



(51) International Patent Classification:

H01L 23/427 (2006.01) *F16L 25/02* (2006.01)
H01L 23/473 (2006.01)

(21) International Application Number:

PCT/EP2013/068052

(22) International Filing Date:

2 September 2013 (02.09.2013)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

12186040.7 26 September 2012 (26.09.2012)

EP

(71) Applicant: **ABB TECHNOLOGY AG** [CH/CH]; Affolternstrasse 44, CH-8050 Zürich (CH).

(72) Inventors: **MAUROUX, Jean-Claude**; Junkerngasse 13A, CH-5502 Hunzenschwil (CH). **KAUFMANN, Patrik**; Wiesenstrasse 2, CH-5400 Baden (CH). **GRADINGER, Thomas**; Birkenweg 3, CH-5032 Rohr (CH).

(74) Agent: **INGOLD, Mathias**; ABB Patent Attorneys, Zusammenschluss 154, c/o ABB Schweiz AG, Intellectual Property CH-IP, Brown Boveri Strasse 6 CH-5400 Baden (CH).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: ISOLATING CONDUIT FOR A DIELECTRIC FLUID

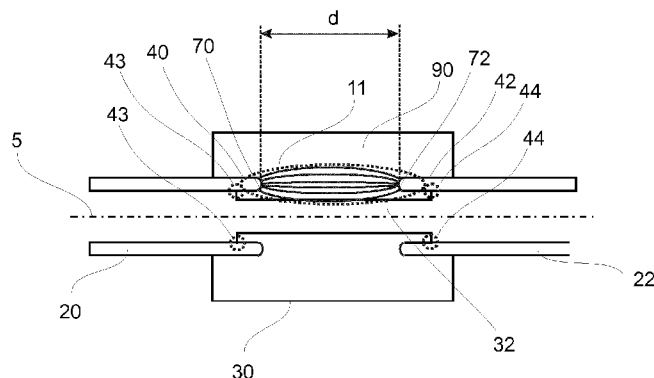


Fig. 2

(57) Abstract: An electric insulating compound conduit (10) for guiding a dielectric cooling fluid for cooling power electronics is provided. It includes a first electrically conductive pipe section (20) having a first pipe end (70) and defining an axis (5), a second electrically conductive pipe section (22) having a second pipe end (72), an electrically insulating conduit section (30), comprising a dielectric material and connecting the first pipe section (20) and the second pipe section (22), together forming a common fluid conduit space (32), wherein a first section (40) of the first pipe section (20) and a second section (42) of the second pipe section (22) are embedded in the insulating material of the insulating conduit section (30), and wherein, when the first pipe section (20) and the second pipe section (22) are on different electric potentials, a region of the highest field strength (11) between the first pipe section (20) and the second pipe section (22) is located inside the dielectric material of the electrically insulating conduit section (30), and is distanced from the fluid conduit space (32) by a distance being at least 5 percent of a minimum distance d between the pipe ends (70, 72). Further, an electric power module employing such a conduit is provided, and a method for producing the conduit (10).

ISOLATING CONDUIT FOR A DIELECTRIC FLUID

TECHNICAL FIELD

[0001] The present disclosure generally relates to cooling systems for electronic and electric components. In particular, it relates to an electrically isolating conduit for guiding a dielectric fluid
5 in a cooling circuit. More particularly, it relates to an isolating compound conduit.

BACKGROUND OF THE INVENTION

[0002] For the cooling of electric and power-electronic systems, passive two-phase cooling by heat pipes or thermosyphons has recently gained attention and importance. These systems are an
10 economic alternative to water cooling, while similar cooling performance is achieved. In contrast to water cooling, the two-phase system can be fully passive i.e., no pump is needed, and hermetically closed. Therefore, essentially no maintenance is required. Since the cooling system is typically a significant part of the overall electrical equipment in terms of cost, reliability and space consumption, advanced cooling solutions can provide a competitive advantage on the market of
15 electrical equipment.

[0003] Applications of two-phase cooling include, for example, cooling of IGBT modules clamped to a plate, cooling of IGCTs clamped together in alternation with coolers in a stack (press pack), cooling of current conductors and contacts of circuit breakers, such as generator circuit breakers (GCB), and cooling of bushings and current conductors of medium voltage (MV) and
20 low voltage (LV) installations. Power electronics building blocks (PEBB) are used in a wide field of applications, for example in voltage conversion. Thereby, particularly in the medium to high voltage range, it is a demanding task to simultaneously fulfill the requirements with respect to heat dissipation, i.e. cooling, and safety against the problem of partial discharges.

[0004] In many of the above applications, it is necessary to electrically insulate different
25 evaporators in a two-phase cooling system from each other, or to insulate the evaporator(s) from the condenser. Often, while the evaporators are on the respective application voltage, the condenser is installed at the outside of the housing and, thus, on ground potential.

[0005] Such a potential separation within a cooling system is known from water cooling with de-ionized (DI) water, typically applied to drives using press-packs of IGBTs. DI water requires technologically complex and costly installations due to the fact that it must constantly be de-ionized and the conductivity monitored. Despite the de-ionization, its conductivity is never exactly zero, and long plastic tubes between components on different voltage must therefore be provided to keep the parasitic electrical currents through the water low enough.

[0006] In two-phase cooling, the electrical insulation between evaporator(s) and condenser(s) is achieved by means of an insulated tubing section(s) and a dielectric cooling liquid (like e.g. HFE-7100, R134a, R245fa). Because the evaporators and the condensers are typically manufactured from aluminum, one would like to have the ductwork also made of aluminum, in order to avoid galvanic corrosion and thermal stress. Thereby, it is a demanding task to insert an electrically insulating section having different physical characteristics (e.g. thermal expansion coefficient) within those aluminum components, that is typically between two aluminum pipes.

[0007] In view of the above, there is a need for an insulating conduit which is usable in two-phase cooling and avoids the disadvantages of the known solutions.

SUMMARY OF THE INVENTION

[0008] The problems mentioned above are at least partly solved by an insulating compound conduit according to claim 1 and a method for producing the same according to claim 13.

[0009] In a first aspect, an electric insulating compound conduit for guiding a dielectric cooling fluid for cooling power electronics is provided. It includes a first electrically conductive pipe section having a first pipe end and defining an axis, a second electrically conductive pipe section having a second pipe end, an electrically insulating conduit section, comprising a dielectric material and connecting the first pipe section and the second pipe section, together forming a common fluid conduit space, wherein a first section of the first pipe section and a second section of the second pipe section are embedded in the insulating material of the insulating conduit section, and wherein, when the first pipe section and the second pipe section are on different electric potentials, a region of the highest field strength between the first pipe section and the second pipe section is located inside the dielectric material of the electrically insulating conduit

section, and is distanced from the fluid conduit space by a distance being at least 5 percent of a minimum distance d between the pipe ends.

[0010] In a further aspect, an electrical power module is provided. It includes electronic components, and a first portion of a two-phase cooling system for cooling the electronic components, including evaporators and an electric insulating compound conduit for guiding a dielectric cooling fluid, comprising a first electrically conductive pipe section having a first pipe end and defining an axis, a second electrically conductive pipe section having a second pipe end, an electrically insulating conduit section, comprising a dielectric material and connecting the first pipe section and the second pipe section, together forming a common fluid conduit space, wherein a first section of the first pipe section and a second section of the second pipe section are embedded in the insulating material of the insulating conduit section, and wherein, when the first pipe section and the second pipe section are on different electric potentials, a region of the highest field strength between the first pipe section and the second pipe section is located inside the dielectric material of the electrically insulating conduit section and is distanced from the fluid conduit space by a distance being at least 5 percent of a minimum distance d between the pipe ends.

[0011] In a further aspect, a high voltage, a high current or a medium voltage installation are provided depending on the requirements. Said installation comprises a current conductor, and a first portion of a two-phase cooling system for cooling the current conductor wherein the first portion includes an evaporator. The two-phase cooling system comprises an electric insulating compound conduit for guiding a dielectric cooling fluid. Said electric insulating compound conduit in turn comprises a first electrically conductive pipe section having a first pipe end and defining an axis (5), a second electrically conductive pipe section having a second pipe end, plus an electrically insulating conduit section comprising a dielectric material and connecting the first pipe section and the second pipe section together such that a common fluid conduit space is formed. Again, a first section of the first pipe section and a second section of the second pipe section are embedded in the insulating material of the insulating conduit section such that when the first pipe section and the second pipe section are on different electric potentials in an operating state of the installation, a region of the highest field strength between the first pipe section and the second pipe section is located inside the dielectric material of the electrically insulating conduit

section and is distanced from the fluid conduit space by a distance being at least 5 percent of a minimum distance d between the pipe ends.

[0012] In a yet further aspect, a method for producing an insulating conduit is provided. It includes providing first and second electrically conductive pipe sections, providing a mold,
5 placing the first and second pipe sections in the mold, molding the insulating conduit by applying a mold mass, thus forming an electrically insulating compound conduit section, comprising a dielectric material and connecting the first and second pipe sections, together forming a fluid conduit space, wherein a first section of the first pipe section and a second section of the second pipe section are embedded in the insulating material of the insulating conduit section during the
10 molding.

[0013] Further aspects, advantages and features of the present invention are apparent from the dependent claims, the description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] A full and enabling disclosure, including the best mode thereof, to one of ordinary skill in the art is set forth more particularly in the remainder of the specification, including reference to
15 the accompanying figures wherein:

Fig. 1 schematically shows a cross sectional view of an exemplary insulating conduit;

Fig. 2 schematically shows a cross-sectional side view of an insulating compound conduit according to embodiments;

Fig. 3 schematically shows a cross-sectional side view of an insulating compound conduit
20 according to further embodiments;

Fig. 4 schematically shows a perspective view of the conduit of Fig. 3;

Fig. 5 schematically shows a cross-sectional perspective view of an insulating compound conduit according to embodiments;

Fig. 6 schematically shows a cross-sectional perspective view of an insulating compound conduit according to embodiments;

Fig. 7 schematically shows a cross-sectional side view of an insulating compound conduit in the form of a manifold with four pipes, according to embodiments.

- 5 Fig. 8 schematically shows a cross-sectional side view of an insulating compound conduit in the form of a T-junction with three pipes, according to embodiments.

Fig. 9 schematically shows an electrical power module according to embodiments.

Fig. 10 shows a sectional view of a generator circuit breaker wherein the sectional plane extends transversally to a switching axis defined by the generator circuit breaker.

- 10 Fig. 11 shows a longitudinal section along a switching axis through the generator circuit breaker of Fig. 10 comprising several insulating compound conduits according to the present invention.

Fig. 12 schematically shows the effects of various electrode shapes on electric fields.

DETAILED DESCRIPTION OF THE INVENTION

- [0015] Reference will now be made in detail to various embodiments, one or more examples of which are illustrated in each figure. Each example is provided by way of explanation and is not
15 meant as a limitation. For example, features illustrated or described as part of one embodiment can be used on or in conjunction with other embodiments to yield yet further embodiments. It is intended that the present disclosure includes such modifications and variations.

- [0016] Within the following description of the drawings, the same reference numbers refer to the same components. Generally, only the differences with respect to the individual embodiments are
20 described. When several identical items or parts appear in a figure, not all of the parts have reference numerals in order to simplify the appearance. Cross-hatching is applied to some figures only, which is due to illustrational purposes.

- [0017] The systems and methods described herein are not limited to the specific embodiments described, but rather, components of the systems and/or steps of the methods may be utilized

independently and separately from other components and/or steps described herein. Rather, the exemplary embodiment can be implemented and used in connection with many other applications.

[0018] Although specific features of various embodiments of the invention may be shown in some drawings and not in others, this is for convenience only. In accordance with the principles of the invention, any feature of a drawing may be referenced and/or claimed in combination with any feature of any other drawing.

[0019] As used herein, the term “electrical power module” may be a power converter or the like and include power electronic components and at least a part of a cooling system, and is understood to be an electrical device having a block voltage of about at least 500 Volts. The term “power electronic components” is used hereinafter for diodes, thyristors and other semiconductor elements whose block-voltage is more than 500 Volts, such that they can be used in an electric power module, e.g. for a drive or converter of a mill, a vehicle and the like.

[0020] As used herein, the term “fluid” is intended to be a dielectric coolant, wherein the coolant fluid may be a gas and/or a liquid. Thus, in a two-phase cooling system as referred to herein, a fluid may refer to both the coolant in its liquid and its gaseous phase, or “fluid” may refer to a mixture of the former, meaning that both phases are present in coexistence. Thereby, typically the coolant fluid in its liquid form may be transformed to the gaseous phase by the take-up of thermal energy, e.g., by cooling an electronic device with the coolant, and the gaseous phase may be transformed back into the liquid phase by removing energy from the gas, for example in a condenser. During this transformation process, both phases typically coexist. Therefore, in a two-phase cooling system as described herein, there are typically regions in the cooling system where both phases coexist. This may also be the case in the insulating conduit according to embodiments, which will be referred to further below.

[0021] The condensate could be returned towards the evaporator by an electric insulating tube nested inside of the conduit. Therefore the upwards and downwards flows of fluid could be separated in separate spaces in the tube, enabling an increase in heat throughput or/and reduction in size of the conduit cross-section. This additional tube would also be nested inside the insulating compound conduit.

[0022] Further, as used herein, the term “operational state” of the insulating compound conduit is defined as a state where a voltage is applied between the pipes, which is isolated by the dielectric material of the insulating section, and wherein a coolant is present in the conduit.

[0023] Further, as used herein, an expression of the form “an element is embedded in a material” is intended to mean that a part of the element is surrounded by the material. As an example, a rod is being dipped vertically into a resin for half of its length, and the resin is cured. Afterwards, the half of the rod is in this sense regarded to be “embedded in the resin”. Similarly, an end portion or section of an electrode or tube can be embedded in a resin, meaning that a significant part of the surface of the respective part or electrode section is covered by resin, wherein a tube type electrode typically has an inner channel left out. An electrode end portion may also be regarded as embedded as defined herein, if the embedding isolating material is in some regions of the electrode surface only a thin layer, e.g. 1 mm or more thick, or 3 mm or more thick. In particular, embedded means, that the outer surface and the inner surface of a tube or pipe section is covered by material.

[0024] As used herein, the expression “field-enhancement factor” (FEF) is defined to be a scalar value attributed to a geometrical spot or region in an electric field, the value being calculated as the local field strength at this location (or region) divided by the nominal field strength between the electrodes. Thereby, the nominal field is the voltage between two electrodes divided by the distance between the electrodes. In a real electric field, the field enhancement factor often varies between different locations in the field. Of particular interest for the present disclosure is a spot or a geometrical region in an electric field having the largest field enhancement factor, that is, the region where the greatest field strengths occur. For reasons of operational safety and to prevent partial discharges, it can be an aim to minimize the FEF over the whole volume of the electric field, such that peaks in the electric field connected to peaks in the FEF are reduced, or ideally eliminated entirely. In the present disclosure, the insulating compound conduit is designed such that the highest FEF, and thus the highest field strengths, are located within the insulating material in which the electrodes are embedded, and thus, that the fluid flowing through the conduit is not exposed to the highest field strengths. The spot or region of the highest field strengths between the electrodes is thereby distanced from the fluid conduit by a safety distance. Typically, this distance

is greater than 5, more typically greater than 10, even more typically greater than 20 percent of the smallest distance between the electrodes.

[0025] In an idealized model or case, the field between two electrodes is absolutely homogeneous, and the resulting field enhancement factor (FEF) is 1, corresponding to no enhancement at all. In most, actually nearly all technical use cases, the field enhancement factor is greater than 1 at least for a part of the volume of the electric field. Thereby, it may be difficult to calculate the electrode distance for some cases, if the electrodes do not exhibit a symmetrical structure. However, in the embodiments disclosed herein, the electrodes are usually shaped such that the electrode distance may be precisely determined, and thus the enhancement factor may either be simulated by a dedicated computer simulation software or be determined experimentally. It shall, however, be added that in cases where no exact electrode distance can be determined for some reason, it is still possible to determine the FEF for various locations of the electric field, when a reference value for the nominal field strength is defined which is estimated on the basis of the geometry of the electrodes and the applied voltage, or which can alternatively be measured at locations estimated by the skilled person to be representative for the nominal field strength.

[0026] Generally, embodiments of the invention disclosed herein pertain to an electrically insulating pipe section, also called insulating compound conduit. Thereby, the insulating part typically, but not necessarily includes epoxy, i.e., a filled epoxy resin, which is joined to end portions of metallic pipes. In the following, these pipe ends or end sections are also called electrodes. They typically include metal, such as aluminum, copper, steel, or metal alloys, or may include non-metallic conducting materials, or combinations of the former. If required, the electrically insulating conduit section may comprise Polyarylsulphones (PSU) or Polyether ether ketone (PEEK) in alternative embodiments.

[0027] In embodiments, the electrodes are cast in epoxy resin, which after curing embodies the insulating section, also called insulator. This allows to omit a step of gluing the electrodes into the insulator, and thus to ease the process of manufacturing. In contrast to gluing, the casting of the epoxy insulator and the adhesion with the electrodes are performed in one process step. In order to improve the adhesive strength between the electrodes and the epoxy insulator, the electrode's surfaces may be pretreated before casting, e.g., by sand blasting, plasma treatment, etching, or

another technique suitable to make the surface more prone to adhesion with the epoxy material. Additionally or alternatively to the pretreatment, an additional bonding agent between the epoxy resin and the electrodes may be used, such as a glue. Typically, a portion of the insulating material protrudes into the ends of the pipes, such that a part of the interior surface of the metallic pipes is
5 covered with dielectric material, shielding it from the fluid conduit in the middle of the conduit.

[0028] In embodiments, the insulator can be made by automatic pressure gelling (APG). More generally, the insulator includes a plastic. It can be made, e.g., by injection molding of a thermoplastic, or any suitable casting process, e.g. vacuum-casting, known to the skilled person.

[0029] In embodiments, the electrodes have a field shaping geometry which serves to lower the
10 field enhancement factor in the volume between the electrodes, thus they are field shaping electrodes. This may be typically achieved by electrodes having a rounded shape at their ends. For example, a toroidal shape can be provided. Thereby, the end portions of the electrodes are tori, which are embedded in the insulator after the production process, and which typically have a larger diameter than the rest of the electrode protruding out of the insulator. The electrodes are
15 fully surrounded by the insulation material, such that high field peaks in the surrounding air or in the fluid are avoided. These toroidal end portions are surrounded by the insulating material, such that the region of the highest field strengths is entirely located inside the insulator, when a voltage is applied between the electrodes. As the absolute field strength typically has a maximum value in this region between the electrodes, due to the distance between the electrodes having a minimum,
20 the position(s) of the maximum of the electric field is maintained inside the insulating material of the insulator. Thus, the conduit portion for the fluid is kept free of the high field strength, so that the coolant is not exerted to high field strengths which might promote partial discharges inside the dielectric coolant and degrade it, that is the dielectric coolant may be modified to have an undesirable higher conductivity. The shape having toroidal end portions embedded in the epoxy
25 insulator makes the insulator suitable for higher voltages, as occur in medium-voltage drives or circuit breakers.

[0030] Further, with the configuration described above, the triple line, which is herein defined to include the adjacent locations where the three materials of the insulator, the electrode and the fluid material (when present during operation) are in physical contact with each other, is in a region

having a lower field strength than between the end portions of the electrodes. Differently said, the triple region is in the field shadow of the field-shaping torus, or another type of field-shaping geometry at the end portion of the electrodes. Thereby, field enhancement at the triple region, meaning a high FEF, and its negative consequences are strongly reduced. This is of particular relevancy, as a high field strength at the triple region might lead to partial discharges in that region, leading to undesirable effects caused by the discharges close to or in the dielectric coolant fluid, such as degradation of the fluid worsening its dielectric properties. Further, corrosive side effects on the conduit wall being of metal and the insulating material at this location might occur due to high local field strengths and partial discharges.

10 [0031] In embodiments, the axial length of the insulator, i.e. the distance between the electrodes can be variable according to the voltage that has to be insulated, and the dielectric properties of the dielectric material.

[0032] In embodiments, the electrodes may feature a geometry located at their distal end with respect to the center of the insulating conduit, such as a ring with a circumferential groove, to receive an O-ring for sealing against the casting mold on the outside. This geometry has a diameter basically similar to the diameter of the end portions of the electrodes, so that the O-ring fitting thereon has a diameter sufficiently large such that it can be slid over the electrode from its field-shaping end portion, e.g. the torus described above. The O-ring may be needed for sealing during the molding process, such that the electrodes do not have to be processed with narrow tolerances of the outer diameter of the aluminum tube - which would make the machining of the aluminum part more costly.

[0033] In embodiments, the insulating conduit section has a substantially constant inner channel diameter, or the diameter of the fluid conduit, to yield a low flow resistance for the fluid. That is, the insulator is designed with a hollow tube portion between the electrodes, which has substantially the same inner diameter as the inner diameter of the electrodes, such that there is no flow constriction caused by the insulating conduit. "Substantially" means that there may be a slight taper of the walls of the fluid passage, typically less than 3°, more typically less than 2°, even more typically less than 1° in the surface of the epoxy insulator towards the fluid passage, which enables that cores of a mold can be pulled out of the fluid passage after molding. Hence, the

inner diameter of the fluid passage is minimal in the middle – with respect to the longitudinal axis - of the conduit. A low flow resistance is particularly useful in passive two-phase cooling, because in this case, the fluid motion is kept up only by gravitational forces. The fluid passage further typically features a smooth transition at the triple line, where the insulating material, the electrodes and the fluid (in operation) are in contact, smooth being defined that there is no change in the inner diameter of the fluid passage at the triple line.

[0034] In embodiments, the insulating section may have ripples on the outside in order to increase the creepage distance on the outside, that is, air side. Expressed differently, the insulating section may include, in an axial direction, alternating larger and smaller diameters to increase a creepage distance between the first pipe section and the second pipe section. The ripples may be cast or formed by an additional outer tube, for example by shrinking a silicone ripple tube onto the cast insulator. Further, diffusion-proof layers, such as, e.g., glass or aluminum, may be embedded in the cast for the insulator, in order to reduce the long term permeation (i.e. diffusion) of the coolant through the material, or of gas or moisture from the surroundings into the coolant.

[0035] In embodiments, layers of a fibrous material, e.g., glass-fiber or carbon fiber, may be embedded into the insulating material during casting, in order to improve the mechanical strength of the insulator and thus of the insulating conduit. The layers may be applied on the outer surface of the insulator, hence they may be placed into the mold before casting. Additionally or alternatively, they may be added to the molded material during the production of the insulating section, which might involve interruption of the casting process, or conducting the casting in a two-stage-process. That is, in between the two stages, the fiber material is placed around the part of the insulator already casted, and then the outer layer of resin material or plastic is added to that part.

[0036] The insulator according to embodiments may be employed in any type of cooling system, that is, one phase and two-phase systems, the latter being either passive and thus gravity driven, or active, which means using a pump for circulating the dielectric coolant. In a two-phase system, the conduit section, including the electrodes/pipes and the insulator, may typically comprise a mixture between gaseous coolant and liquid coolant. The return flow of condensate towards the evaporator could be separated by a nested electric insulating tube from the fluid. In embodiments,

the fluid passage of the conduit may comprise a gaseous fluid, a liquid fluid, or a mixture of both phases in any combination of both fractions.

[0037] Fig. 1 shows an insulating conduit according to conventional technology. The end portions of the pipes 20, 22 are in contact with the fluid conduit 32 over their entire length. An applied voltage between the pipes 20, 22 in this case leads to an electric field which to a significant part protrudes with relatively high field strengths inside the fluid conduit 32, such that a region 11 with high field strengths is located very close to or partly in the fluid conduit 32. Moreover, the triple region 43, 44 (in the center of the dashed circles), where the pipes 20, 22, the insulating material 30 and the fluid conduit space 32 are in physical contact with each other, is located at the ends of the pipes 20, 22 in this example. At this geometrical region, there are also high field strengths, when the pipes 20, 22 are on different electrical potentials. However, high field strength in the conduit fluid passage 32 and at the triple point(s) 28 are undesirable due to various negative side effects mentioned above. The region 11 only schematically shows a region with high field strengths, the electric field is also present in the space outside region 11.

[0038] Fig. 2 shows an electric insulating compound conduit 10 for guiding a dielectric cooling fluid for cooling power electronics according to embodiments. The compound conduit 10 includes a first electrically conductive pipe section 20, which defines an axis 5, with a first pipe end 70. Further, it includes a second electrically conductive pipe section 22 having a second pipe end 72. An electrically insulating conduit section 30 includes a dielectric material and connects the first pipe section 20 and the second pipe section 22, whereby a common fluid conduit space 32 is formed by the first and second pipe sections and the electrically insulating section 30. A first section 40 of the first pipe section 20, and a second section 42 of the second pipe section 22 are thereby embedded in the insulating material of the insulating conduit section 30. When the first pipe section 20 and the second pipe section 22 are on different electric potentials, a region of the highest field strength between the first pipe section 20 and the second pipe section 22 is located inside the dielectric material of the electrically insulating conduit section 30. In Fig. 2, the region of the highest electrical field strength is located around a straight line between the ends 70, 72 of the pipe sections 20, 22 having rounded edges. According to embodiments, the region is typically distanced from the fluid conduit space 32 by a distance being at least 5 percent, more typically more than 10 percent, even more typically more than 20 percent of a minimum distance d between

the pipe ends 70, 72. The triple regions 43, 44 are situated in the field shadows of the pipe ends 70, 72 when the first pipe section 20 and the second pipe section 22 are on different electric potentials.

[0039] A region having the highest field strengths may be determined by computational simulation methods known to a skilled person. For example, a model of the insulating compound conduit and the surrounding space may be modeled by small cubes having a volume of, e.g., 0,5 mm³, 1 mm³, 2 mm³, 4 mm³, or the likes. An electric field between the electrodes 20, 22 is simulated and the average field strength in each cube of the simulated space (compound conduit plus surrounding air) is calculated. Then, a region made up by the cubes having the highest field strength values, for example 1, 2, or 5 percent of the cubes with the highest average values, is marked in a visual representation. In Fig. 2, for example, this method will yield a substantially straight region with the highest field strengths between the electrode ends 70, 72, which is a two dimensional representation of a region having a substantially cylindrical shape in a three dimensional view, due to the tube like rotational symmetry of the pipe sections 20, 22. This marked region representing the highest calculated field strengths is distanced from the fluid conduit 32 as described before.

[0040] In Fig. 3, an insulating compound conduit 10 according to embodiments is shown. It includes two electrodes or pipe sections 20, 22 having a pipe shape, or round tubular shape, and the insulator 30 (herein also called insulating conduit section) in which end portions of the pipes 20, 22 are embedded, henceforth called first and second sections 40, 42. A first section 40 of the first pipe 20 and a second section 42 of the second pipe 22 are embedded in the insulating material of the insulating conduit section 30. Typically, a portion 38 of the electrically insulating conduit section 30 extends into the interior space of a pipe end 70, 72. Thereby, the dielectric material of the insulator 30 extends into the interior of the pipe sections 20, 22 for a distance being at least 5 percent, more typically 10 percent, even more typically at least 20 percent, of the length of the first and second sections 40, 42 in an axial direction of the pipe sections 20, 22. Thereby, an outer surface and an inner surface of the pipe sections is covered by, or adjacent to, the insulating material. The length of the first and second sections 40, 42 is thereby measured from the entry of the pipe section 20, 22 into the dielectric material of the insulating conduit section 30, to the plane

defined by the end 70, 72 of the pipe sections 20, 22 projected on the axis of the respective pipe sections 20, 22.

[0041] The first and second sections 40, 42 of the pipes 20, 22 are arranged with respect to the insulating conduit section 30 such that, when a voltage is applied between the conductive pipes 20, 22, a location of the greatest electric field strength is typically located inside the dielectric material - and is at the same time distanced from a fluid conduit space 32 by a distance being at least 5 percent, more typically more than 10 percent, even more typically more than 20 percent of the minimum distance d between the pipe ends 70, 72. The regions 11 in which the highest field strengths typically occur is - only schematically for illustrational purposes - marked by dashed elliptical outlines in Fig. 2 and 3. Methods for calculating field strengths in compound conduits are well known to the skilled person and include computerized simulation methods for electric fields. Further, it can be seen that a triple region 43, 44 where the metal of the pipe, the insulating material and the fluid in conduit 32 can come in contact during operation - marked exemplarily with the dashed circles 43, 44 in Fig. 3 - is distanced from the region (exemplarily shown with dashed outline 11) with the highest field strengths. Thus, this region is kept free of particularly high fields, and thus reactions in the fluid caused by partial discharges are avoided. Thus, a long term stability of the compound conduit is improved. For illustrational purposes only, the triple regions 43, 44 are marked with circles on the cross section, whereas it is understood that the triple regions typically protrude in a circular manner in a circumferential direction at the boundary between pipe, insulating material and the conduit space. Typically, in embodiments, the distance between the pipe ends 70, 72 is smaller than the distance between the respective triple regions 43, 44. As a result, when a voltage difference is applied between the pipes 20, 22, the triple regions 43, 44 are in the field shadow of the pipe ends 20, 22, and thus exhibit a significantly lower field strength than in the region of the maximum field (region exemplarily shown by dashed elliptical line 11 in Fig. 3) between the pipe ends 20, 22. In embodiments, at least one of the first pipe section 20 and the second pipe section 22 comprises an element 23 on its outer surface, which secures the pipe section against axial turning in the insulating compound section 30. This increases overall mechanical stability of the compound conduit 10, which is also achieved by the increasing diameters of the pipe sections, respectively their funnel shape, as described below.

[0042] In embodiments, the embedded sections 40, 42 of the pipes comprise a section with a diameter increasing in a direction towards the center of the insulating conduit section 30, as can be seen in Fig. 3. Typically, the diameter of the insulating compound conduit 10 increases continuously over at least 5 percent, more typically more than 10 percent, more typically more than 20 percent, yet even more typically more than 30 percent of the length of the embedded section 40, 42. In embodiments, a floating field control element 41 may be located between the first pipe end 70 and the second pipe end 72, in order to further homogenize or modify the electric field in the insulating material.

[0043] In embodiments, the first and second sections 40, 42 of the pipe sections 20, 22 have a funnel-shaped section. Further, there may be field control electrodes to minimize peak values of an electric field strength when the first pipe section 20 and the second pipe section 22 are on different electric potentials.

[0044] Fig. 4 shows a perspective view of a compound conduit 10 according to embodiments.

[0045] Fig. 5 shows a cross-sectional view of a further insulating compound conduit 10 according to embodiments. It includes a first electrically conductive pipe 20, a second electrically conductive pipe 22, and the electrically insulating conduit section 30, which comprises a dielectric material and connects the two pipe sections 20, 22. Thereby, an end portion 40 of the first pipe 20 and an end portion 42 of the second pipe 22 are embedded in the insulating material of the insulating conduit section 30. The end portions are arranged in a manner, such that the area of the highest electric field is located inside the dielectric material of the insulating conduit section 30, when a voltage is applied between the first pipe 20 and the second pipe 22.

[0046] In embodiments, the embedded sections 40, 42 may have a substantially conically shaped end section, wherein the largest diameter of the cone is situated at the ends 70, 72 of the pipe 20, 22. The cones each comprise a rim located at the ends 70, 72 of the pipes 20, 22. The rim section typically has a greater material thickness than other sections of the cone. In embodiments, the rim section may have the shape of a torus or ring which forms the end of the pipe section towards the center of the electrically insulating conduit section 30. Such a configuration according to embodiments is exemplarily shown in Fig. 6.

[0047] In embodiments, the electrically insulating conduit section 30 may comprise at least one of thermosets, thermoplastics, and elastomer, or combinations of the former, with and without filler. The material may be mechanically strengthened by e.g. glass-fibre nets, isolated metallic rings, or mechanically protected by e.g. an outer silicone layer.

5 [0048] In embodiments, the insulating compound conduit 10 further has isolated, conducting, concentric layer(s), which are adapted to control the electric field.

[0049] In embodiments, an outer surface of the insulating section may have a waved shape to increase a creepage distance between the electrodes 20, 22, hence, the insulating section 30 may include, in an axial direction, alternating larger and smaller diameters to increase a creepage
10 distance between the first pipe section 20 and the second pipe section 22.

[0050] In embodiments, more than two electrodes or conductive pipes 20, 22 are embedded in the insulating material. That is, the insulating compound conduit 10 comprises at least three conductive pipes 20, 22, 24 embedded in the conduit section 30. Thereby, the insulating compound conduit 10 can for example be (non-limiting) a manifold, or a T-junction. This is
15 exemplarily shown in Fig. 7 for four electrodes 20, 22, 24, 26 arranged in form of a manifold, wherein the pipes 22, 24, 26 may together serve as an inlet for the coolant fluid. These electrodes may all be on different potentials, different from ground, wherein pipe 20 is connected to ground. Fig. 78 shows an insulating compound conduit 10 with three pipes or electrodes 20, 22, 24 arranged in form of a T-junction, wherein the inflow of the coolant fluid is typically through pipes
20 22, 24, and pipe 20 is grounded (all electrical potentials provided are non-limiting examples).

[0051] In Fig. 9, an electrical power module 100 according to embodiments is shown. It includes electronic components 102 and a first portion of a two-phase cooling system for cooling the electronic components 102, which includes evaporators 104 and at least one electric insulating compound conduit 10 according to the embodiments as described herein before. For illustrational
25 purposes, some parts which occur multiply are only referenced once or twice.

[0052] Fig. 10 shows an electrical high current installation in the form of a generator circuit breaker 101 in a simplified cross-section extending transversally to a switching axis 103 defined by a movable switching element (not shown in Fig. 10) but in the longitudinal section shown in

Fig. 11. Said generator circuit breaker 101 comprises a housing 105 that is electrically on ground potential in an operating state of the generator circuit breaker 101 whereas a current conductor 106 is electrically on live potential. The current conductor 106 is interruptible and closeable by the a movable switching element at an insulating gap 107 between two breaker contacts 108, 109. Fig. 10 reveals that the generator circuit breaker 101 also comprises a disconnecter 111.

[0053] The generator circuit breaker 101 further comprises several two-phase cooling systems in the form of an electric insulating compound conduit 10 according to the present invention for cooling the current conductor 106 by receiving a thermal load at an evaporator portion and releasing the thermal load at a condenser portion. For that reason each electric insulating compound conduit 10 comprises a first portion with an evaporator 104, and a second portion with a condenser 112. The evaporator 104 and the condenser 112 are connected to one another for guiding the dielectric cooling fluid via a first electrically conductive pipe section 20 a second electrically conductive pipe section 22 and an electrically insulating conduit section 30 which connects the first pipe section 20 and the second pipe section 22 such that a common fluid conduit space 32 is formed. In this embodiment of the electric insulating compound conduit 10 the tubular shape of the first and second pipe ends define an axis 5 of the electric insulating compound conduit 10 which axis extends transversal to the switching axis 103.

[0054] The condenser portion of the second pipe section is thermally connected to heat sink structure 113 for improving the thermal removal off the condenser portion out of the housing 105.

[0055] As already mentioned in the description relating to the embodiment shown in Fig. 9, the first section 40 of the first pipe section 20 and the second section 42 of the second pipe section 22 are embedded in the insulating material of the insulating conduit section 30. Thus when the first pipe section 20 and the second pipe section 22 are on different electric potentials, a region of the highest field strength between the first pipe section 20 and the second pipe section 22 is located inside the dielectric material of the electrically insulating conduit section 30 and is distanced from the fluid conduit space 32 by a distance being at least 5 percent of a minimum distance d between the pipe ends 70, 72 (see Figures 1 to 2 for reference).

[0056] Fig. 12 schematically shows the effects of various shapes of the electrode ends 70, 72 on an electric field, whereby only one side of a simplified view of cross section of an electrode 20

and the axis 5 is shown, the counterpart electrode is also omitted here. In variant A, the electrode 20 has an end 70 with edges, such as in Fig. 1. At the edges, the density of the electric field lines is relatively high, which is undesirable due to reasons already noted. Variant B, such as shown in Fig. 2, has rounded edges at the electrode end 70, which reduces the density of the filed lines and thus the peak values of the electric field. In variant C, the electrode is a field shaping electrode, such as shown in Fig. 3 or 5. The density of the electric field lines is further reduced with respect to B, thus reducing peaks of the electric field in the insulating material (not shown).

[0057] In a method for producing an insulating compound conduit 10 as described before, first and second electrically conductive pipes 20, 22 are provided. These are placed in a provided mold 80, and a mold mass 90 is applied to this arrangement, thereby molding or casting the insulating compound conduit 10.

[0058] In embodiments, the mold mass 90 may be a thermoplastic, a thermoset, or an elastomer. Typically, the mold mass 90 is applied into the mold by either pressure gelation or injection molding.

[0059] In order to ease the production of the insulating compound section, in embodiments at least one of the pipes 20, 22 can have a portion with a circumferential groove 100. An O-ring 110 is provided in the groove for sealing a gap 120 between the mold 80 and the outer surface of the pipe 20, 22 during the molding process.

[0060] This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. While various specific embodiments have been disclosed in the foregoing, those skilled in the art will recognize that the spirit and scope of the claims allows for equally effective modifications. Especially, mutually non-exclusive features of the embodiments described above may be combined with each other. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal language of the claims.

CLAIMS

1. Electric insulating compound conduit (10) for guiding a dielectric cooling fluid for cooling one of a power electronics, a high voltage installation, a high current installation and a medium

5 voltage installation (101),

the electric insulating compound conduit (10) comprising:

- a first electrically conductive pipe section (20) having a first pipe end (70) and defining an axis (5),

- a second electrically conductive pipe section (22) having a second pipe end (72),

10 - an electrically insulating conduit section (30), comprising a dielectric material and connecting the first pipe section (20) and the second pipe section (22), together forming a common fluid conduit space (32),

wherein a first section (40) of the first pipe section (20) and a second section (42) of the second pipe section (22) are embedded in the insulating material of the insulating conduit section (30),

15 and

wherein the electrically insulating compound conduit section (30) is molded, and

wherein the electric insulating compound conduit (10) has triple regions (43, 44) where a conductive pipe section (20, 22), the electrically insulating conduit section (30) and the fluid conduit space (32) are in physical contact with each other, and

20 wherein at least one triple region (43, 44) is situated in a field shadow of the pipe end (70, 72) with respect to a region of a highest field strength (11) when the first pipe section (20) and the second pipe section (22) are on different electric potentials.

2. Insulating compound conduit (10) according to claims 1, wherein a region of a highest field strength (11) between the first pipe section (20) and the second pipe section (22) is located inside the dielectric material of the electrically insulating conduit section (30) when the first pipe section (20) and the second pipe section (22) are on different electric potentials.
- 5 3. Insulating compound conduit (10) according to claims 1 or 2, wherein a region of a highest field strength (11) between the first pipe section (20) and the second pipe section (22) is distanced from the fluid conduit space (32) by a distance being at least 5 percent of a minimum distance (d) between the pipe ends (70, 72) when the first pipe section (20) and the second pipe section (22) are on different electric potentials.
- 10 4. Insulating compound conduit (10) according to any preceeding claim, wherein a portion (38) of the electrically insulating conduit section (30) extends into the interior space of at least one of the first pipe section (20) and the second pipe section (22), preferably by at least 5 percent of the length of the first or second section (40, 42) in an axial direction.
- 15 5. Insulating compound conduit (10) according to any preceding claim, wherein at least one of the first section and the second section (40, 42) comprise a funnel shape.
6. Insulating compound conduit (10) according to any preceding claim, wherein at least one of the first pipe section (20) and the second pipe section (22) further comprise a field control electrode to minimize peak values of an electric field strength when the first pipe section (20) and the second pipe section (22) are on different electric potentials.
- 20 7. Insulating compound conduit (10) according to any preceding claim, wherein the electrically insulating section (30) comprises at least one of thermosets, thermoplastics, and elastomers, and wherein the isolating part is optionally mechanically strengthened by at least one glass-fibre net.

8. Insulating compound conduit (10) according to any preceding claim, wherein at least one of the first pipe section (20) and the second pipe section (22) comprises an element (23) on its outer surface, which secures the pipe section against turning in the insulating compound section (30).

9. Insulating compound conduit (10) according to any preceding claim, further comprising a floating field control element (41) located between the first pipe end (70) and the second pipe end (72).

10. Insulating compound conduit (10) according to any preceding claim, wherein the insulating section (30) comprises, in an axial direction, alternating larger and smaller diameters, to increase a creepage distance between the first pipe section (20) and the second pipe section (22).

11. Insulating compound conduit (10) according to any preceding claim, wherein the fluid conduit space (32) comprises at least two separated spaces.

12. Insulating compound conduit (10) according to any preceding claim, comprising at least three conductive pipes (20, 22, 24) embedded in the conduit section (30), wherein the conduit (10) is at least one of: a manifold, and a T-junction.

13. Insulating compound conduit (10) according to any preceding claim, wherein the first pipe end (70) and the second pipe end (72) has rounded edges proximal to the minimum distance (d) between the pipe ends (70, 72).

14. Electrical power module (100), comprising:

- electronic components (102), and

a first portion of a two-phase cooling system for cooling the electronic components (102), including evaporators (104) and

an electric insulating compound conduit (10) for guiding a dielectric cooling fluid, comprising:

- a first electrically conductive pipe section (20) having a first pipe end (70) and defining an axis (5),

- a second electrically conductive pipe section (22) having a second pipe end (72),

5 - an electrically insulating conduit section (30), comprising a dielectric material and connecting the first pipe section (20) and the second pipe section (22), together forming a common fluid conduit space (32),

wherein the electronic components have a block voltage of at least 500 V, and wherein a first section (40) of the first pipe section (20) and a second section (42) of the second pipe section (22)

10 are embedded in the insulating material of the insulating conduit section (30), and

wherein the electrically insulating compound conduit section (30) is molded, and

wherein the electric insulating compound conduit (10) has triple regions (43, 44) where a conductive pipe section (20, 22), the electrically insulating conduit section (30) and the fluid conduit space (32) are in physical contact with each other, and

15 wherein at least one triple region (43, 44) is situated in a field shadow of the pipe end (70, 72) with respect to a region of a highest field strength (11) when the first pipe section (20) and the second pipe section (22) are on different electric potentials.

15. A high voltage, a high current or a medium voltage installation (101), comprising:

- a current conductor (106), and

20 a first portion of a two-phase cooling system for cooling the current conductor (106), the first portion including an evaporator (104) and

an electric insulating compound conduit (10) for guiding a dielectric cooling fluid, comprising:

- a first electrically conductive pipe section (20) having a first pipe end (70) and defining an axis (5),

- a second electrically conductive pipe section (22) having a second pipe end (72),

5 - an electrically insulating conduit section (30), comprising a dielectric material and connecting the first pipe section (20) and the second pipe section (22), together forming a common fluid conduit space (32),

wherein a first section (40) of the first pipe section (20) and a second section (42) of the second pipe section (22) are embedded in the insulating material of the insulating conduit section (30),

10 and

wherein the electrically insulating compound conduit section (30) is molded, and

wherein the electric insulating compound conduit (10) has triple regions (43, 44) where a conductive pipe section (20, 22), the electrically insulating conduit section (30) and the fluid conduit space (32) are in physical contact with each other, and

15 wherein at least one triple region (43, 44) is situated in a field shadow of the pipe end (70, 72) with respect to a region of a highest field strength (11) when the first pipe section (20) and the second pipe section (22) are on different electric potentials.

16. Installation according to claim 15, wherein the installation comprises a generator circuit breaker (101).

20 17. Method for producing an insulating conduit (10) according to claims 1 to 13, comprising:

providing first and second electrically conductive pipe sections (20, 22),

providing a mold (80),

placing the first and second pipe sections (20, 22) in the mold (80),

molding the insulating conduit (10) by applying a mold mass (90), thus forming an electrically insulating compound conduit section (30), comprising a dielectric material

5 and connecting the first and second pipe sections (20, 22), together forming a fluid conduit space (32),

wherein a first section (40) of the first pipe section (20) and a second section (42) of the second pipe section (22) are embedded in the insulating material of the insulating conduit section (30) during the molding.

10

18. Method according to claim 17, wherein the molding of the insulating compound conduit section (30) is made by one of automatic pressure gelling, injection molding of a thermoplastic, casting, vacuum-casting.

15

19. Method according to claim 17 or 18, wherein the electric insulating compound conduit (10) has triple regions (43, 44) where a conductive pipe section (20, 22), the electrically insulating conduit section (30) and the fluid conduit space (32) are in physical contact with each other, and wherein at least one triple region (43, 44) is situated in a field shadow of the pipe end (70, 72)

with respect to a region of a highest field strength (11) when the first pipe section (20) and the

20

second pipe section (22) are on different electric potentials.

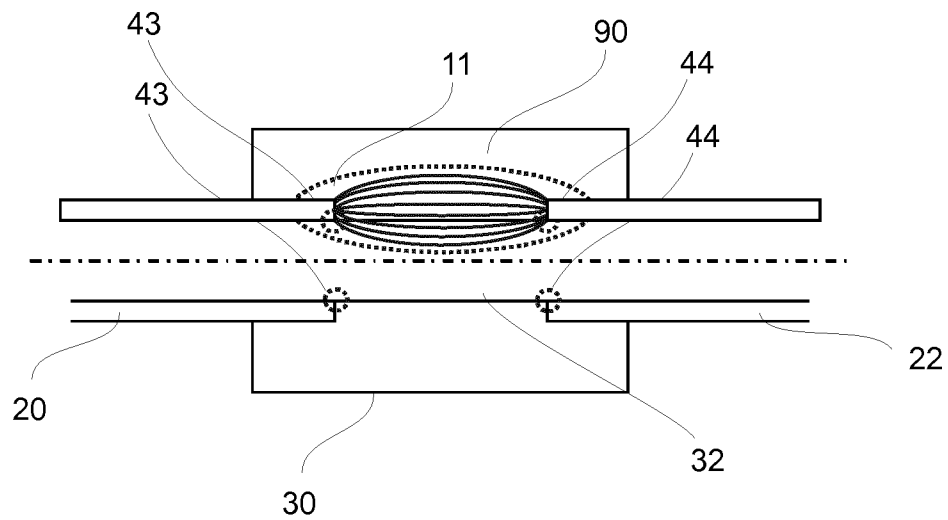


Fig. 1

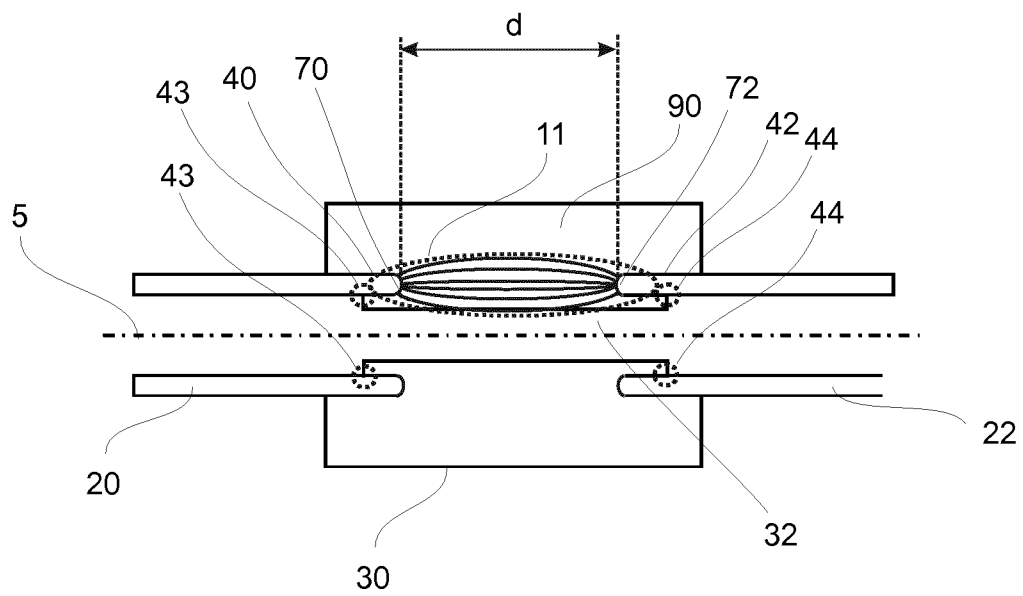


Fig. 2

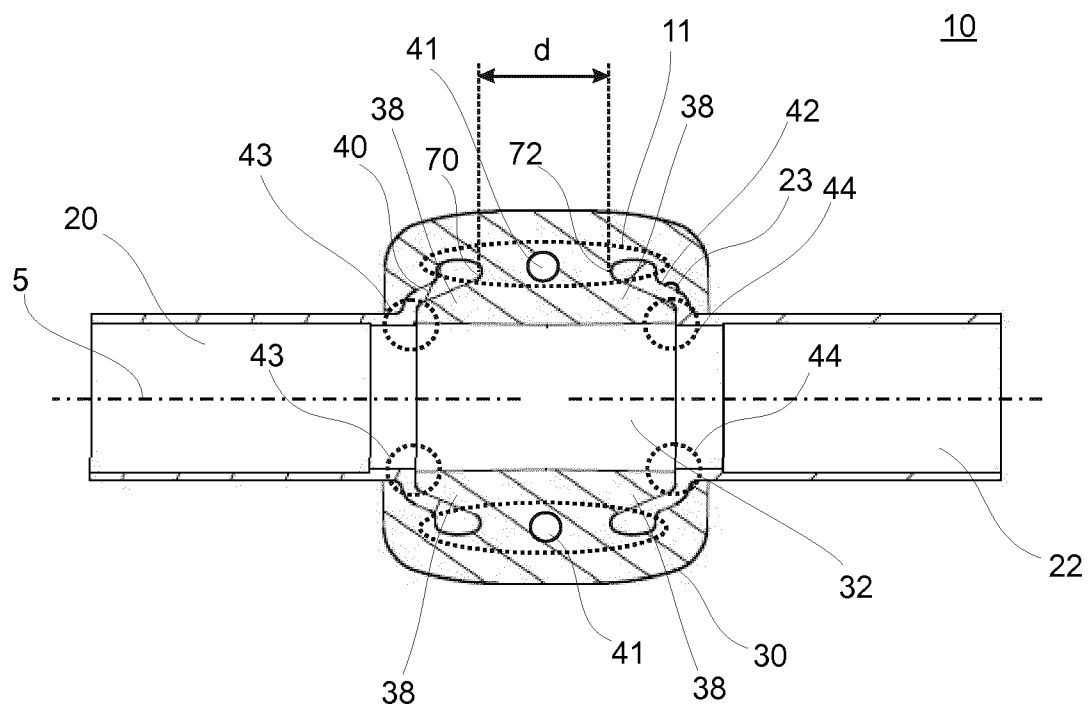


Fig. 3

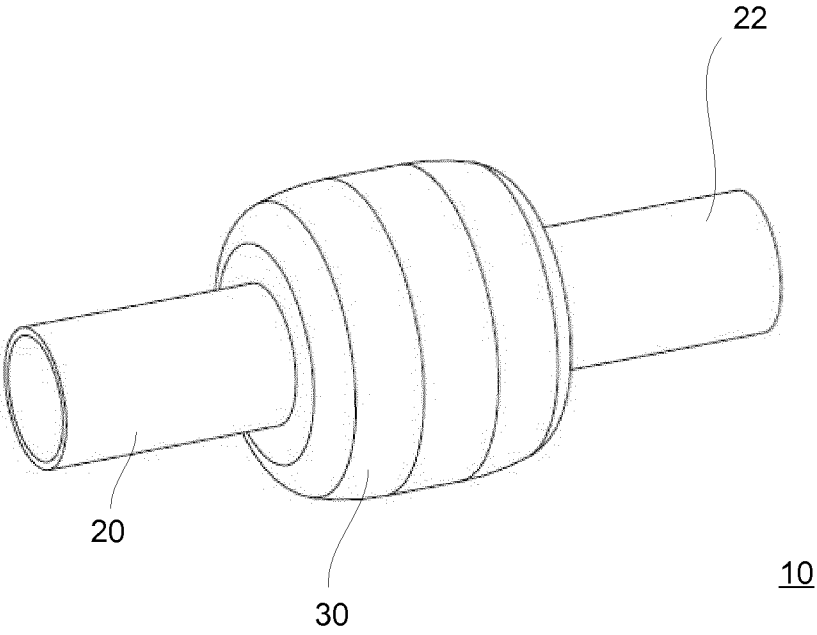


Fig. 4

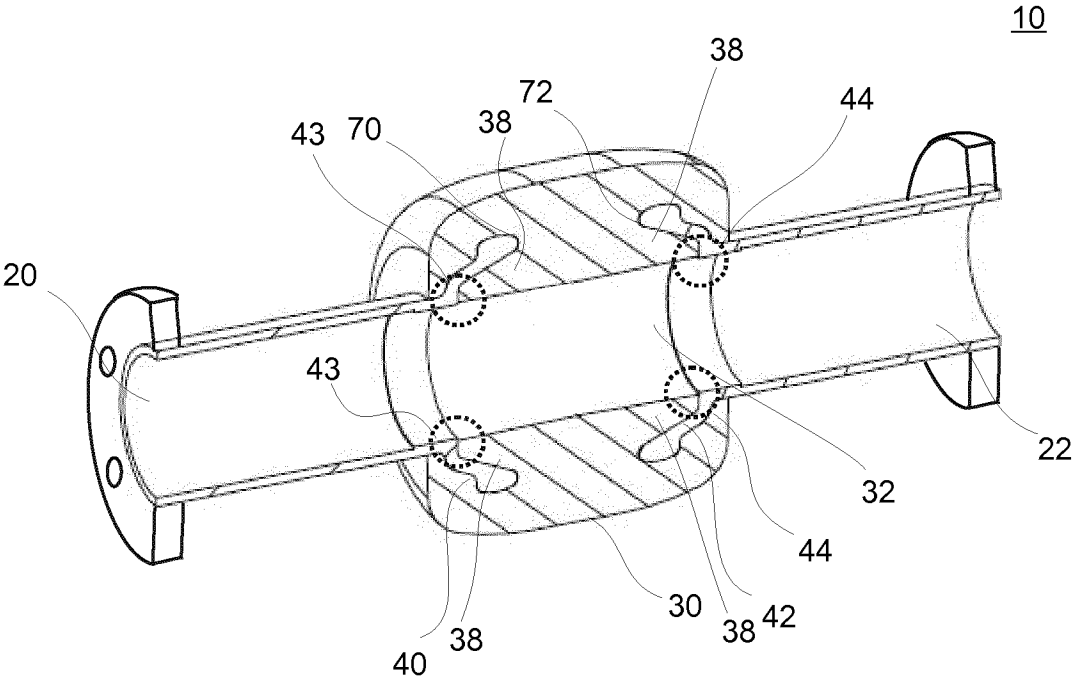


Fig. 5

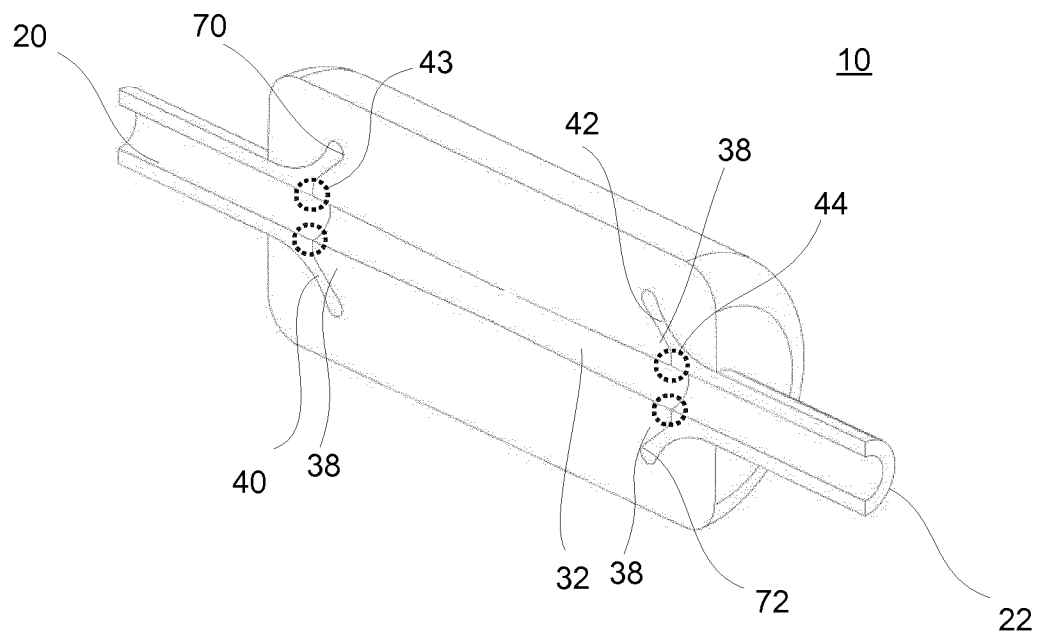


Fig. 6

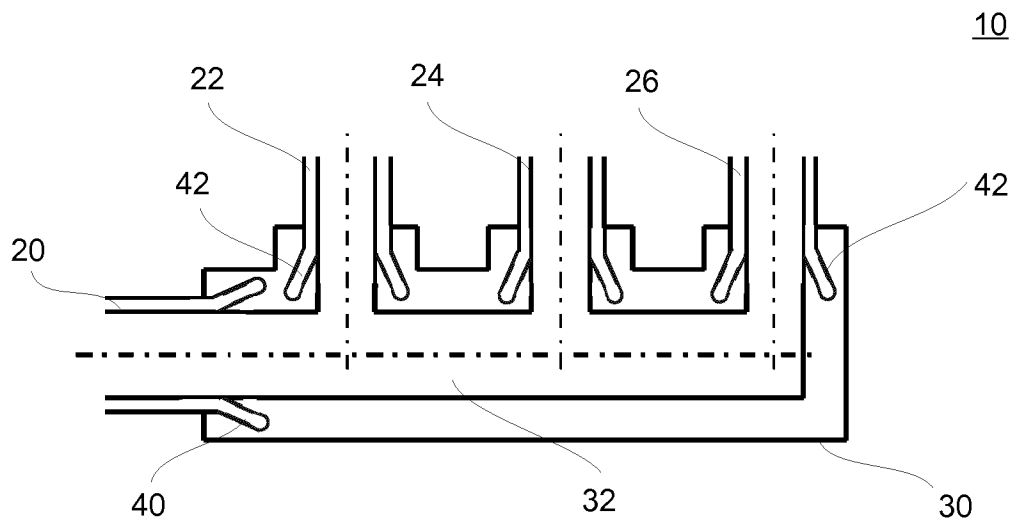


Fig. 7

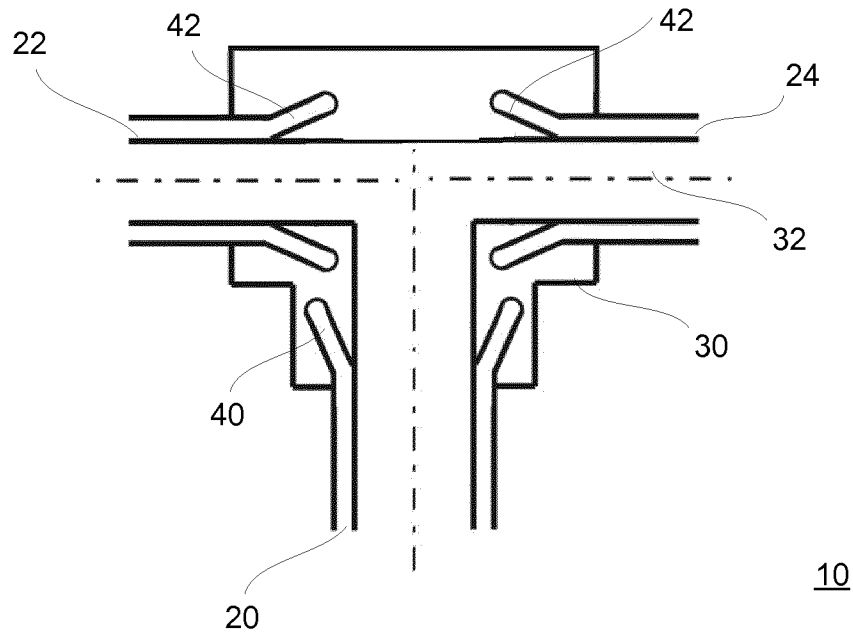


Fig. 8

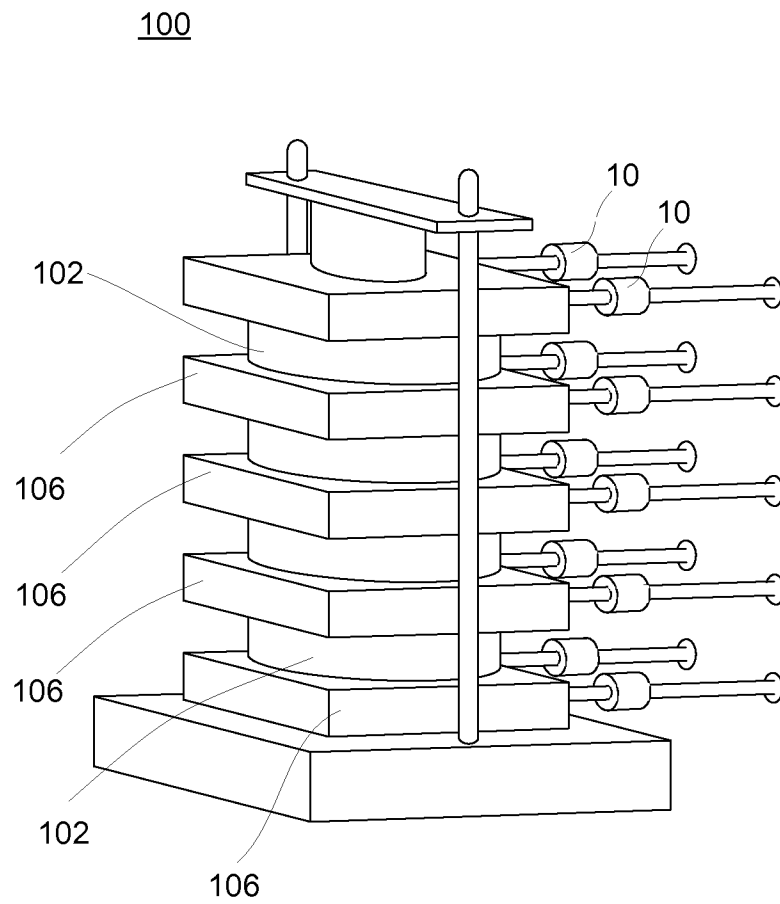


Fig. 9

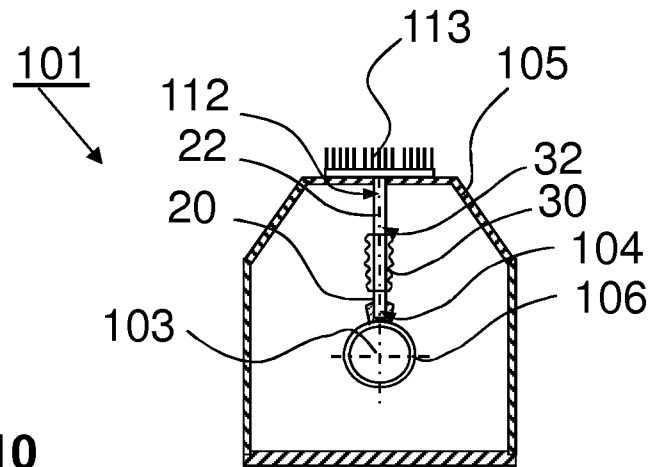


Fig. 10

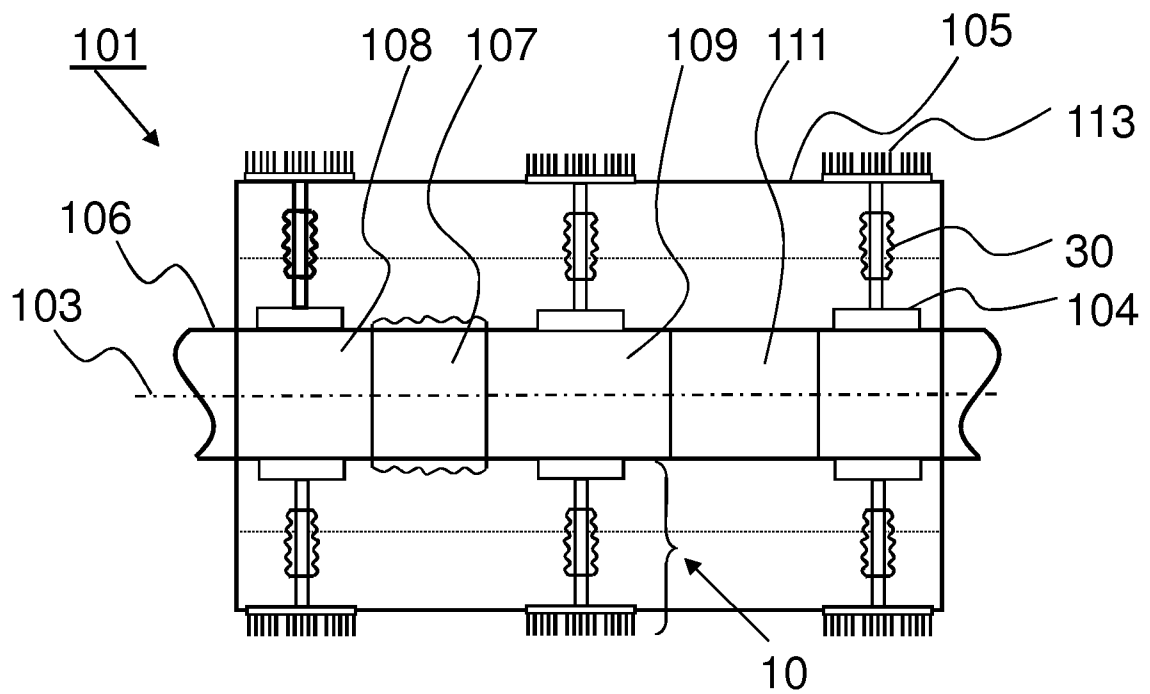


Fig. 11

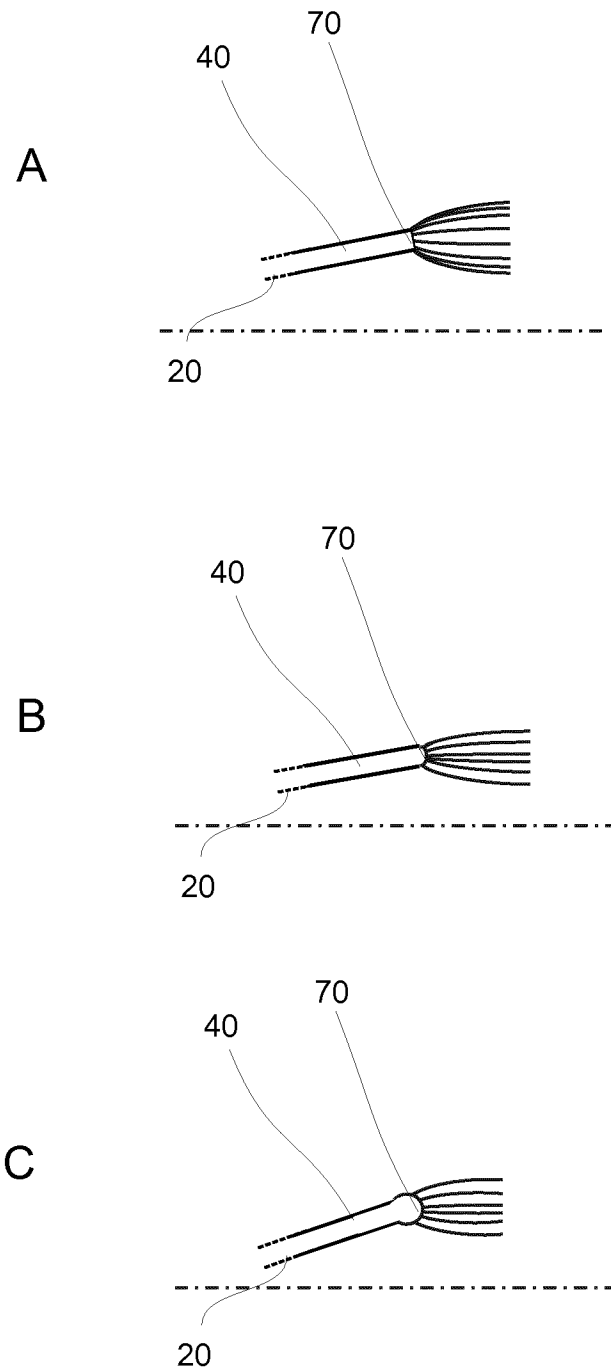


Fig. 12

**ANY REFERENCE TO FIGURE 78
SHOULD BE CONSIDERED
AS NON-EXISTENT**

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2013/068052

A. CLASSIFICATION OF SUBJECT MATTER

INV. H01L23/427 H01L23/473 F16L25/02
ADD.

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)

H01L H05K F16L

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 21 20 474 A1 (BROWN, BOVERIE AND CIE) 2 November 1972 (1972-11-02) page 1, lines 1-9; figure 1 page 2, lines 20-25 page 3, lines 1-5, 19-20 page 4, line 16 - page 5, line 1 -----	1-5, 7, 14-16
Y	US 3 686 747 A (BAGNULO LUIGI) 29 August 1972 (1972-08-29) column 1, lines 25-32 column 2, line 41 - column 3, line 44; figures 3, 4 -----	1-5, 7, 14-16
A	GB 1 559 291 A (CAUNNED AG) 16 January 1980 (1980-01-16) column 3, line 7 - line 17; figure 4 ----- -/-	1, 14, 15, 17



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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

"E" earlier application or patent 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 when the document is taken alone

"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

Date of the actual completion of the international search

14 November 2013

Date of mailing of the international search report

22/11/2013

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Zeisler, Peter

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2013/068052

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 1 347 419 A (KEROTEST MFG CORP) 27 February 1974 (1974-02-27) the whole document -----	1,14,15, 17
A	DE 37 09 006 C1 (LICENTIA GMBH) 28 July 1988 (1988-07-28) the whole document -----	1,14,15, 17

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2013/068052

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 2120474	A1	02-11-1972	NONE
US 3686747	A	29-08-1972	CH 506016 A 15-04-1971
		DE 1965422 A1	09-07-1970
		ES 374768 A1	01-02-1972
		FR 2026806 A1	18-09-1970
		GB 1249839 A	13-10-1971
		NL 6919057 A	23-06-1970
		NO 133635 B	23-02-1976
		SE 371682 B	25-11-1974
		US 3686747 A	29-08-1972
		YU 318469 A	31-08-1974
GB 1559291	A	16-01-1980	BR 7605135 A 28-02-1978
		CA 1047063 A1	23-01-1979
		CH 595580 A5	15-02-1978
		DE 2636402 A1	24-02-1977
		ES 450575 A1	16-11-1977
		FR 2321087 A1	11-03-1977
		GB 1559291 A	16-01-1980
		JP S5222786 A	21-02-1977
GB 1347419	A	27-02-1974	NONE
DE 3709006	C1	28-07-1988	NONE