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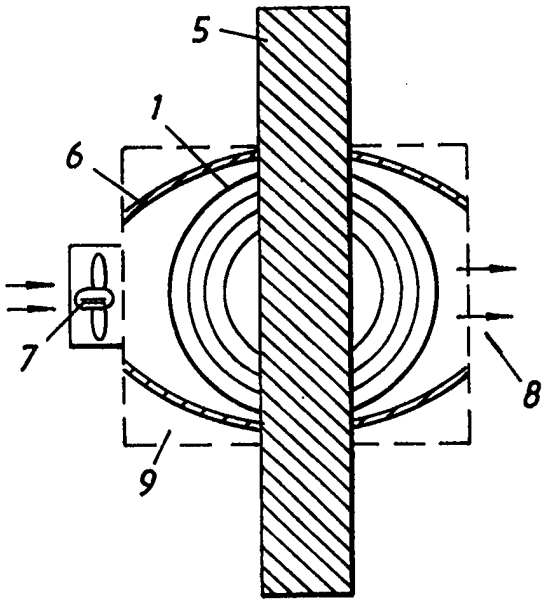
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(54) Title: HORIZONTAL AIR-COOLING IN A TRANSFORMER

(57) Abstract

A power transformer comprising a transformer core wound with a high-voltage cable (111), wherein the cable comprises an electrically conducting core surrounded by an inner semiconducting layer (113), an insulating layer (114) surrounding the inner semiconducting layer (113) and consisting of solid material, and an outer semiconducting layer (115) surrounding the insulating layer, said layers (113, 114, 115) being adhered to each other and that the winding is provided with spacers (3) arranged to separate each cable turn in axial direction in the winding in order to create disc-shaped cooling ducts, said winding being provided with at least one fan (7) arranged to either force or suck air through all turns of the winding perpendicularly to the leg (2) of the transformer core.



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Horizontal air-cooling in a transformer

TECHNICAL FIELD:

The present invention relates to an air-cooled, conductor-wound power transformer and to a method of air-cooling conductor-wound power transformers.

BACKGROUND ART:

Modern power transformers are usually oil-cooled. The core, consisting of a number of core legs joined by yokes, and the windings (primary, secondary, control), are immersed in a closed container filled with oil. Heat generated in coils and core is removed by the oil circulating internally through coils and core. The circulating oil is conveyed out to an external unit where it is cooled. The oil circulation may either be forced, the oil being pumped around, or it may be natural, created by temperature differences in the oil. The circulating oil is cooled externally by arrangements for air-cooling or water-cooling. External air-cooling may be either forced or through natural convection. Besides its role as conveyor of heat, the oil also has an insulating function in oil-cooled transformers for high voltage.

Dry transformers are usually air-cooled. They are usually cooled through natural convection since today's dry transformers are used at low power loads. The present technology relates to axial cooling ducts produced by means of a pleated winding as described in GB 1,147,049, axial ducts for cooling windings embedded in casting resin as described in EP 83107410.9, and the use of cross-current fans at peak loads as described in SE 7303919-0.

The cooling requirement is greater for a conductor-wound power transformer. Forced convection is necessary to satisfy the cooling requirement in all the windings. Natural convection is not sufficient to cool the conductor windings. A short transport route for the heat to the coolant is important, and also that it is efficiently transferred to the coolant. It is

therefore important that all windings are in direct contact with sufficient quantities of coolant.

A conductor is known through US 5 036 165, in which the insulation is provided with an inner and an outer layer of semiconducting pyrolized glassfiber. It is also known to provide conductors in a dynamo-electric machine with such an insulation, as described in US 5 066 881 for instance, where a semiconducting pyrolized glassfiber layer is in contact with the two parallel rods forming the conductor, and the insulation in the stator slots is surrounded by an outer layer of semiconducting pyrolized glassfiber. The pyrolized glassfiber material is described as suitable since it retains its resistivity even after the impregnation treatment.

OBJECT OF THE INVENTION:

The object of the invention is to provide a device according to the present claims, i.e. of the type described in the introduction which will enable air-cooling of a cable-wound power transformer comprising a high-voltage cable of the type presented in the description. The invention aims at producing horizontal cooling ducts between each layer of cables where the coolant is correctly distributed in order to satisfy the cooling requirements of the cable layers. The core and winding are cooled by cooling air flowing radially through horizontal ducts in the winding. The air is distributed in the ducts according to their cooling requirement by varying the height of the horizontal ducts.

SUMMARY OF THE INVENTION:

The present invention relates to a power transformer comprising a transformer core wound with cable, arranged so that the winding is provided with spacers separating each cable turn in axial direction in the winding in order to create cooling ducts.

The invention thus comprises radial disc-shaped cooling ducts between each layer of cable, i.e. each winding turn in axial direction, created by means of spacers arranged in various ways during winding of the coil, as can be seen in the embodiments illustrated. The embodiments also comprise horizontally acting fans for the transport of air through the ducts. It is to be understood that the coolant "air" also can be other gas coolants, such as helium gas.

In a power transformer according to the invention the windings are composed of cables having solid, extruded insulation, of a type now used for power distribution, such as XLPE-cables or cables with EPR-insulation. Such a cable comprises an inner conductor composed of one or more strand parts, an inner semiconducting layer surrounding the conductor, a solid insulating layer surrounding this and an outer semiconducting layer surrounding the insulating layer. Such cables are flexible, which is an important property in this context since the technology for the device according to the invention is based primarily on winding systems in which the winding is formed from cable which is bent during assembly. The flexibility of a XLPE-cable normally corresponds to a radius of curvature of approximately 20 cm for a cable 30 mm in diameter, and a radius of curvature of approximately 65 cm for a cable 80 mm in diameter. In the present application the term "flexible" is used to indicate that the winding is flexible down to a radius of curvature in the order of four times the cable diameter, preferably eight to twelve times the cable diameter.

Windings in the present invention are constructed to retain their properties even when they are bent and when they are subjected to thermal stress during operation. It is vital that the layers retain their adhesion to each other in this context. The material properties of the layers are decisive here, particularly their elasticity and relative coefficients of thermal expansion. In a XLPE-cable, for instance, the

insulating layer consists of cross-linked, low-density polyethylene, and the semiconducting layers consist of polyethylene with soot and metal particles mixed in. Changes in volume as a result of temperature fluctuations are completely absorbed as changes in radius in the cable and, thanks to the comparatively slight difference between the coefficients of thermal expansion in the layers in relation to the elasticity of these materials, the radial expansion can take place without the adhesion between the layers being lost.

The material combinations stated above should be considered only as examples. Other combinations fulfilling the conditions specified and also the condition of being semiconducting, i.e. having resistivity within the range of 10^{-1} - 10^{6} ohm-cm, e.g. 1-500 ohm-cm, or 10-200 ohm-cm, naturally also fall within the scope of the invention.

The insulating lay may consist, for example, of a solid thermoplastic material such as low-density polyethylene (LDPE), high-density polyethylene (HDPE), polypropylene (PP), polybutylene (PB), polymethyl pentene (PMP), cross-linked materials such as cross-linked polyethylene (XLPE), or rubber such as ethylene propylene rubber (EPR) or silicon rubber.

The inner and outer semiconducting layers may be of the same basic material but with particles of conducting material such as soot or metal powder mixed in.

The mechanical properties of these materials, particularly their coefficients of thermal expansion, are affected relatively little by whether soot or metal powder is mixed in or not - at least in the proportions required to achieve the conductivity necessary according to the invention. The insulating layer and the semiconducting layers thus have substantially the same coefficients of thermal expansion.

Ethylene-vinyl-acetate copolymers/nitrile rubber, butyl graft polyethylene, ethylene-butyl-acrylate-copolymers and ethylene-ethyl-acrylate copolymers may also constitute suitable polymers for the semiconducting layers. Even when different types of material are used as base in the various layers, it is desirable for their coefficients of thermal expansion to be substantially the same. This is the case with combination of the materials listed above.

The materials listed above have relatively good elasticity, with an E-modulus of E<500 MPa, preferably <200 MPa. The elasticity is sufficient for any minor differences between the coefficients of thermal expansion for the materials in the layers to be absorbed in the radial direction of the elasticity so that no cracks or other damage appear and so that the layers are not released from each other. The material in the layers is elastic, and the adhesion between the layers is at least of the same magnitude as the weakest of the materials.

The conductivity of the two semiconducting layers is sufficient to substantially equalize the potential along each layer. The conductivity of the outer semiconducting layer is sufficiently large to contain the electrical field in the cable, but sufficiently small not to give rise to significant losses due to currents induced in the longitudinal direction of the layer.

Thus, each of the two semiconducting layers essentially constitutes one equipotential surface, and these layers will substantially enclose the electrical field between them. There is, of course, nothing to prevent one or more additional semiconducting layers being arranged in the insulating layer.

BRIEF DESCRIPTION OF THE DRAWINGS:

The invention will now be described in more detail with reference to the accompanying drawings.

Figure 1a shows a view in perspective of a winding coil in a first embodiment according to the invention showing horizontal ducts between the layers of cable.

Figure 1b shows a corresponding view to that in Figure 1 but including the iron core.

Figure 2a shows a view from above of the first embodiment according to Figure 1, with spacers constituting horizontal ducts for air flowing through at right angles to the spacers.

Figure 2b shows a second embodiment corresponding to Figure 2a but where the spacers are oriented parallel to the direction of flow.

Figure 2c shows a view from above of a third embodiment of the present invention, with four radial spacers forming ducts, with arrows indicating the direction of air flow.

Figure 2d shows a view from above of a fourth embodiment of the present invention having eight radial spacers forming ducts, with arrows indicating the direction of air flow.

Figure 3 shows schematically a radial section through the embodiment according to Figure 2c, with a fan arrangement according to the invention.

Figure 4 shows a section through a high-voltage cable used in the winding coil according to the present invention.

DESCRIPTION OF THE INVENTION:

Figure 1a shows a winding coil 1 arranged with cable. The cable is wound in a disk winding, each new turn being wound radially outside the previously wound layer. The winding coil 1 is wound with spacers 3 inserted between each turn. The spacers are in the form of blocks 30 shaped to abut the outer surface of the cable.

In corresponding manner Figure 1b shows part of a transformer with a cable-wound coil 1, but arranged around a laminated iron core in the form of a leg 2 of the transformer core. The winding coil 1 is wound with spacers 3 as above inserted between each winding turn.

Figure 2 shows windings provided with a different type of spacer, beam-shaped spacers, placed in four different ways. As is clear from Figures 2a-d, the spacers can be arranged in several different ways in order to obtain spaces between the disc-shaped winding turns in order to enable horizontal cooling through the winding coil with the aid of an air flow.

Figure 2a shows a first embodiment corresponding to that shown in Figure 1, in which the spacers 3 are placed between each winding turn with an orientation perpendicular to the flow direction. The spacers are arranged with one spacer diametrically, like the one in the middle of the Figure, and/or as at least one chord through the winding between each winding turn, like the two spacers on each side of the iron core. The spacers are oriented perpendicularly to the direction of flow. The air flow is indicated by arrows in the Figure and is perpendicular to the spacers and horizontal in the case of upright winding coils.

Figure 2b shows a second embodiment substantially identical to that in Figure 2a but with the spacers instead oriented parallel to the direction of flow. The air flow is indicated by arrows in the Figure and is substantially parallel with the spacers in this embodiment.

Figure 2c shows a third embodiment with spacers 3 placed radially outwardly from the iron core between each winding turn. The embodiment is arranged with at least four spacers 3 distributed uniformly around the leg 2 of the transformer core. In this embodiment also, the air flow is indicated by

arrows in the Figure and is directed perpendicularly to the iron core, parallel to two of the spacers and perpendicular to the other two spacers.

Figure 2d shows a fourth embodiment provided with spacers 3 placed radially out from the iron core between each winding turn. In this embodiment eight spacers 3 are distributed uniformly around the leg 2 of the transformer core. In this embodiment also the air flow is indicated by arrows in the Figure and is directed perpendicularly in towards the iron core, parallel with two of the spacers, perpendicular to another two of the spacers and partly parallel to the remaining four spacers. The air flow is the same as in Figure 2c, but around additionally four spacers.

Figure 3 is a view from above of part of a three-phase power transformer provided with windings 1 constituting coils which, by means of the spacers shown above, have been provided with cooling ducts. From the cooling aspect the shape and material of the spacers are of minor significance. The mechanical, magnetic and electrical aspects of the transformer determine the shape, number and material of the spacers. The figure also shows the yoke 5 of the transformer, which constitutes a part of its iron core. The yoke 5 is shown in section and is provided with a laminar structure corresponding to the leg 2 of the transformer core. Each winding coil is also surrounded by a fan cowl 6 inside which cooling air is arranged to flow. At one side of the fan cowl 6 the winding 1 is provided with a fan 7 arranged to either force or suck cooling air through the winding 1. At the side opposite the fan, the fan cowl is provided with an opening 8 which may be shaped in many ways but preferably extends along the entire length of the winding coil. The width of the opening 8 is 0.1 Ø - 0.6 Ø, where Ø is the outer diameter of the coil. The cooling requirement is different for the various turns of the winding, which means that the flows of coolant in the horizontal ducts differ. To achieve a correct distribution of coolant flow the ducts have

different dimensions in axial direction in order to give different resistance in the ducts and thus distribute the flow in accordance with the needs of the ducts. Ducts with little cooling requirement thus have a smaller axial extension than ducts with greater cooling requirement. Arrows indicate a cooling air flow in the Figure, effected by the fan 7 forcing air through the winding coil. The fan cowl 6 is arranged to seal at both ends of the coil against either an end plate 9, indicated in broken lines in Figure 3, or curving in to seal against the outermost winding turn so that cooling air can flow out axially along the leg of the iron core. The embodiment in Figure 3 has one fan per winding coil.

Figure 4 shows a cross-sectional view of a high-voltage cable 111 for use as transformer winding in accordance with the present invention. The high-voltage cable 111 comprises a number of strands 112 of copper (Cu), for instance, having circular cross section. These strands 112 are arranged in the middle of the high-voltage cable 111. Around the strands 112 is a first semi-conducting layer 113. Around the first semi-conducting layer 113 is an insulating layer 114, e.g. XLPE insulation. Around the insulating layer 114 is a second semi-conducting layer 115. Thus the concept "high-voltage cable" in the present application does not include the outer sheath that normally surrounds such cables for power distribution. The high-voltage cable has a diameter within the range of 20-250 mm and a conducting area within the range of 40-3000 mm^2.

The invention is not limited to the examples shown. Several modifications are feasible within the scope of the invention. A fan is not necessary for each coil, for instance. An arrangement is feasible with one fan supplying all three coils with sufficient air. As also indicated above, the air can be either sucked or forced through the coils in order to achieve the desired cooling. Similarly, neither the number of spacers

nor their shape is fixed and several different spacer variants are possible to achieve the correct cooling.

Another modification is to arrange speed control of the fan with the aid of temperature sensors in order to enable a varied cooling requirement, depending on the load in the transformer.

Furthermore, the casing may also be arranged in a number of other ways than shown in the embodiments described above. The outermost cable winding can be used as outer casing and thus cool the outside by means of natural convection. It is also possible to use the uppermost or lowermost cable layer as end plates. The uppermost and lowermost sides of the cable layers would then be cooled through auto-convection.

CLAIMS

1. A power transformer comprising a transformer core, characterized in that the core is wound with a cable and that the cable is a high-voltage cable (111) which is flexible and comprises an electrically conducting core surrounded by an inner semiconducting layer (113), an insulating layer (114) surrounding the inner semiconducting layer (113) and consisting of solid material, and an outer semiconducting layer (115) surrounding the insulating layer, said layers (113, 114, 115) being adhered to each other and that the winding is provided with spacers (3) arranged to separate each cable turn in axial direction in the winding in order to create disc-shaped cooling ducts, said winding being provided with at least one fan (7) arranged to either force or suck air through all turns of the winding perpendicularly to the leg (2) of the transformer core.

2. A power transformer as claimed in claim 1, characterized in that the spacers (3) are in the form of blocks (30) shaped to abut the outer surface of the cable.

3. A power transformer as claimed in claim 1 or claim 2, characterized in that the spacers (3) are arranged radially outwardly from the leg (2) of the transformer core, between each winding turn.

4. A power transformer as claimed in claim 3, characterized in that at least four spacers (3) are distributed uniformly around the leg (2) of the transformer core.

5. A power transformer as claimed in claim 4, characterized in that at least eight spacers (3) are distributed uniformly around the leg (2) of the transformer core.

6. A power transformer as claimed in claim 1, characterized in that the spacers (3) are arranged diametrically and/or as at least one chord through the winding between each winding turn.

7. A power transformer as claimed in claim 6, characterized in that the spacers (3) are oriented either parallel with the flow of cooling air or perpendicular to the flow of cooling air.

8. A power transformer as claimed in any of the preceding claims, characterized in that the transformer coil is provided with an end plate (9) sealing against the uppermost winding turn and an end plate (9) sealing against the lowermost winding turn.

9. A power transformer as claimed in any of claims 1-7, characterized in that the uppermost and lowermost cable layer of the transformer coil form sealing end plates.

10. A power transformer as claimed in claim 8 or claim 9, characterized in that the periphery of the transformer winding is provided with a surrounding fan cowl (6) to which a fan (7) is connected and arranged to either force or suck air through all winding turns perpendicularly to the leg (2) of the transformer core.

11. A power transformer as claimed in any of claims 1-10, characterized in that said layers (113,114,115) are of materials having such elasticity and such coefficient of thermal expansion that the changes in volume in the layers (113,114,115) caused by temperature fluctuations during operation are absorbed by the elasticity of the material, the layers (113,114,115) thus retaining their adhesion to each other upon the temperature fluctuations that occur during operation.

12. A power transformer as claimed in any of claims 1-11, characterized in that the material in said layers (113,114,115) has high elasticity, preferably with a modulus of elasticity less than 500 MPa, preferably less than 200 MPa.

13. A power transformer as claimed in any of claims 1-12, characterized in that the coefficients of thermal expansion for the materials in said layers (113,114,115) are substantially the same.

14. A power transformer as claimed in any of claims 1-13, characterized in that the adhesion between layers (113,114,115) is of at least the same magnitude as in the weakest of the materials.

15. A power transformer as claimed in any of claims 1-14, characterized in that each of the semiconducting layers (113,115) essentially constitutes one equipotential surface.

16. A method for air-cooling a cable-wound power transformer according to any of the previous claims, characterized in that at least one fan (7) forces or sucks air perpendicularly to the leg (2) of the transformer core, between each winding turn.

17. A method as claimed in claim 16, characterized in that spacers (3) are inserted between each turn during the winding procedure of the transformer.

18. A method as claimed in claim 17, characterized in that temperature sensors control the fan speed to produce a suitable flow of air.

Fig. 1b

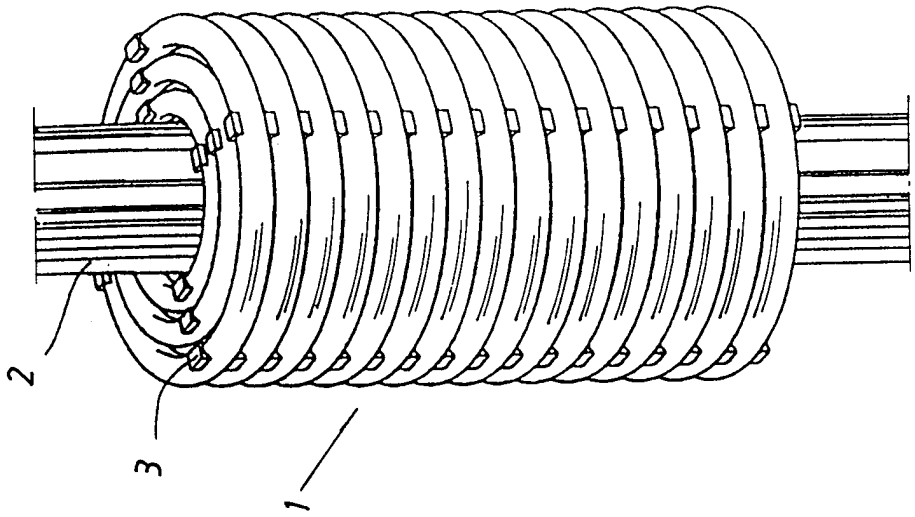


Fig. 1a

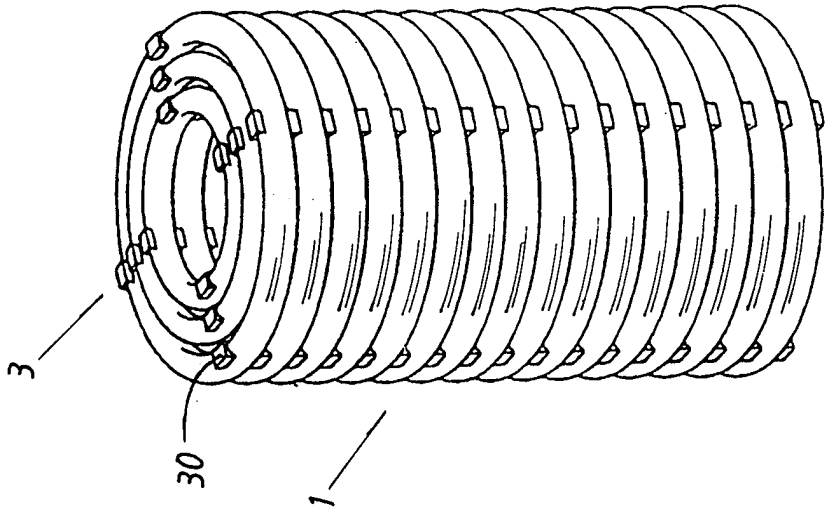


Fig. 2

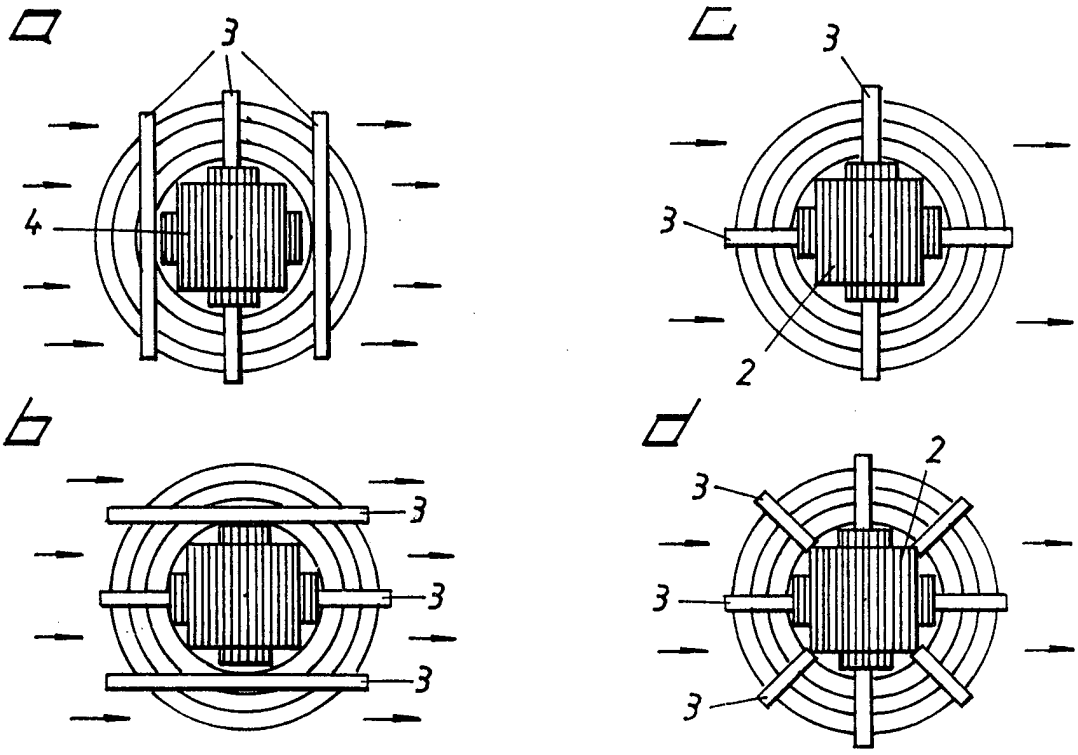


Fig. 3

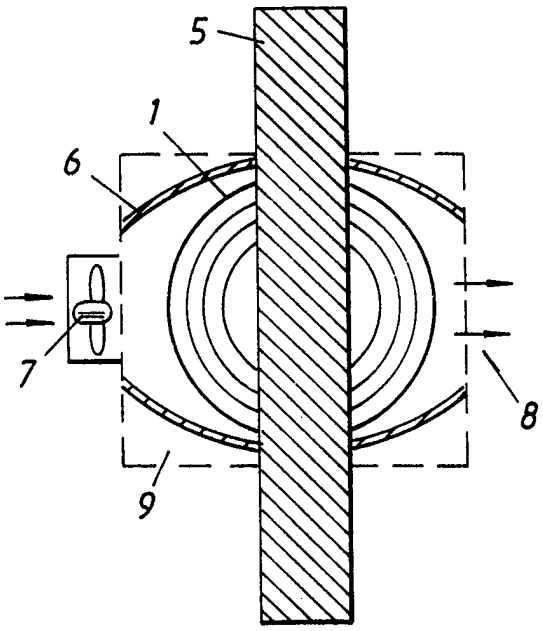
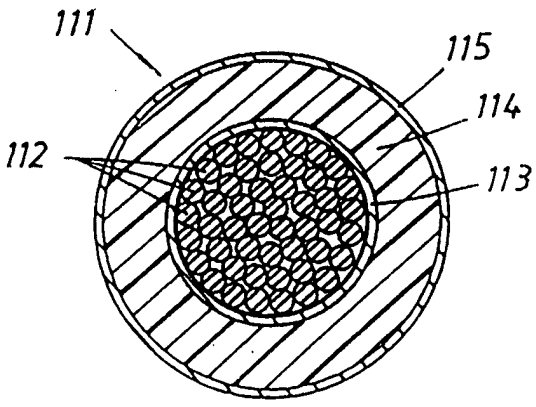


Fig. 4



INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

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B. FIELDS SEARCHED

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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EDOC, WPIL, JAPIO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 1742985 A (L.H. BURNHAM), 7 January 1930 (07.01.30), page 1, line 51 - line 54; page 1, line 68 - line 72, figure 2 --	1
A	US 5036165 A (RICHARD K. ELTON ET AL), 30 July 1991 (30.07.91), abstract --	1

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INTERNATIONAL SEARCH REPORT

Information on patent family members

29/04/98

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 1742985 A	07/01/30	NONE	
US 5036165 A	30/07/91	US 5066881 A	19/11/91
		US 5067046 A	19/11/91
		CA 1245270 A	22/11/88
		US 4853565 A	01/08/89