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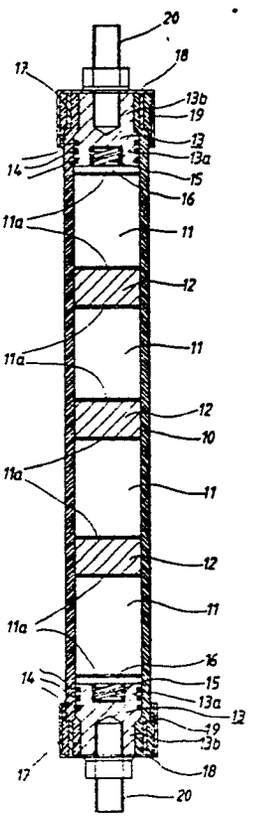
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(54) Surge arrester.

(57) A surge arrester comprising a plurality of cylindrical arrester elements (11) of metal oxide varistor material, which are arranged one after the other in the axial direction of the arrester elements between two end electrodes (13) in an elongated protective housing (10) of a plastic material. The protective housing is resistant to deformation under the operating conditions for the surge arrester and makes contact with the envelope surface of the arrester elements. The end surfaces of the arrester elements is provided with electrodes (11a) secured to said arrester elements. According to the invention the protective housing consists of cross-linked HD polyethylene and is shrunk onto the arrester elements arranged one after the other. Between at least the main part of the arrester elements heat-absorbing bodies (12) of metallic material are arranged adapted to make contact between confronting end surfaces of adjacent arrester elements.

FIG. 1



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Surge arrester

The invention relates to a surge arrester according to the introductory part of claim 1.

In the case of a passage of current, caused by overvoltages, through a surge arrester of the afore-indicated kind, the arrester elements are heated. When the passage of current is of considerable magnitude, the temperature may amount to 150 - 200 °C. In surge arresters which are subjected to such considerable heating, this has reduced the choice of protective housing to a housing which, nearest the arrester elements, consists of a thermosetting resin, for example an epoxy resin in the form of a casting around the arrester elements, or in the form of an epoxy resin impregnated wrapping of a fibre material, such as a woven glass fibre, around the arrester elements. A polymer in the form of a shrinkable hose or a shrinkable tube with projections for extending creep distance may be applied on the thermosetting resin. The provision of such a protective housing is relative expensive and complicated.

The invention aims at a surge arrester of the above-mentioned kind with a protective housing that meets the afore mentioned resistance requirements but can be provided in a considerably simpler way than what has previously been possible.

To achieve this aim the invention suggests a surge arrester according to the introductory part of claim 1, which is characterised by the features of the characterising part of claim 1.

Further developments of the invention are characterised by the features of the additional claims.

According to the invention a protective housing of cross-linked HD (High Density) polyethylene is used, which housing is resistant to deformation under operating conditions for the surge arrester and remains intact when subjected to the influence of arrester elements which have been heated to temperatures of the magnitude stated above.

These favourable results are achieved by arranging, between at least the main part of the arrester elements, heat-absorbing bodies of metallic material which make contact between confronting end surfaces of adjacent arrester elements. The wall thickness of the protective housing is made sufficient, preferably at least 2 mm, for the parts of the protective housing located furthest away from the arrester elements to attain a temperature, during maximum heating of the arrester elements, which is safely below the softening temperature of the cross-linked HD polyethylene, i.e. even if the inside of the protective housing is in contact with an arrester element which is briefly heated to a temperature in the vicinity of 200 °C, the outside is only heated, in the presence of the heat-absorbing bodies, to a temperature safely below 130 °C. The outside is preferably heated to at most around 100 °C. The heat-absorbing bodies have a total length in the longitudinal direction of the protective hous ing which is at least 10% and preferably 15-35% of the total length of the arrester elements in the same direction.

The varistor material in the arrester element may be of a known kind and preferably 70-97 mole per cent thereof consists of ZnO with additives of one or more oxides and/or carbonates of Bi, Sb, Cr, Mn, Co, Ni, Si, B, Ba, Pb, Al, each in an amount of 0.01-10 mole percent. The arrester elements are manufactured from a powder of the varistor material which under known conditions are moulded pressed and sintered into bodies of the desired shape.

The electrodes on the end surfaces of the arrester element may, inter alia, consist of layers of copper or aluminium which have been applied by arc spraying or other spraying of metal, or of varnish layers which are electrically conductive, for example of epoxy resin containing powder of silver. It may also consist of surface layers in the varistor material itself which have been made low-ohmic by laser treatment.

Upon heating, cross-linked HD polyethylene is transformed from crystalline to substantially amorphous state. In the amorphous state, the shape of an object of the polymer material may be changed and, upon cooling, be brought to maintain the changed shape. If the object is heated again, the object resumes its original shape. This property of cross-linked HD polyethylene is utilized when it is applied around the stack of arrester elements disposed on top of each other with the heat-absorbing bodies disposed therebetween.

The cross-linked HD polyethylene is suitably of the kind which is manufactured by silane grafting of linear HD polyethylene and a subsequent cross-linking of the grafted polymer after extrusion or other moulding by the moulded product being subjected to moisture or water so that the hydrolyzable groups in the silane radical are hydrolyzed and provide siloxane bonds between the grafted polyethylene molecules. This cross-linked HD polyethylene has a softening temperature of around 130 °C.

The end electrodes, which like the heat-absorbing bodies may advantageously be of aluminium or copper, are preferably provided with annular recesses or projections, into which and between which, respectively, parts of the protective housing project.

Particularly if the surge arrester is intended for outdoor use, the protective housing is provided on its outside with means extending the creep distance. This can be done by covering the outside of the protective housing with a separate creep distance extending body, supported by the protective housing, preferably a body which, in a known manner, is formed with a plurality of surrounding projections arranged one after the other in the longitudinal direction of the protective housing. It can also be done by forming the outside of the protective housing itself with a plurality of creep distance extending projections arranged one after the other in the longitudinal direction of the protective housing. The projections are then of the same material as the protective housing and form a coherent unit with the rest of the protective housing.

The invention will now be described in greater detail with reference to the accompanying drawings showing - by way of example - in

Figure 1 an axial section through an embodiment of a surge arrester according to the invention without any creep distance extending means,

Figure 2 an axial section through such a surge arrester with a creep distance extending means,

Figure 3 a modification of the surge arrester according to Figure 1.

A tube of cross-linked HD (High Density) polyethylene (silane-grafted), which in one case, selected as example, has an inner diameter of 28 mm and a wall thickness of 3 mm, is placed in a tube of steel or aluminium with an inner diameter of 38 mm. The tubes are heated to 150 °C, whereafter the polyethylene tube is expanded by compressed air supplied to the interior of the polymer tube, so that its outer envelope surface makes allround contact with the inside of the metal tube. Thereafter, the tubes are cooled down in this expanded state of the polymer tube, whereby its inner diameter becomes 32 mm. The expansion of the polyethylene tube can also be performed, inter alia, with a mandrel. After removing the metal tube, a plurality of arrester elements 11 in the form of circular-cylindrical ZnO blocks provided with electrodes 11a alternately with a plurality of heat-absorbing bodies 12 in the form of circular-cylindrical blocks of aluminium are placed, in a stack one after the other, in the tube of HD polyethylene. In its shrunk state the polyethylene tube is designated 10 in the Figures. At each end of the stack an electrode 13 is arranged in the form of a substantially circular-cylindrical block of aluminium. In the exemplified case, the ZnO blocks 11 have a diameter of 30 mm and a height of 47 mm and the aluminium blocks 12 have the same diameter and a height of 15 mm. That part 13a of the aluminium blocks 13 which faces the interior of the surge arrester has a diameter of 30 mm, and that part 13b of the aluminium blocks 13 which faces away from the interior has a diameter of 28 mm. The blocks 13 have a height of 40 mm. They are provided with annular slots or recesses 14 with a depth of 2 mm and, at the end facing the interior of the surge arrester, with a spring 15 which exerts a pressure on a washer 16, made for example, of aluminium. When the stark of the blocks 11, 12 and 13 has been placed in the expanded cross-linked tube of HD polyethylene, the blocks and the tube are heated to a temperature of 150 °C. This causes the tube 10 to shrink so as to make contact with the envelope surfaces of the blocks 11,12,and 13, as is clear from Figure 1, and to penetrate into the slots 14, thus forming a protective housing for the arrester elements. The springs 15 ensure that the blocks 12 and 13, the latter via the washers 16, make contact, with an effective contact pressure, with the electrodes 11a secured to the end surfaces of the ZnO blocks. The electrodes 11a may consist of sprayed-on layers of aluminium. The wall thickness of the tube, after shrinking, is still 3 mm.

That part of the protective housing which makes contact with the part 13b on each end electrode 13 is surrounded with a binding strap or a hose clamp 17 to strengthen the fixing of the protective housing to the end electrodes. Over the outer portion of each end electrode there is arranged a cap 18, for example of aluminium, together with a seal, for example in the form of an O-ring or a sealing compound 19, such as silicone rubber. Finally, the surge arrester is provided with terminals 20. The surge arrester according to Figure 1 is designed for indoor use.

Surge arresters according to the invention, which are designed for outdoor use, are provided, as is clear from Figure 2, with a creep distance extending body 21, which is formed with a plurality of surrounding projections 21a arranged one after the other in the longitudinal direction of the protective housing. The body 21 may be of an elastomer, for example ethylene propylene terpolymer (EPDM rubber) and is passed over the protective housing 10. It may also consist of a shrinking plastic, for example of a cross-linked ethylene-propylene polymer or cross-linked HD polyethylene, applied on the protective housing 10 by shrinkage. The body 21 is applied on the protective housing 10 before the caps 18 are fitted.

According to one embodiment of the invention, a creep distance extending body 21 is formed with the same shape as that shown in Figure 2 as part of the protective housing 10, so that the parts 10 and 21 form a coherent unit of cross-linked HD polyethylene manufactured in one piece. In the forming operation, the protective housing is then provided with a plurality of creep distance extend-

ing projections, arranged one after the other in the longitudinal direction of the protective housing, of a kind analogous to those designated 21a in Figure 2. The protective housing is then preferably manufactured by injection moulding, since a manufacture by extrusion of a thick-walled tube with subsequent milling away of material for forming projections would involve a considerable waste of material.

Figure 3 illustrates an alternative embodiment of the surge arrester according fo Figure 1. The surge arrester shown in Figure 3 may also be used for outdoor use if provided with a creep distance extending body 21 similar to that shown in Figure 2. In accordance with Figure 3, spring elements in the form of disc springs 22 are arranged between the arrester elements 11 and the heat-absorbing bodies 12 and between the arrester elements 11 and the end electrodes 13 to ensure maintenance of an effective contact pressure between the parts 11, 12 and 13 in the entire stack under varying conditions. Instead of cup springs there may be used springs 15 of the kind shown in Figures 1 and 2 which are built into the end electrodes in the manner shown in Figures 1 and 2 and in analogous manner into the heat-absorbing bodies.

Claims

1. A surge arrester comprising a plurality of cylindrical arrester elements (11) of metal oxide varistor material, which are arranged one after the other in the axial direction of the arrester elements between two end electrodes (13) in an elongated protective housing (10) of a plastic material, said protective housing being resistant to deformation under the operating conditions for the surge arrester and making contact with the envelope surface of the arrester elements, the end surfaces of the arrester elements being perpendicular to the axial direction of the arrester elements and provided with electrodes (11a) secured to said arrester elements, **characterized** in that the protective housing consists of cross-linked HD polyethylene and is shrunk onto the arrester elements arranged one after the other and that between at least the main part of the arrester elements heat-absorbing bodies (12) of metallic material are arranged adapted to make contact between confronting end surfaces of adjacent arrester elements.

2. Surge arrester according to claim 1, **characterized** in that the protective housing (19) has a wall thickness of at least 2 mm.

3. Surge arrester according to claim 1 or 2, **characterized** in that the heat-absorbing bodies (12) have a total length in the longitudinal direction of the protective housing (19) which is at least 10% of the total length of the arrester elements (11) in the same direction.

4. Surge arrester according to any of the preceding claims, **characterized** in that the end electrodes (13) are at least substantially cylindrical and that the protective housing is shrunk onto the end electrodes.

5. Surge arrester according to any of the preceding claims, **characterized** in that the end electrodes (13) are provided with annular recesses (14) or projections, into which or between which parts of the protective housing (10) project.

6. Surge arrester according to any of the preceding claims, **characterized** in that the protective housing (10) is covered with a separate creep distance extending body (21), supported by the protective housing, preferably a body which is formed with a plurality of creep distance extending projections (21a) arranged one after the other in the longitudinal direction of the protective housing. (Figure 2).

7. Surge arrester according to any of claims 1 to 5, **characterized** in that the protective housing (10) at the envelope surface is provided with a plurality of creep distance extending projections (21a), arranged one after the other in the longitudinal direction of the protective housing, said projections being of the same material as the protective housing and forming a coherent unit with the rest of the protective housing.

8. Surge arrester according to any of the preceding claims, **characterised** in that spring elements (22) are arranged between the arrester elements (11) and the heat-absorbing bodies (12).

FIG. 1

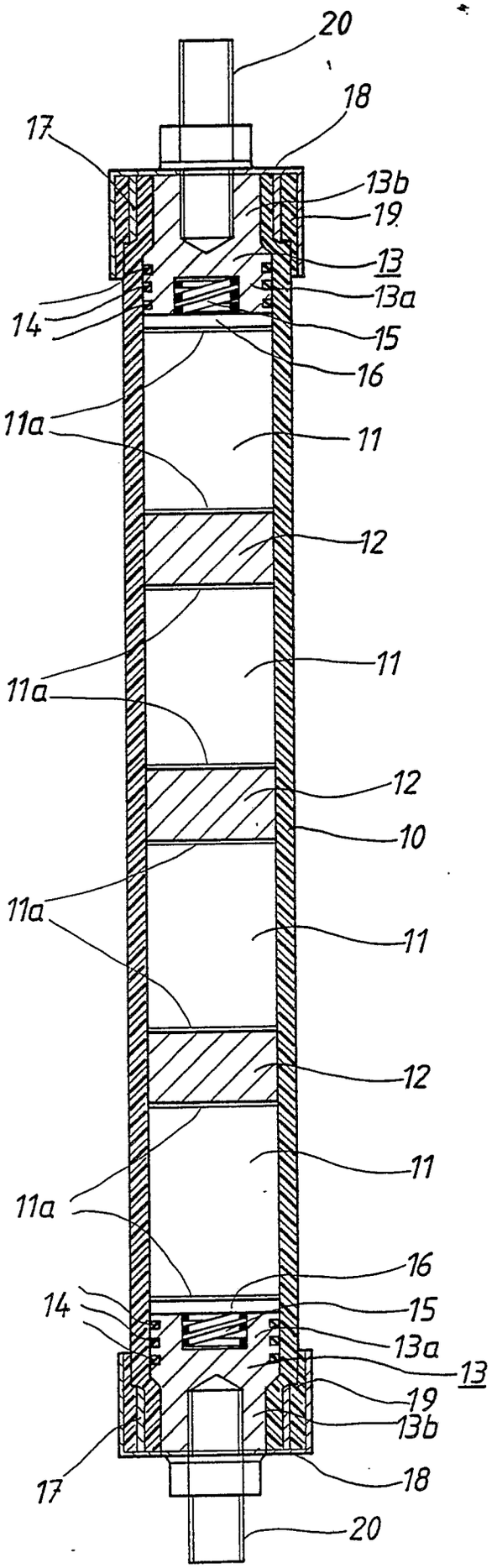

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FIG. 2

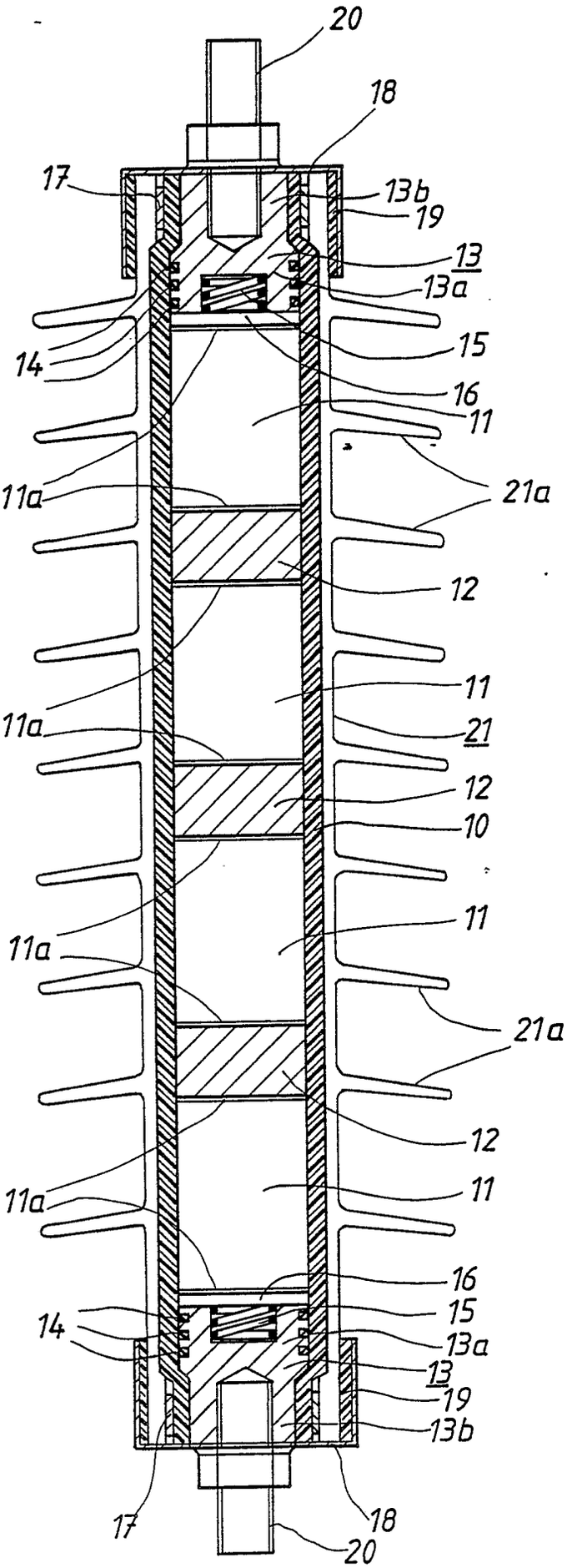
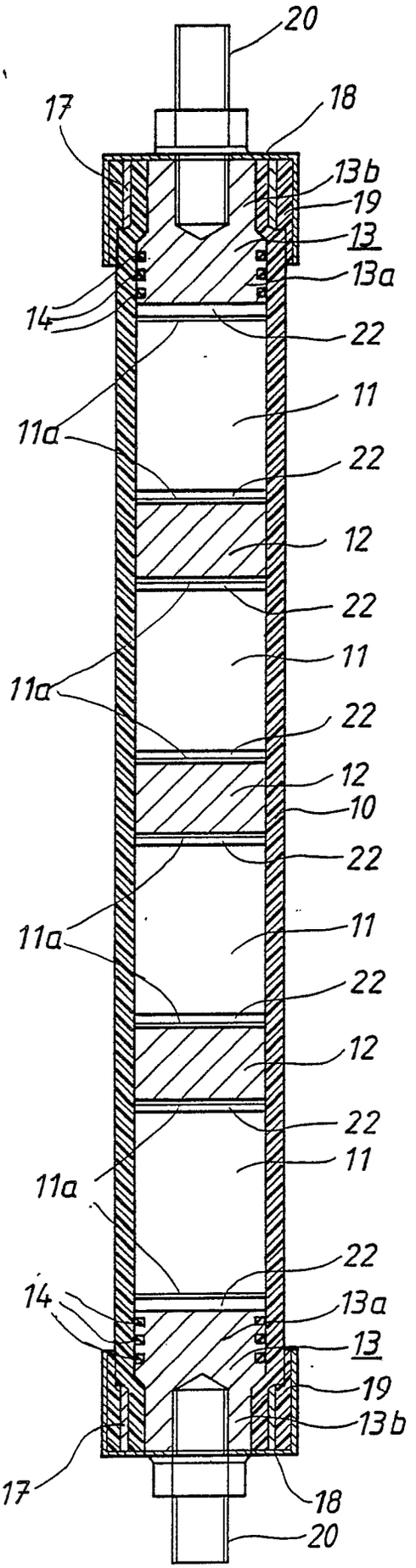

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FIG.3


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EUROPEAN SEARCH REPORT

Application Number

EP 88 12 0326

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	EP-A-0 233 022 (BOWTHORPE EMP LTD) * Claims 1,2,3,7; figure 1 *	1	H 01 C 7/12
Y	EP-A-0 230 103 (RAYCHEM GmbH) * Claims 1,5-8; page 5, paragraph 2; page 6, paragraph 2; page 8, last paragraph - page 9, paragraph 1; figure 1 *	1	
A		6-8	
A	EP-A-0 153 199 (RAYCHEM CORP.)		
A	DE-A-3 002 014 (R.P. BRAGINSKIJ et al.) * Claims 1,2 *	1	
A	GB-A-2 073 965 (BOWTHORPE EMP LTD) * Claims 1,4,6-8; page 1, lines 79-102; figure 1 *	1,4,5,7	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

H 01 C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	11-07-1989	DECANNIERE L.J.

CATEGORY OF CITED DOCUMENTS

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