PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :		(11) International Publication Number:	WO 93/07630
H01C 7/12	A1	(43) International Publication Date:	15 April 1993 (15.04.93)

(21) International Application Number: PCT/SE92/00667

(22) International Filing Date: 25 September 1992 (25.09.92)

(30) Priority data:
9102881-1 4 October 1991 (04.10.91) SE

(71) Applicant *(for all designated States except US):* ASEA BROWN BOVERI AB [SE/SE]; S-721 83 Västerås (SE).

(72) Inventors; and
(75) Inventors/Applicants *(for US only) :* LUNDQUIST, Jan [SE/SE]; Lavendelstigen 11, S-771 43 Ludvika (SE). WIECK, Håkan [SE/SE]; Carlavägen 2 A, S-771 30 Ludvika (SE).

(74) Agent: LUNDBLAD VANNESJÖ, Katarina; ABB Corporate Research, Patent Department, S-721 78 Västerås (SE).

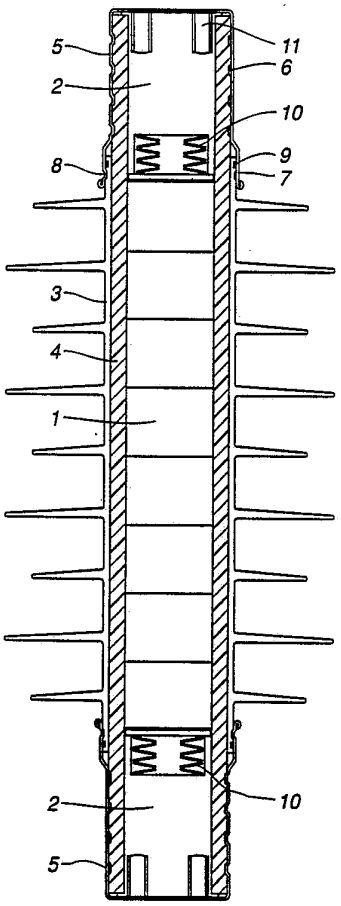
(81) Designated States: AU, BR, CA, JP, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, SE).

Published
With international search report.

(54) Title: SURGE ARRESTER

(57) Abstract

The invention relates to a surge arrester comprising a stack of arrester elements (1), for example of zinc oxide, arranged between two end electrodes (2) in an elongated insulating casing (3) of polymeric material, for example EPDM rubber. To mechanically reinforce the arrester, a tube (4) of fibre-reinforced plastic is arranged between the stack of arrester elements (1) and the polymer insulator (3). This tube (4) is manufactured by profile drawing, so-called pultrusion, whereby all reinforcement fibres extend in the axial direction of the tube. This gives the tube (4) a high tensile strength while at the same time the strength in the radial direction is relatively low. This is advantageous in the event of an arrester failure with an internal short circuit, since the tube will then easily crack up and provide a rapid pressure relief without any explosion hazard.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria
AU	Australia
BB	Barbados
BE	Belgium
BF	Burkina Faso
BG	Bulgaria
BJ	Benin
BR	Brazil
CA	Canada
CF	Central African Republic
CG	Congo
CH	Switzerland
CI	Côte d'Ivoire
CM	Cameroon
CS	Czechoslovakia
CZ	Czech Republic
DE	Germany
DK	Denmark
ES	Spain
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
GN	Guinea
GR	Greece
HU	Hungary
IE	Ireland
IT	Italy
JP	Japan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
LI	Liechtenstein
LK	Sri Lanka
LU	Luxembourg
MC	Monaco
MG	Madagascar
ML	Mali
MN	Mongolia
MR	Mauritania
MW	Malawi
NL	Netherlands
NO	Norway
NZ	New Zealand
PL	Poland
PT	Portugal
RO	Romania
RU	Russian Federation
SD	Sudan
SE	Sweden
SK	Slovak Republic
SN	Senegal
SU	Soviet Union
TD	Chad
TG	Togo
UA	Ukraine
US	United States of America
VN	Viet Nam

Surge arrester

The present invention relates to a surge arrester comprising a stack of a plurality of cylindrical arrester elements which are preferably made of metal oxide varistor material and which are arranged one after the other in the axial direction of the arrester elements between two end electrodes and surrounded by an elongated outer casing.

The outer casing of currently used surge arresters is usually made of porcelain. A porcelain casing has good electrical insulating properties and also has sufficient mechanical strength to take up, inter alia, the axially directed compressive force on the arrester elements, which is generated by springs and which is required to obtain good electrical contact between the elements. In arresters with a porcelain casing, however, some form of overpressure relief arrangement is required to avoid an explosion-like failure, if, for example in the event of a fault on an arrester element, a short-circuit arc is formed inside the arrester with an ensuing pressure increase.

Recently, for certain types of surge arresters, the porcelain casing has begun to be replaced by a protective casing of polymeric material, for example EPDM rubber. Such a casing is considerably less expensive, and because of the elasticity of the polymer material, the possibilities of a less dramatic process without any explosion hazard in the event of a surge arrester failure are improved. However, a polymer insulator casing must be supplemented by some form of mechanical stiffening to attain sufficient strength against bending and tensile stresses.

From US-A-4 404 614 a surge arrester with a polymer casing is previously known, in which a mechanical stiffening in the form of a glassfibre-reinforced plastic tube is arranged. Also this surge arrester is provided with an overpressure relief arrangement of, in principle, the same type as that

used in connection with surge arresters with a porcelain casing.

In the construction of surge arresters with polymer insulator casing and glassfibre-reinforced tube, but without an overpressure relief arrangement of the above-mentioned kind, there are contradictory demands on the glassfibre-reinforced tube: On the one hand the tube shall have sufficient strength against bending and tensile stresses, and on the other the tube shall easily crack up in case of an arrester failure. When using cross-wound glassfibre-reinforced tubes, too high a radial strength in the tube is obtained. The same thing occurs when a fibre is wound directly on the block stack and thereafter impregnated with thermosetting resin: With suitable strength in the axial direction, too high a strength in the radial direction is obtained to provide good failure properties. Attempts to solve the problem have been made by providing the tube with holes (see, e.g. EP-A-0 335 480) or longitudinal weakened portions in the form of ground slots etc., but this renders the manufacture more complicated and more expensive.

The object of the present invention is to obtain a surge arrester which is provided with polymer casing and which does not suffer from the above-mentioned drawbacks. This is achieved according to the invention by using, for mechanical reinforcement of the polymer casing, a fibre-reinforced plastic tube which is made by profile drawing, so-called pultrusion, whereby all reinforcement fibres extend in the axial direction of the tube.

A pultruded fibre-reinforced tube has a very high tensile strength. The required bending strength is obtained by choosing a suitable wall thickness and amount and type of reinforcement fibres. Despite the high tensile and bending strength, a relatively low strength in the radial direction is obtained. This permits a favourable failure process since the tube easily cracks up also at low short-circuit

currents. In addition, pultruded tubes are very cost-effective.

The invention will be explained in greater detail by describing an embodiment with reference to the accompanying drawing, which shows in axial section a surge arrester designed according to the invention.

The surge arrester shown in the figure is primarily intended for use in distribution networks with operating voltages of up to about 40 kV. However, the same design principle may be used to advantage also in surge arresters for operating voltages of the order of magnitude of 100 kV and higher. The arrester shown comprises a stack of arrester elements 1 in the form of circular-cylindrical ZnO blocks, possibly with heat-absorbing spacers of metal, and an end electrode 2 in the form of a metal pellet at each end of the stack. The end electrodes 2 and the spacers, if any, may suitably be made of aluminium. The entire stack of ZnO blocks 1, end electrodes 2 and spacers, if any, is arranged in an elongated tube 4 of glassfibre-reinforced plastic, which in turn is surrounded by an insulating casing 3 made of polymeric material. The stack is axially fixed to the tube 4 by means of metal cases 5, which surround the end portions of the tube 4 and are fixed to the tube by pressing the cylindrical mantle part of the respective case into annular slots 6 in the tube. The figure shows, on opposite sides of the centre line of the surge arrester, the metal case 5 before and after the pressing of the mantle part into the annular slots.

The metal cases 5 are formed with a collar 7, which surrounds the respective end portion of the polymer insulator 3 and is fixed to the insulator by a surrounding indentation 8. Between the metal collar 7 and the insulator 3 there is a seal 9, for example in the form of an O-ring.

The pressing of the metal cases 5 onto the plastic tube 4, in certain types of plastic material, may be performed without the tube being provided in advance with the surrounding slots 6. In this case, the slots in the plastic material are formed directly in connection with the pressing of the metal cases.

To ensure that a sufficient contact pressure is maintained between the individual arrester elements 1 and between the stack of arrester elements and the end electrodes 2, a spring device in the form of a disc spring assembly 10 is arranged near the end electrodes.

The end electrodes 2 are provided with threaded fixing holes 11 for connection members.

The tube 4 is a glassfibre-reinforced tube of plastic material, for example polyester, polyvinyl ester, epoxy or a thermoplastic resin. The tube is made by profile drawing, so-called pultrusion. This is a method of production for fibre composites in which the raw materials included are continuously and automatically directly converted into a finished product. In tubes manufactured according to this method, all reinforcement fibres are arranged axially. This gives the tube very special properties, of which a high tensile strength in combination with a low strength in the radial direction are particularly important properties for the present invention. Tubes of this type are available on the market.

The outer insulating casing 3 may be an elastomer, for example an ethylene-propylene-terpolymer (EPDM rubber) which is fitted over the tube 4. It may also consist of shrinking plastic, for example a crosslinked ethylene-propylene polymer or crosslinked HD-polyethylene which is applied to the tube 4 by shrinking. The insulating casing 3 may also be formed directly on the tube 4 by casting or injection moulding.

To achieve an airless connection between the stack of ZnO blocks 1 and the tube 4, the gap between the stack and the tube may be filled with an electrically insulating compound, for example epoxy or silicone compound. Alternatively, the tube 4 may consist of a shrinkable plastic material and be applied on the ZnO stack by shrinkage.

ZnO blocks are usually manufactured in a number of different transverse dimensions (diameters) to make it possible to build surge arresters for different current ranges in an economical way. In a surge arrester according to the present invention, it may be an advantage from the manufacturing point of view if the pultruded tube 4 can be manufactured with one and the same outside diameter for all sizes of ZnO blocks. Tubes which are intended for the smaller blocks are thereby provided internally with a number of longitudinal bars for centering the blocks, the spaces between the bars then being filled with silicone compound or the like.

If a fault should occur inside the surge arrester with an ensuing short circuit, the tube 4 will burst in the longitudinal direction in a controlled manner at a relatively low internal overpressure. The risk of explosion causing personal danger is thereby eliminated.

CLAIMS

1. A surge arrester comprising a stack of a plurality of cylindrical arrester elements (1), preferably made of metal oxide varistor material, which are arranged one after the other in the axial direction of the arrester elements between two end electrodes (2) and surrounded by an elongated outer casing (3), which consists of an insulator made of polymeric material, whereby for mechanical reinforcement a tube (4) of fibre-reinforced plastic is arranged between the stack of arrester elements (1) and the polymer insulator (3), **characterized in that** the fibre-reinforced plastic tube (4) is manufactured by profile drawing, so-called pultrusion, whereby all the reinforcement fibres extend in the axial direction of the tube (4).

2. A surge arrester according to claim 1, **characterized in that** the outer insulating casing (3) is applied to the fibre-reinforced plastic tube (4) by shrinking.

3. A surge arrester according to claim 1, **characterized in that** the outer insulating casing (3) is applied to the fibre-reinforced plastic tube (4) by direct forming on the tube by injection moulding or casting.

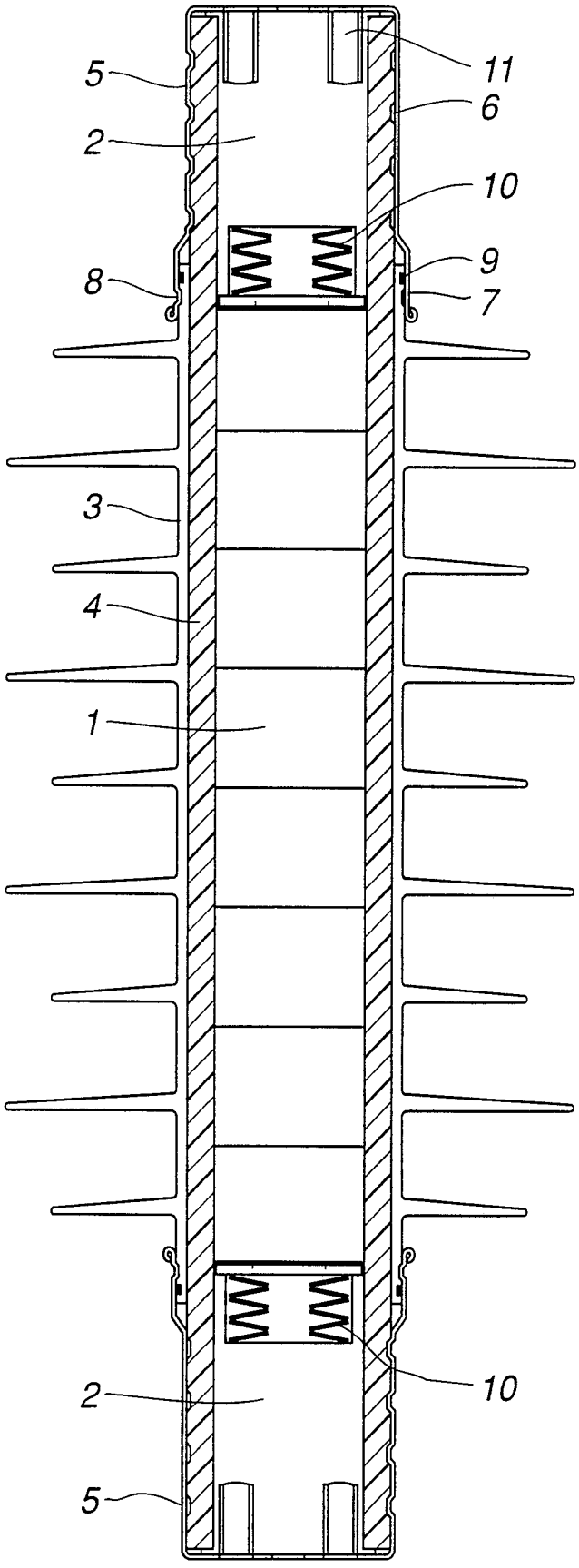
4. A surge arrester according to claim 1, 2 or 3, **characterized in that** between the plastic tube (4) and the stack of arrester elements (1) there is a gap filled with insulating compound, for example epoxy or silicone compound.

5. A surge arrester according to claim 1, 2 or 3, **characterized in that** the plastic tube (4) is applied to the stack of arrester elements (1) by shrinking.

6. A surge arrester according to any of claims 1-4, **characterized in that** the plastic tube (4) is internally provided with a number of longitudinal crests for centering

the arrester elements (1), whereby the spaces between the crests are filled with an insulating compound, for example silicone compound.

1/1



INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 92/00667

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: H01C 7/12

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	H01C

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
A	US, A, 4404614 (R.E. KOCH ET AL) 13 September 1983, see the whole document --	1
A	EP, A2, 0335480 (HUBBELL INCORPORATED) 4 October 1989, see the whole document --	1

---

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
28th December 1992	12 -01- 1993
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Magnus Westöö

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.PCT/SE 92/00667

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the Swedish Patent Office EDP file on 02/12/92
The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4404614	83-09-13	NONE	
EP-A2- 0335480	89-10-04	JP-A- 1255437	89-10-12
		US-A- 4905118	90-02-27