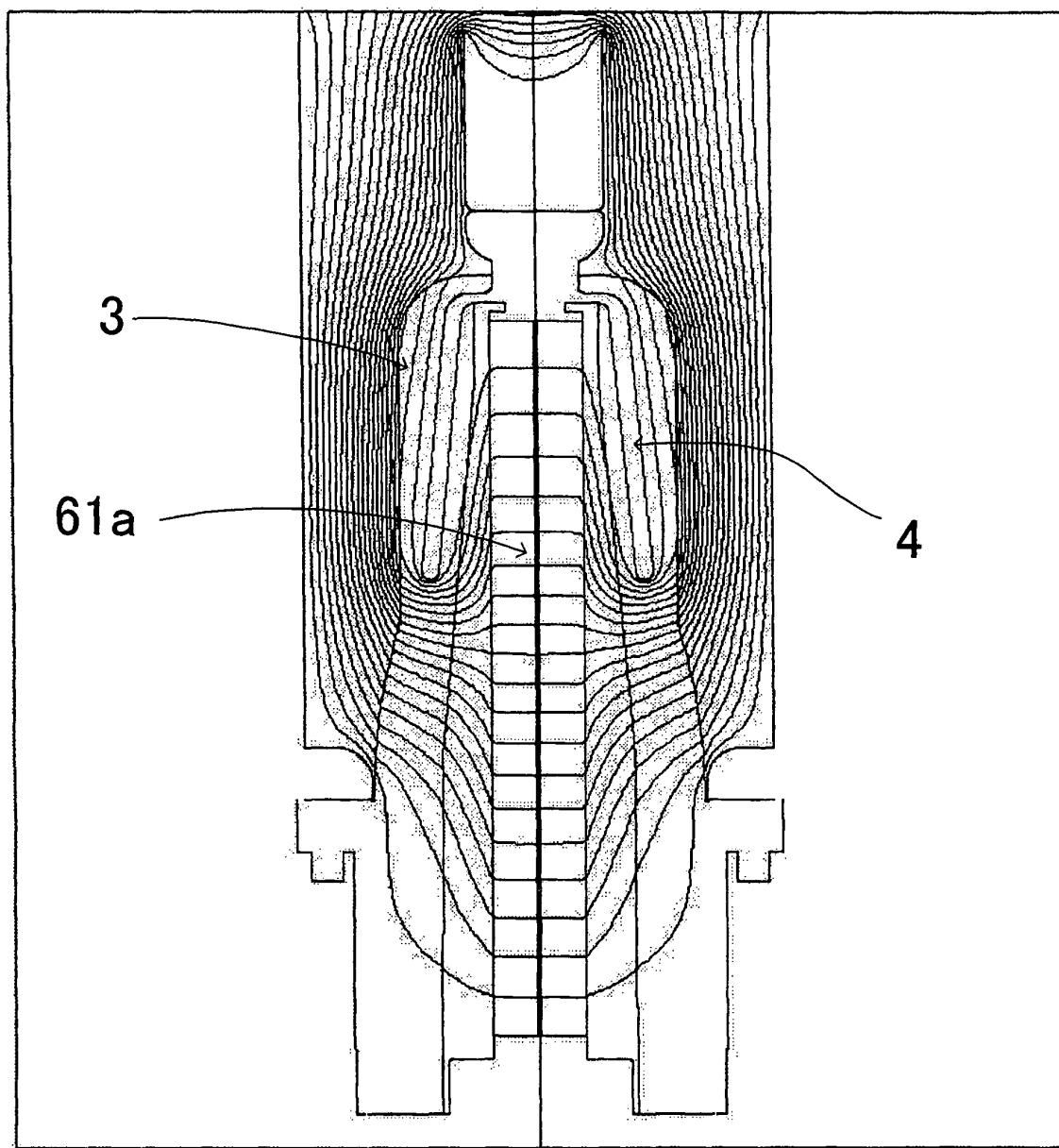


Fig.3

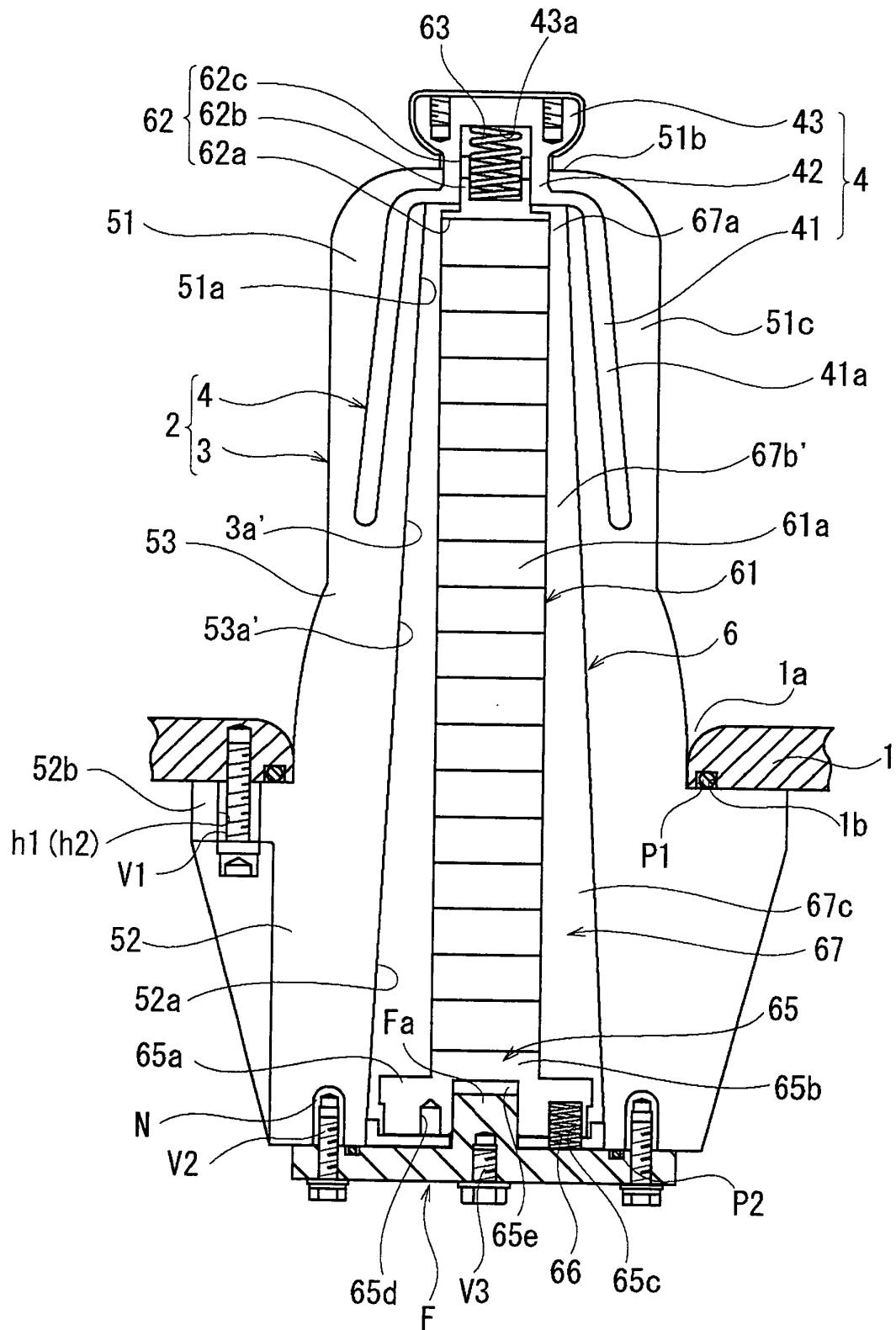


Fig.4

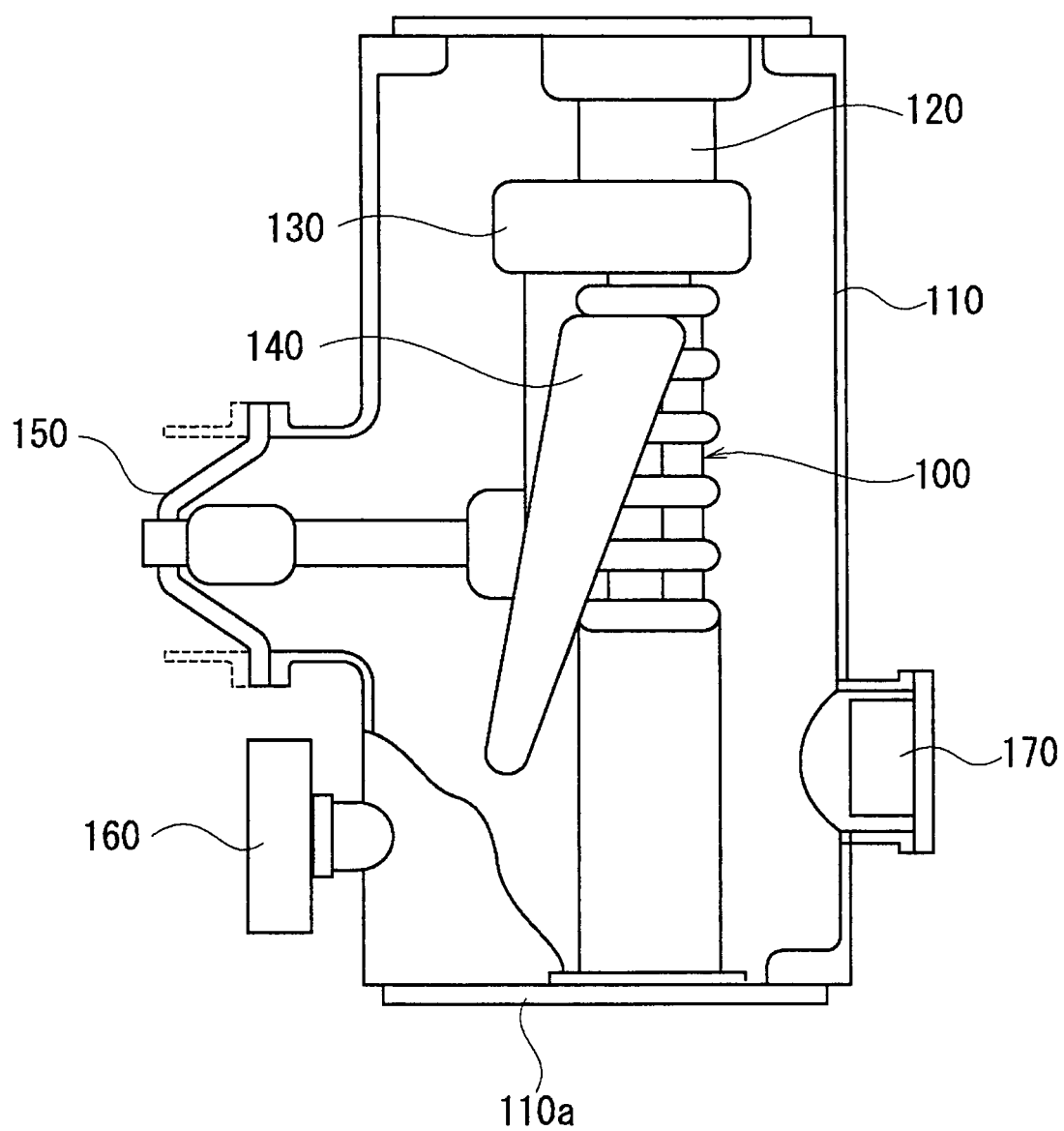


Fig.5

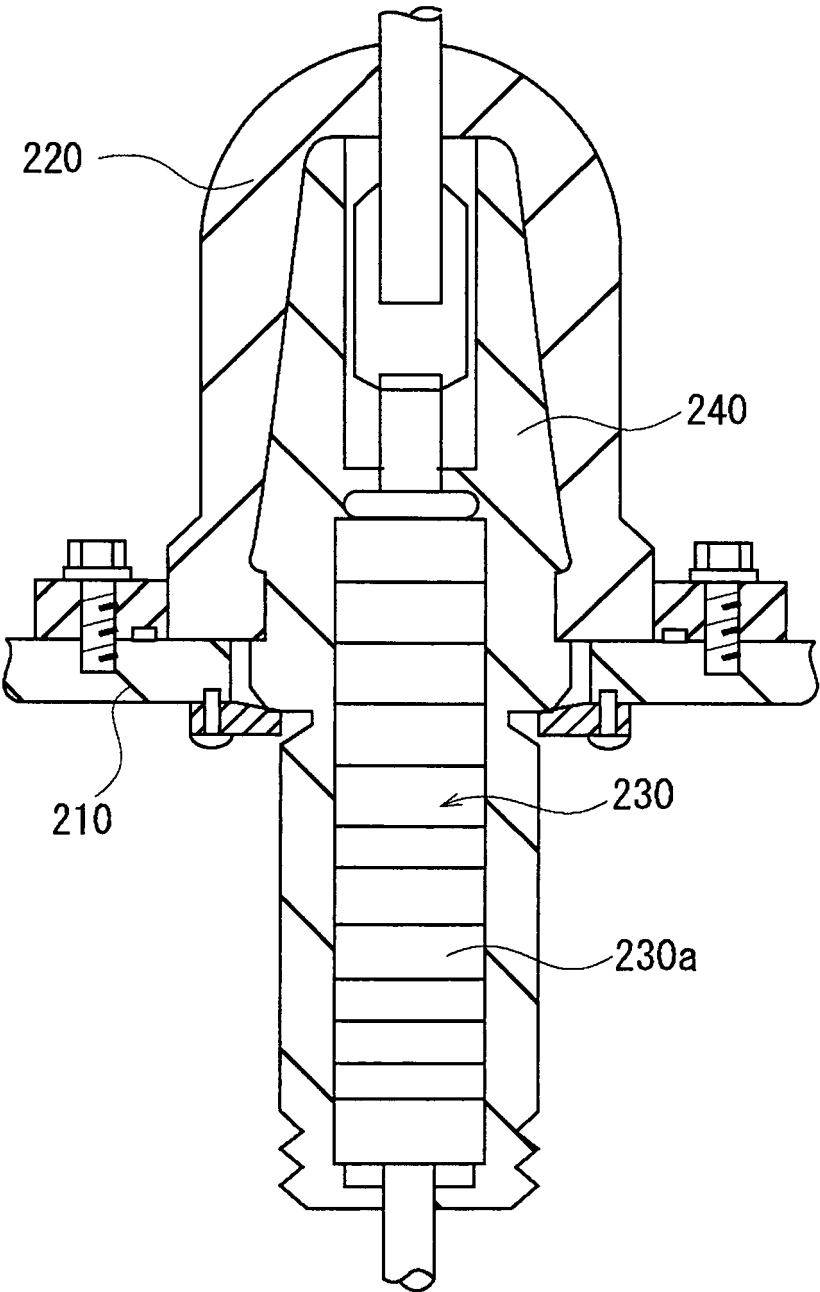


Fig.6

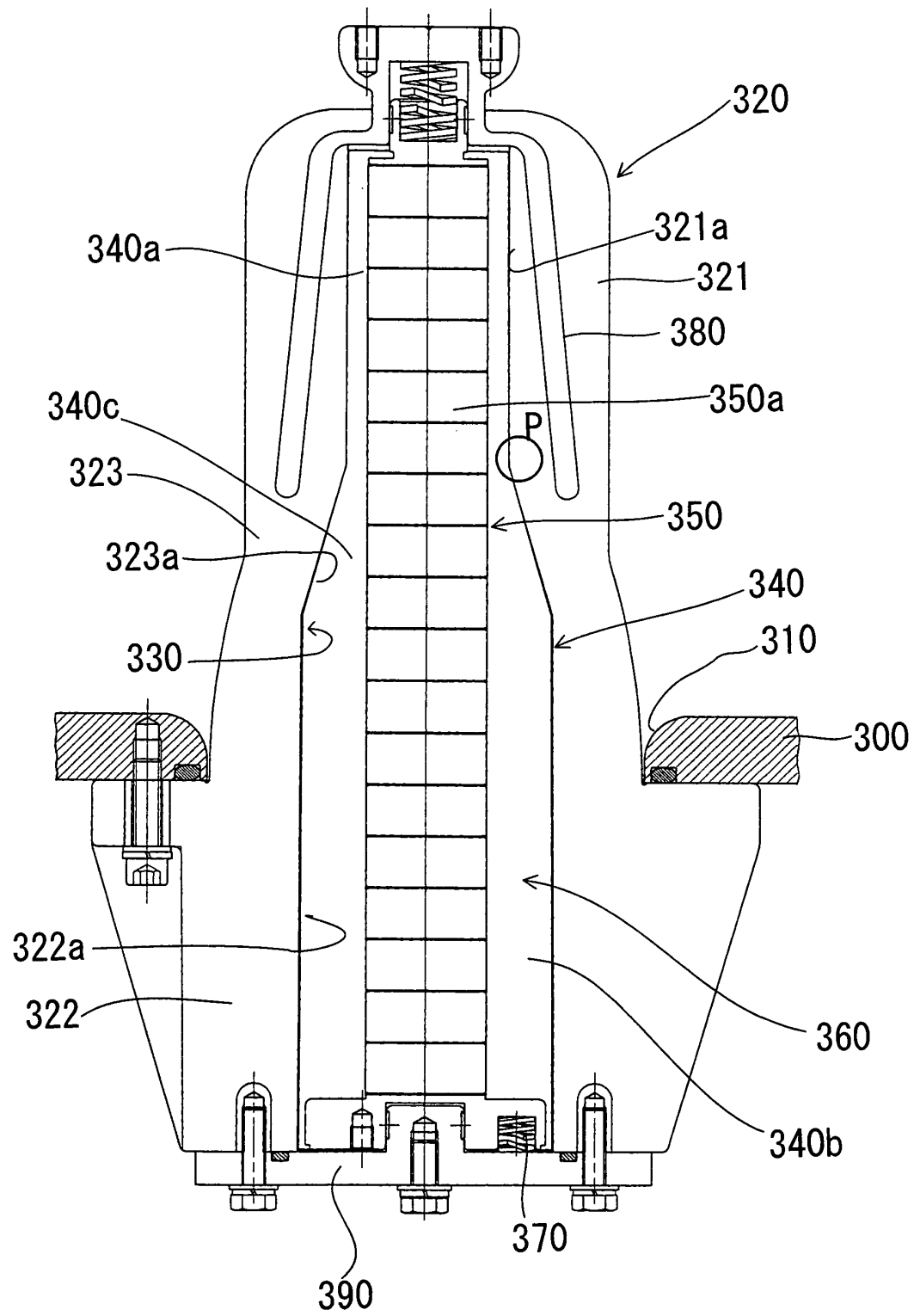


Fig.7

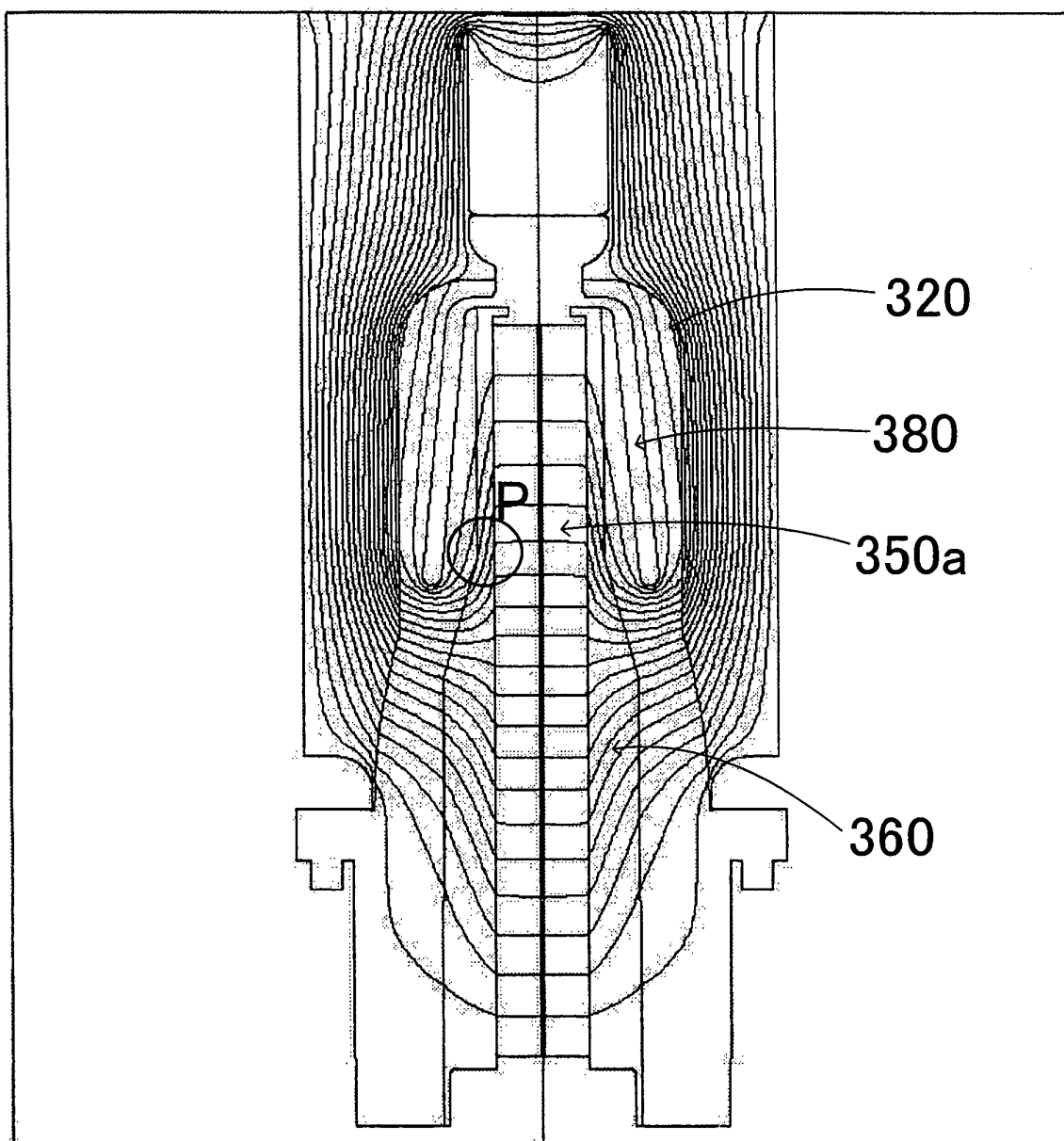
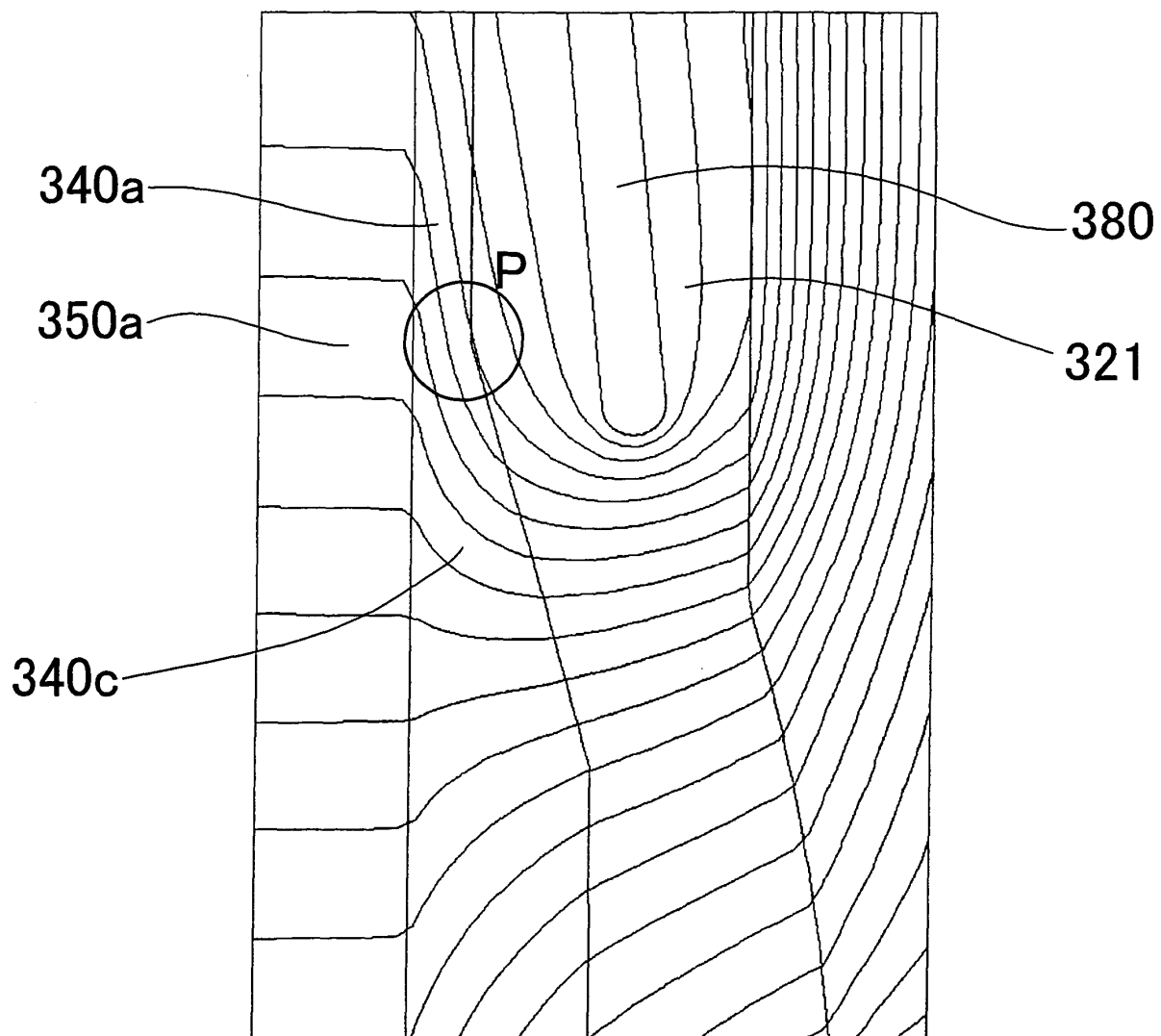


Fig.8



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2007/000162

A. CLASSIFICATION OF SUBJECT MATTER

H02B13/02(2006.01) i, H01C7/10(2006.01) i, H01C7/12(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)

H02B13/02, H01C7/10, H01C7/12

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	1996-2007
Kokai Jitsuyo Shinan Koho	1971-2007	Toroku Jitsuyo Shinan Koho	1994-2007

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. 169797/1987 (Laid-open No. 76107/1989) (Fuji Electric Co., Ltd.), 23 May, 1989 (23.05.89), Full text; Fig. 1 (Family: none)	1-9
A	JP 2003-297608 A (Meidensha Corp.), 17 October, 2003 (17.10.03), Par. No. [0018]; Fig. 1 (Family: none)	1-5

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

* Special categories of cited documents:

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Date of the actual completion of the international search

23 May, 2007 (23.05.07)

Date of mailing of the international search report

05 June, 2007 (05.06.07)

Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/000162

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2005-348596 A (ABB Technology AG.), 15 December, 2005 (15.12.05), Par. Nos. [0003] to [0009], [0019], [0032] to [0036], [0038]; Figs. 1, 3 & EP 1603140 A1	1-8
A	JP 2002-135959 A (Showa Electric Wire & Cable Co., Ltd.), 10 May, 2002 (10.05.02), Par. Nos. [0002], [0015], [0019], [0021]; Figs. 1, 3 (Family: none)	1-5

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

REFERENCES CITED IN THE DESCRIPTION

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- WO 2004357915 A [0006]
- JP HEI01232681 B [0011]