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54 Bushing for gas-insulated electrical equipment.

57 The present invention relates to a bushing for gas-insulated electrical equipment, and consists in a bushing wherein a conductor (1) penetrates through a porcelain tube (7,8) which has a fitting flange (5) connected to one end thereof and wherein main electrodes (3) concentric with the conductor (1) are interposed between layers of an insulating member (2) which insulates an outer periphery of the conductor, wherein an end part of said each main electrode (3) closer to the other end of said porcelain tube (8) is exposed a predetermined length from said insulating member, and wherein annular auxiliary electrode means (12) are electrically connected with said main electrode (3) and the external shape of which having a curved surface is arranged at the exposed end part of said main electrode (3), whereby electric fields near the end part of said main electrode (3) are moderated so as to enhance the dielectric strength of the bushing.

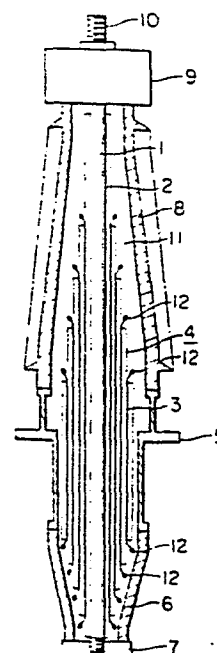


FIG. 3

BUSHING FOR GAS-INSULATED ELECTRICAL EQUIPMENT

This invention relates to a bushing for use in the lead-out portion of tank type electrical equipment such as transformers and gas-insulated electrical equipment.

5 In general, a bushing for use in the lead-out portion of tank type electrical equipment is a condenser bushing provided with a condenser core which has a sheet material, such as insulating paper, wound round a central conductor and in which a plurality of cylindrical electrodes
10 conforming with a working voltage are arranged at suitable positions in the shape of concentric cylinders so that the electric field distributions inside and outside the bushing may become uniform.

Figure 1 shows a prior-art condenser bushing.
15 Referring to the figure, numeral 1 designates a central conductor, round which an insulating sheet member 2 such as insulating paper and syntheric resin film is wound. In the member 2, cylindrical main electrodes 3 are inserted at suitable positions in the shape of concentric cylinders
20 so as to make uniform the distribution of electric fields inside and outside the bushing. Thus, a condenser core 4 is formed. Numeral 5 designates a fitting flange, numeral 6 a lower porcelain tube, and numeral 7 a lower terminal with which the lower end part of the central conductor 1 is
25 held in threadable engagement. Numeral 8 designates an upper

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porcelain tube, and numeral 9 a head fixture which receives therein a compression spring (not shown) that serves to fix the upper porcelain tube 8, fitting flange 5 and lower porcelain tube 6 by utilizing the central conductor 1 as a tensile strength member. Shown at numeral 10 is an upper terminal. A space surrounding the condenser core 4 is filled with an insulating medium 11.

The condenser core 4 is so constructed that, in the course of winding the insulating sheet material 2, the main electrodes 3 made of an electrically conductive material and each being in the form of a sheet cut to a predetermined size are inserted and wound at predetermined suitable positions in the shape of concentric cylinders. Thus, each main electrode 3 is sandwiched between the layers of the insulating sheet material 2, and its end part as viewed in section is pointed. For this reason, the distribution of electric fields when a voltage is applied to the bushing becomes such that equipotential surfaces crowd on the electrode ends as illustrated in an enlarged sectional view of the end parts of the main electrodes 3 in Figure 2. The field intensity of the crowded parts needs to be designed to a value which the surrounding insulating material can endure. The electric field at the end of main electrode 3 can amount to several times of that at the middle part, so that the utilization rate is not very good. If the electric field crowding at the end part of the main electrode 3 can be moderated, the utilization rate of the insulating portion will be enhanced, and enhancement of the dielectric strength of condenser core 4

1 or reduction in the diameter thereof will become possible.

In order to moderate the electric field crowding at the end part of the main electrode 3, the end part of the main electrode 3 is put into a shape that is bent in parallel with the equipotential surfaces. An alternative measure moderates the electric field crowding by disposing a rounded ring. However, these measures have been put into practical use in an epoxy-injection resin bushing, and it has been difficult to shape the end of the main electrode 3 in parallel with the equipotential surfaces in the bushing in which the condenser core 4 is formed of the insulating sheet material.

The invention is intended to remedy these drawbacks and to eliminate the disadvantages described above. Accordingly, the invention provides a bushing which is easy to fabricate wherein annular auxiliary electrodes which are electrically connected with corresponding main electrodes and the external shape of which have a curved surface, are arranged at the end parts of the main electrodes, whereby electric fields near the end parts of the main electrodes are moderated to enhance the dielectric strength of an insulating portion

30 Further features and advantages of the invention will be explained in detail below with reference to the drawings illustrating various embodiments, wherein

35 Figure 1 is a sectional view of a prior-art bushing;

Fig. 2 is an explanatory view showing electric field distributions at the end parts of main electrodes

in Figure 1;

Figure 3 is a sectional view of an embodiment of this invention;

Figure 4 is an enlarged sectional view of the 5 vicinities of the end parts of main electrodes in Figure 3;

Figure 5 is a sectional view of another embodiment of this invention;

Figure 6 is a sectional view of still another embodiment of this invention;

10 Figure 7 is an enlarged sectional view of the vicinities of the end parts of main electrodes in Figure 6; and

Figure 8 is a sectional view of yet another embodiment of this invention.

15 In the drawings, the same symbols indicate the same or corresponding parts.

Now, an embodiment of this invention will be concretely described with reference to Figures 3 and 4.

Figure 3 is a sectional view showing one embodiment according 20 to the present invention, while Figure 4 is an enlarged sectional view of the end parts of electrodes. In the embodiment of this invention, as illustrated in the figures, an insulating sheet member 2 is worked stepwise at the end parts of main electrodes 3 so as to expose the end parts 25 of these main electrodes 3. Further, annular auxiliary electrodes 12 formed of wire rods circular in section are fixed to each end part of each main electrode 3 and are

electrically connected with the main electrode 3 by means of electrically-conductive supporters 13 which are arranged in a number of 3 - 4 at equal intervals in the peripheral direction of the main electrode 3. In addition, an
5 insulating film 14 is disposed on the outer periphery of each auxiliary electrode 12 in such a way that a tape type insulating material is wound to a suitable thickness. Owing to such structure, electric fields at the end part of the main electrode 3 are moderated by the diameter of
10 the auxiliary electrodes 12, and the dielectric strength of the bushing is sharply increased.

The design of the electrode arrangement of the condenser bushing is determined by the field strength of that end part of the main electrode 3 at which the electric
15 fields crowd. Therefore, the attachment of the auxiliary electrodes 12 as described above allows reduction in the insulation thickness of the middle part of the main electrode 3 of a condenser core 4. It is also possible to design the maximum field strength at a lower value in
20 consideration of the combination between the dimensions of the main electrode 3 and the auxiliary electrodes 12. Another effect is that reliability is enhanced.

The auxiliary electrode 12 is surrounded with the insulating film 14 obtained by winding the insulating tape
25 material to a suitable thickness. In this regard, since the dielectric constant of the insulating film 14 is greater than that of an insulating medium 11 surrounding the film 14, the field strength of the surface electric fields of the auxiliary electrode 12 is lowered in inverse proportion to

the former dielectric constant, so that the dielectric strength of the bushing is more enhanced conjointly with the dielectric strength of the insulating film 14.

The insulating film 14 on the surface of the auxiliary electrode 12 may well be formed by a method in which the epoxy resin powder or the like, in a semi-hardened state, is applied on the surface by a swing coating process or the like and is then hardened. With this method, the insulating job for the auxiliary electrode 12 is facilitated, and an effect equivalent to that in the case of taping is attained.

Figure 5 shows another embodiment of this invention applied to a bushing in which a conical spacer 15 is disposed in the lower part thereof.

Figure 6 shows another embodiment of this invention. In the embodiment shown in Figure 6, an auxiliary electrode 16 is so constructed that an elastic material such as electrically-conductive rubber and electrically-conductive synthetic resin is put into a sectional shape, such as an elliptical or oval shape, causing no electric field crowding and into a diameter somewhat smaller than that of the main electrode 3, the diameters being taken with respect to the axis of the bushing. As shown in Figure 7, the auxiliary electrode 16 is arranged at the end part of the main electrode 3 in a manner to abut on this main electrode 3. The auxiliary electrode 16 of the smaller diameter is attached to the condenser core 4 by utilizing its elasticity, whereby the attachment job is very easily performed.

1 Figure 8 shows another embodiment of this
invention wherein an auxiliary electrode 16 having
elasticity is disposed on the main electrode 3 of a
5 bushing which is equipped with a conical spacer 15 in
the lower part thereof.

As set forth above, according to this invention,
the end part of a main electrode is exposed a predetermined
10 length from an insulating member, and an annular electrode
which is electrically connected with the main electrode
and the external shape of which has a curved surface is
15 arranged at the end part of the main electrode, whereby the
electric fields crowding in the vicinity of the end part
of the main electrode can be readily moderated, and
the dielectric strength can be enhanced.

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1 What is claimed is:

5 1. A bushing wherein a conductor penetrates
through a porcelain tube which has a fitting flange
connected to its one end, and wherein main electrodes
concentric with the conductor are interposed between
layers of an insulating member which insulates the outer
10 periphery of the conductor, characterized in that an
end part of said each main electrode (3) closer to
the other end of said porcelain tube (8) is exposed a
predetermined length from said insulating member, and
15 that annular auxiliary electrode means (12) electrically
connected with said main electrode (3) and the external
shape of which is a curved surface is arranged at the
exposed end part of said main electrode (3).
20

25 2. A bushing according to claim 1, characterized
in that said auxiliary electrode means (12) has a cir-
cular section.

30 3. A bushing according to claim 1 or 2, characterized
in that said auxiliary electrode means (12) has an
insulating film (14) which is formed by winding a sheet
insulator.

35 4. A bushing according to any of claims 1 to 3,
characterized in that said auxiliary electrode means (12)
has an insulating film (14) which is made of a coating
of a high polymer.

5. A bushing according to claim 1, characterized
in that said auxiliary electrode means (12) is made of

1 electrically-conductive rubber or electrically-conductive
synthetic resin which is elastic.

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FIG. 1

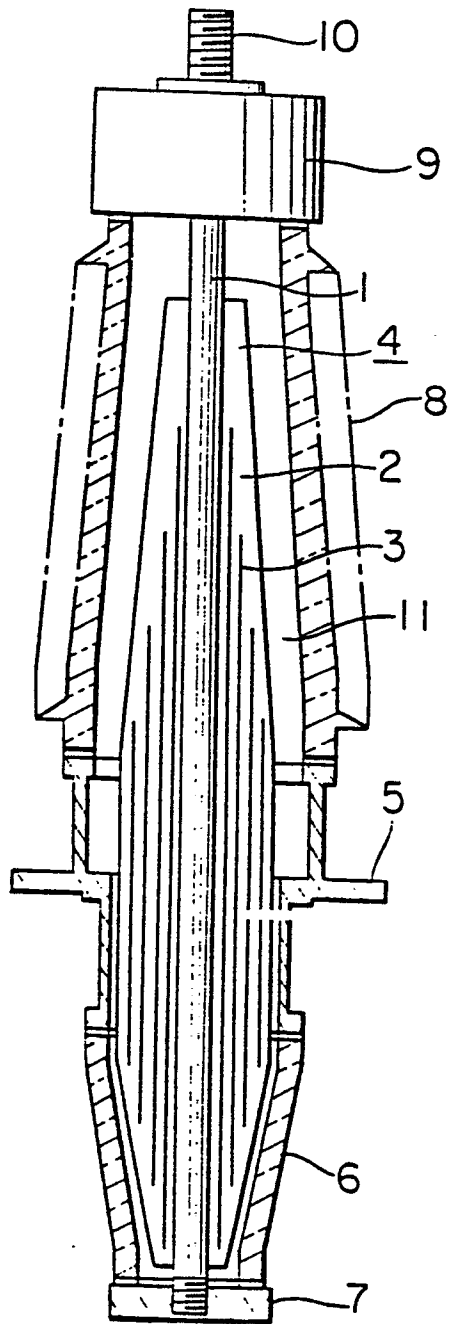


FIG. 2

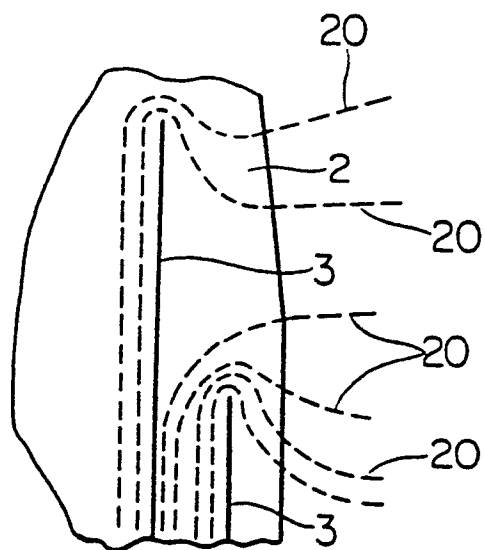


FIG. 3

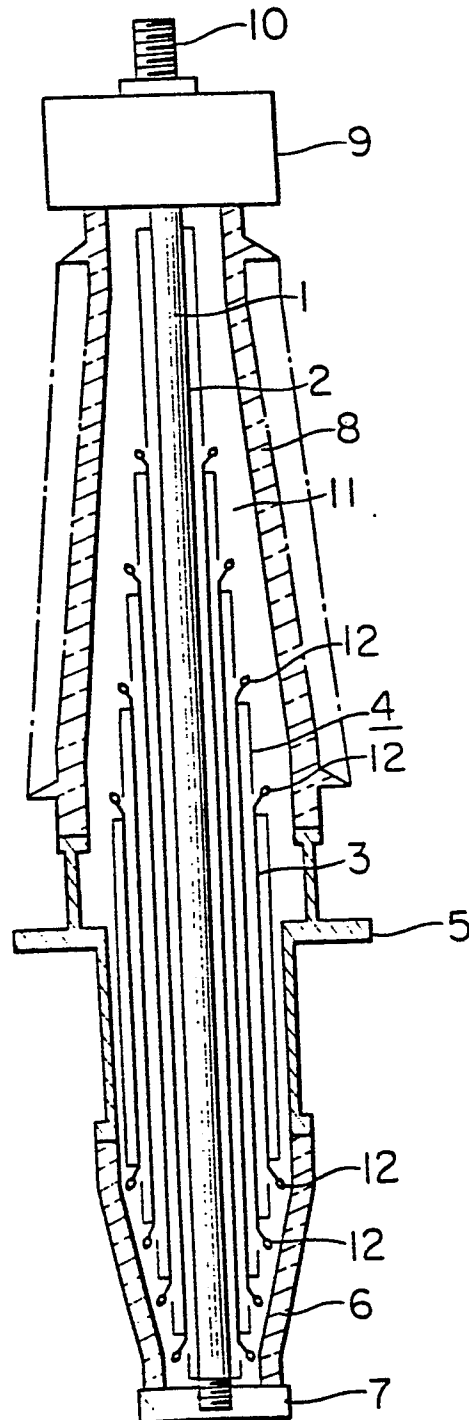


FIG. 4

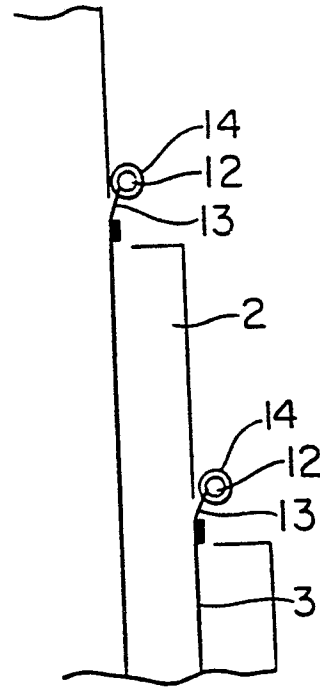


FIG. 5

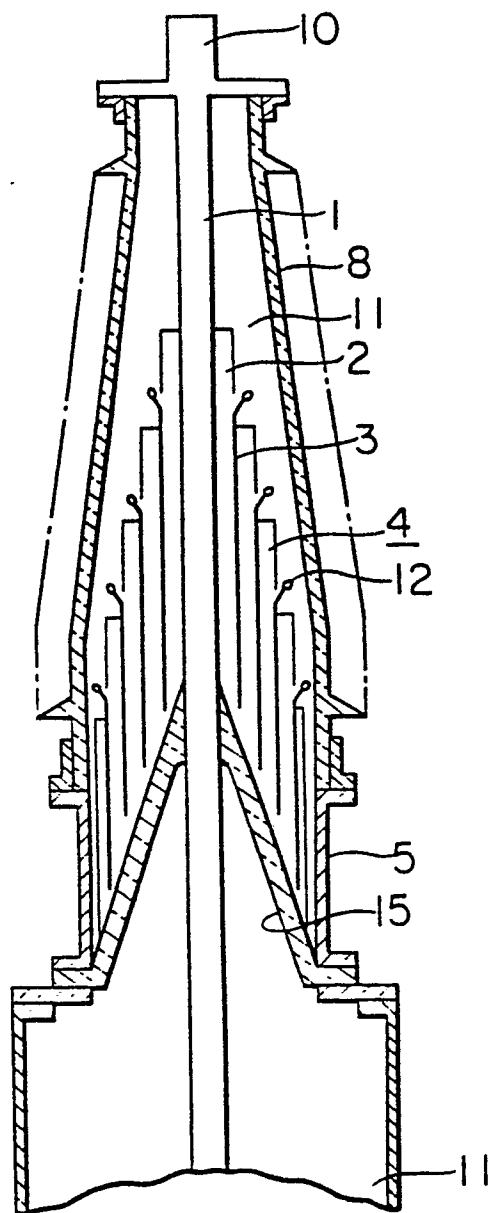


FIG. 6

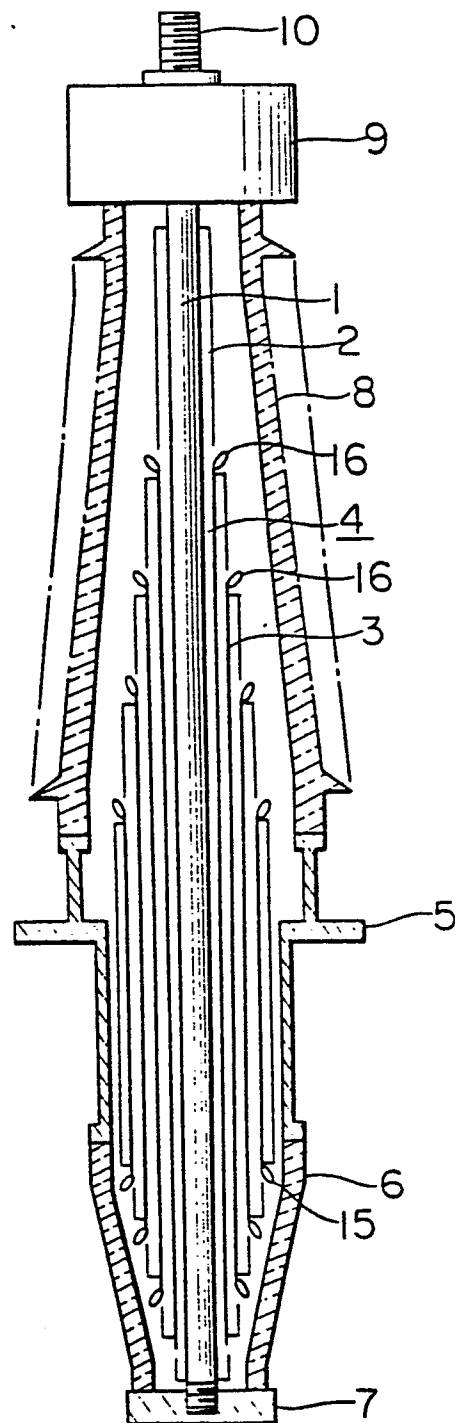


FIG. 7

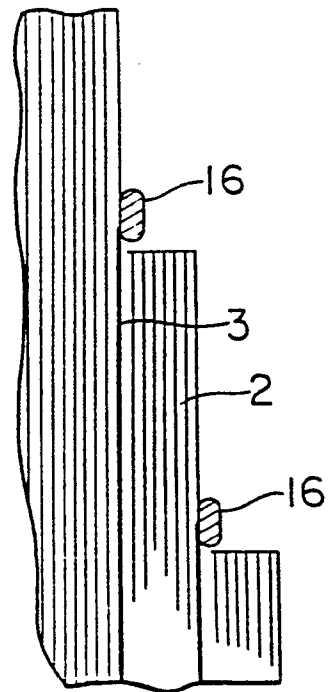
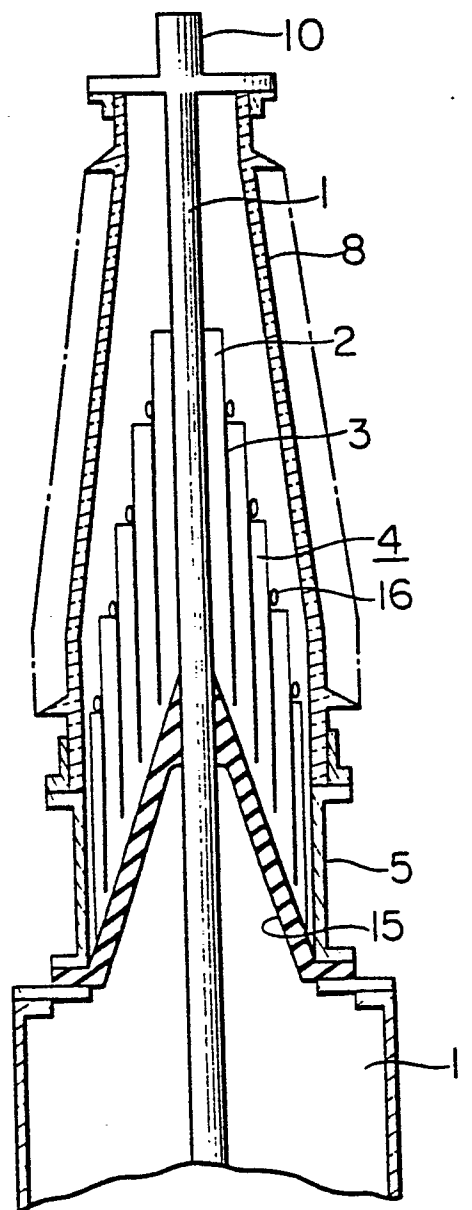


FIG. 8





DOCUMENTS CONSIDERED TO BE RELEVANT			EP 83101074.9												
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)												
A	US - A - 3 849 590 (OZAWA) * Fig. 2,3; claims * --	1,2	H 01 B 17/26 H 01 B 17/36 H 01 F 27/04												
A	WO - A1 - 80/00 762 (BBC) * Fig. 2; abstract * --	1,2													
A	EP - A1 - 0 044 179 (NGK INSULATORS) * Abstract; fig. 3 * --	1,2													
A	US - A - 4 159 401 (KAMATA) * Fig. 6 * --	1,2													
A	AT - C - 345 368 (HAEFELY) * Fig. 2; claims * --	1,2	TECHNICAL FIELDS SEARCHED (Int. Cl. 3)												
A	DE - A - 1 800 667 (SPRECHER & SCHUH) * Totality * --		H 01 B 17/00 H 02 G 15/00 H 01 F 27/00												
A	US - A - 3 538 241 (REIN) * Fig. 1 * --	1													
A	GB - A - 612 061 (SCARPA) * Totality * --														
The present search report has been drawn up for all claims															
Place of search VIENNA		Date of completion of the search 10-05-1983	Examiner SCHMIDT												
<table border="0"><tr><td>CATEGORY OF CITED DOCUMENTS</td><td>T : theory or principle underlying the invention</td></tr><tr><td>X : particularly relevant if taken alone</td><td>E : earlier patent document, but published on, or after the filing date</td></tr><tr><td>Y : particularly relevant if combined with another document of the same category</td><td>D : document cited in the application</td></tr><tr><td>A : technological background</td><td>L : document cited for other reasons</td></tr><tr><td>O : non-written disclosure</td><td>& : member of the same patent family, corresponding document</td></tr><tr><td>P : intermediate document</td><td></td></tr></table>				CATEGORY OF CITED DOCUMENTS	T : theory or principle underlying the invention	X : particularly relevant if taken alone	E : earlier patent document, but published on, or after the filing date	Y : particularly relevant if combined with another document of the same category	D : document cited in the application	A : technological background	L : document cited for other reasons	O : non-written disclosure	& : member of the same patent family, corresponding document	P : intermediate document	
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