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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, IR, 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.

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Published:

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(54) **Title:** A COVER WITH AN ELECTRICAL LEAD THROUGH CONNECTOR

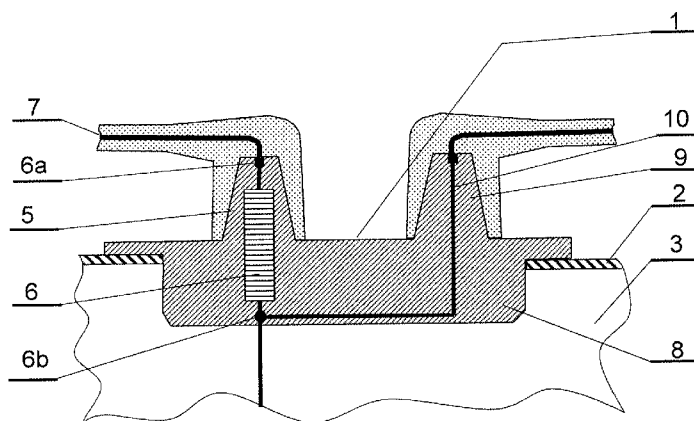


Fig. 2

(57) **Abstract:** The subject of the invention is a cover (2) with an electrical lead through connector (1) for connecting MV or HV conductor (7) with a load (4) placed in a tank containing a dielectric liquid or dielectric gas. An electrical lead through connector (1) comprises a plug-in bushing member (5) made of insulating material, where a series filtering choke (6) is embedded. The filtering choke (6) has a first terminal (6a) which is electrically connected with an external HV or MV line (7) and has a second terminal (6b) which is connected to a load (4) placed inside the tank (3). The lead through connector (1) is further provided with an additional bushing member (9) which is mechanically connected with the plug-in bushing member (5) through a common insulating base (8). The additional bushing member (9) is equipped with a conductor (10) located inside the bushing member (9), where the conductor (10) is directly connected with the second terminal (6b) of the filtering choke (6) and with an external protective component (11) against electrical surges.



A cover with an electrical lead through connector

The subject of the invention is a cover with an electrical lead through connector for connecting MV or HV conductor with a load placed in a tank containing a dielectric liquid or dielectric gas.

Power equipment, such as transformers, reactors, and motors is typically protected against electrical surges by shunt-connected with respect to ground, surge arresters and/or surge capacitors or RC snubbers. Recently new concept of high du/dt transients suppression by means of a series-connected RL choke has been developed. In the particular applications the optimum performance of the RL choke often requires combining it with an additional, shunt-connected with respect to ground capacitor and a surge arrester downstream the choke element. Such a solution is depicted in a publication:

Glinkowski, M., Piasecki, W., Florkowski, M., Arauzo, F., „ SmartChoke-protecting power equipment from fast transients”, IEEE PES Transmission and Distribution Conference, Chicago, USA, 2008. These additional components can not be connected outside the protected equipment, when the series-connected choke element is integrated within the bushing, which is a cost-efficient solution.

Utilizing a series-choke within a bushing and a shunt-connected protective element at the same time would require either an additional bushing, or locating the second element within the enclosure of the protected device e.g. within the transformer tank.

From patent application EP2605255 there is known a transformer includes a ferromagnetic core; winding structure mounted on the core; electrical terminals connected to the winding structure; a series filtering choke including an impedance circuit serially connected between one of the terminals and the winding structure, and a capacitor connected from the one terminal to the external ground. The series filtering choke is constructed and arranged to reduce a frequency spectrum and magnitude of fast transients. An encasement of an

insulated resin, encapsulates the core, the winding structure and at least the impedance circuit of the series filtering choke. In this solution two bushing members are presented. The two bushing members are attached to the opposite terminals of the winding structure. The encasement of an insulated resin and the bushings members are made as one integral part of the whole transformer.

The inventive cover with an electrical lead through connector for a tank of an electrical equipment containing a dielectric liquid or dielectric gas has a series filtering choke, which is partially embedded in a plug-in bushing member made of insulating material and partially in an insulating base common with an additional insulating bushing member. The additional insulating bushing member is made of insulating material and integrated with the plug-in bushing member via the common base. The filtering choke has a first terminal which is electrically connected with an external HV or MV line and has a second terminal which is connected with a load placed inside the tank. The second terminal is connected with an external protective component against electrical surges through a conductor, where the connector is embedded in the base of the cover and in the additional insulating bushing member. The external protective component is located outside the tank and grounded.

Preferably the additional bushing member is an air-insulated bushing type.

Alternatively the additional bushing member is a plug-in bushing type.

Preferably the additional protective component has a form of surge suppressing elements: such as a surge arrester, a surge capacitor, a R-C scrubber or their combination.

Preferably the insulating material for the plug-in bushing, the base and the additional bushing member is a thermosetting resin.

Alternatively the insulating material for the plug-in bushing member, the base and the additional bushing member is a phenolic compound.

A liquid- insulated transformer having a tank with a cover according to claims 1-6.

A gas-insulated transformer having a tank with a cover according to claims 1-6.

The present invention allows one to combine the benefits of using a series choke located within the bushing with the possibility of connecting a surge capacitor and/or surge arrester in a single element. The filtering capabilities of the choke located in the bushing can thus be efficiently enhanced by an additional, shunt-connected protective component.

The cover according to the present invention is fabricated using a single manufacturing process (epoxy resin molding), therefore the manufacturing cost is similar to the manufacturing of a conventional bushing. Additionally this approach allows one to build a compact device which could be mounted on a cover of small transformers, where space is limited. The case in which the additional bushing member is of the plug-in type allows one to maintain the benefits of a touch-proof transformer cover.

The present invention is presented in an exemplary embodiment in the drawing, where:

Fig.1 shows an inventive device in a cross section in the first embodiment,

Fig.2 shows an inventive device in a cross section in the second embodiment,

Fig.3 shows a schematic electric diagram of the inventive device,

An electrical lead through connector 1 is placed in a cover 2 of a tank 3 of an electrical load 4 such as transformer which is located in an environment of a dielectric liquid or gas. The connector 1 has a form of plug-in bushing member 5 made from an insulating material, where a series filtering choke 6 is embodied. The series filtering choke 6 has a first terminal 6a, which is electrically connected with an external HV or MV line 7, and a second terminal 6b electrically connected to the load 4. The plug-in bushing member 5 has an insulating material base 8 which is integrated with an additional bushing member 9 which is mechanically connected with the plug-in bushing member 5. Inside the additional bushing member 9 an electrical conductor 10 is inserted. The conductor 10 is connected with the second terminal 6b of the filtering choke 6 and with a first terminal of an external protective component 11 against electrical surges having second

terminal grounded. The plug-in member 5 and the additional bushing member 9 together with the base 8 constituting a one single element of the lead trough connector 1 which is connected with the protective component 11.

In the first embodiment of the invention the additional bushing member 9 has a form of an air-insulated bushing what is presented in fig.1.

In the second embodiment of the invention the additional bushing member 9 has a form of a plug-in bushing type what is presented in fig.2.

In the both embodiments of the invention the electrical conductor 10 is directly connected with the second terminal 6b and through this terminal with the load 4 and with the protective component 11. The protective component 11 has a form of surge suppressing elements such as a surge arrester, or a surge capacitor or a R-C snubber. It is possible that any of the surge suppressing elements depicted above are combined one with the other and a such combination can constituting the protective component 11. The insulating material of the plug-in bushing 5, the busing member 9 and the common base 8 for through connector 1 is a thermosetting resin or a phenolic compound.

Operation

In case of a transient overvoltage (surge) in the system, characterized by high rate of rise (du/dt), the surge may penetrate the structure of the electrical load, such as the winding of a transformer. Such events are known to pose a risk of electrical failure as the surge can cause a local overvoltage within the winding, leading to insulation break-down.

When the electrical load is protected by a combination of a series filtering choke (6), and shunt-connected with respect to ground additional protective component (11), the amplitude and the rate of rise (du/dt) of the surge are lowered, and thus the potential negative impact of the transient on the electrical load, such as a transformer is significantly reduced.

Claims

1. A cover (2) with an electrical lead through connector (1) for a tank (3) of an electrical equipment, where the tank (3) containing a dielectric liquid or dielectric gas, **characterized in that** it comprises a series filtering choke (6) partially embedded in a plug-in bushing member (5) made of insulating material and partially in an insulating base (8) common with an additional insulating bushing member (9), made of insulation material and integrated with the plug-in bushing member (5) via the common base (8); the filtering choke (6) has a first terminal (6a) which is electrically connected with an external HV or MV line (7) and has a second terminal (6b) which is connected with a load (4) placed inside the tank (3) and with an external protective component (11) against electrical surges through a conductor (10), where the connector (10) is embedded in the base (8) and in the additional insulating bushing member (9) and where the external protective component (11) is located outside the tank (3) and grounded.
2. A cover according to claim 1, characterized in that the additional bushing member (9) is an air-insulated bushing type.
3. A cover according to claim 1, characterized in that the additional bushing member (9) is a plug-in bushing type.
4. A cover according to claims 1-3, characterized in that the additional protective component (11) has a form of surge suppressing elements such as a surge arrester, or a surge capacitor or a R-C snubber or their combination.
5. A cover according to any previous claims, characterized in that the insulating material for the plug-in bushing (5), the base (8) and the additional bushing member (9) is a thermosetting resin.
6. A cover according to any previous claims, characterized in that the insulating material for the plug-in bushing member (5), the base (8) and the additional bushing member (9) is a phenolic compound.

7. A liquid- insulated transformer characterized in that it has a tank (3) with a cover (2) according to claims 1-6.
8. A gas-insulated transformer characterized in that it has a tank (3) with a cover (2) according to claims 1-6.

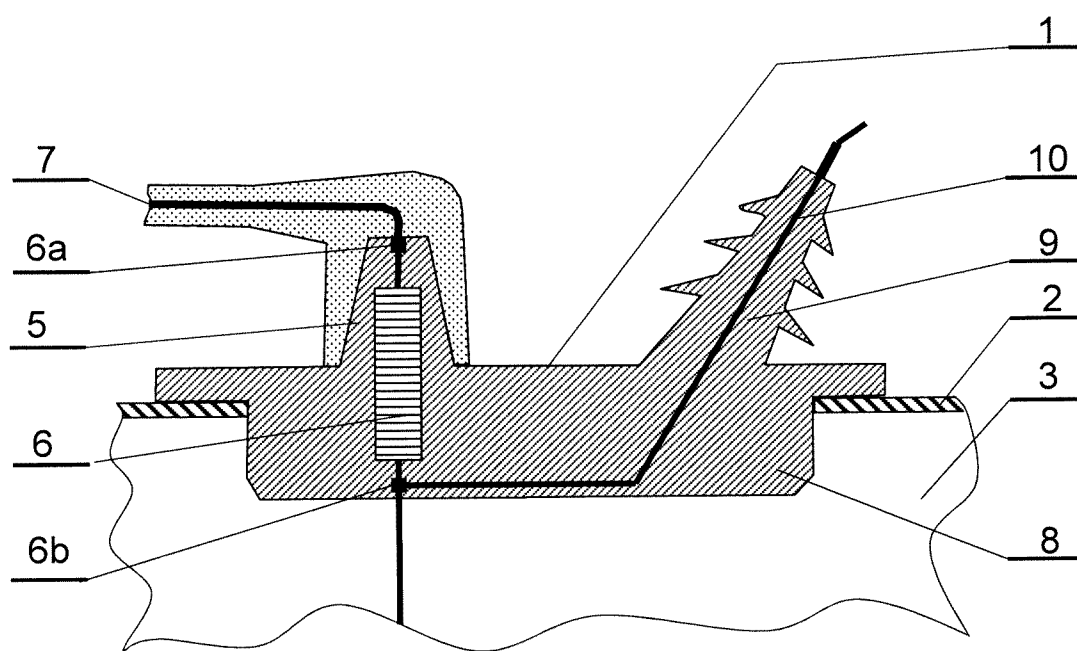


Fig. 1

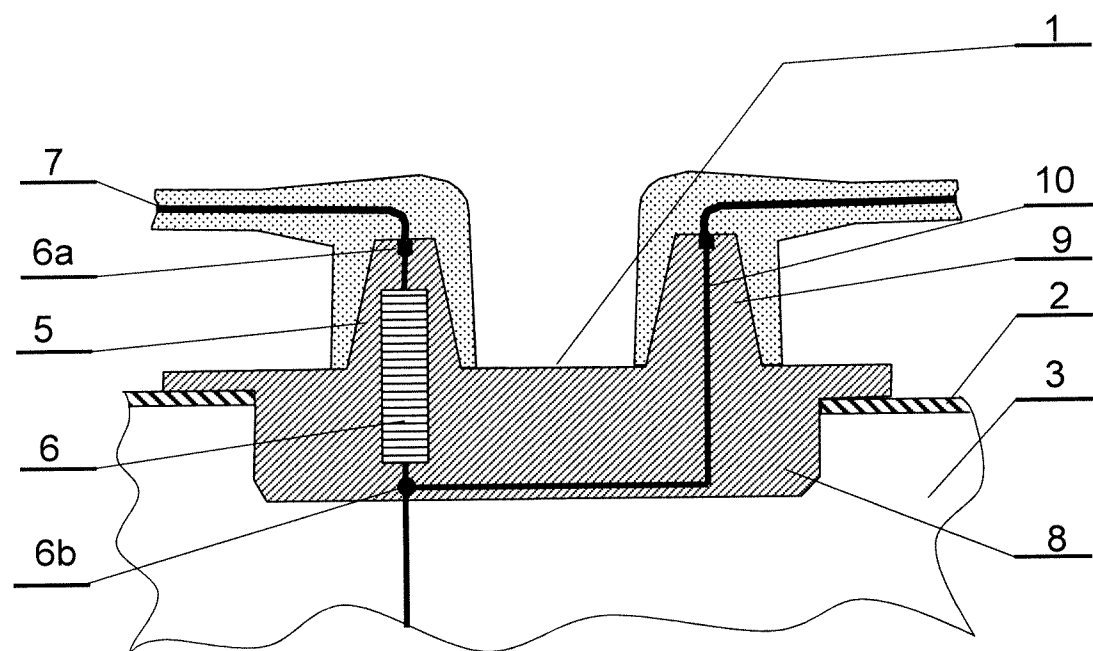


Fig. 2

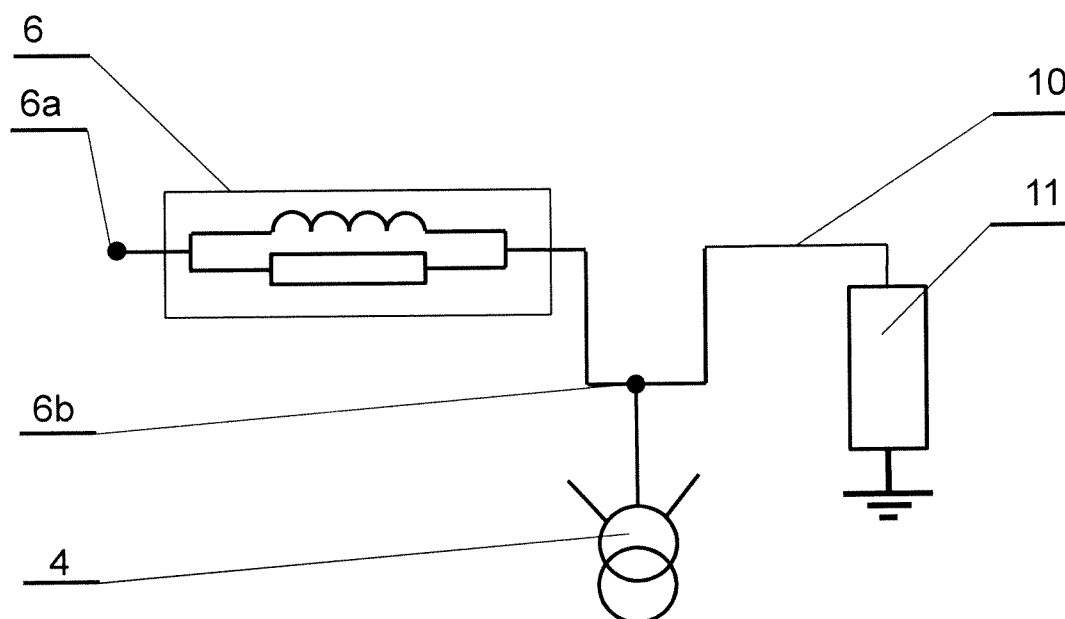


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/001538

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01F27/04 H01F27/34
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)
H01F

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.
A	WO 2009/127934 A2 (FICK LUKAS MARTHINUS [ZA]; VAN HEERDEN ANTON [ZA]) 22 October 2009 (2009-10-22) figures 1,2,4,7 pages 1,6-11	1-8
A	----- US 4 975 797 A (VEVERKA EDWARD F [US] ET AL) 4 December 1990 (1990-12-04) figures 1,4 columns 3,4	1-8
A	----- JP H05 299269 A (MITSUBISHI ELECTRIC CORP) 12 November 1993 (1993-11-12) abstract; figure 1 ----- -/-	1-8



Further documents are listed in the continuation of Box C.



See patent family annex.

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"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

10 July 2014

Date of mailing of the international search report

22/07/2014

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/001538

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	MIETEK GLINKOWSKI ET AL: "SmartChoke - protecting power equipment from fast transients", TRANSMISSION AND DISTRIBUTION CONFERENCE AND EXPOSITION, 2008. T&D. IEEE/PES, IEEE, PISCATAWAY, NJ, USA, 21 April 2008 (2008-04-21), pages 1-7, XP031250074, ISBN: 978-1-4244-1903-6 cited in the application the whole document	1-8
A	----- EP 2 605 255 A1 (ABB TECHNOLOGY AG [CH]) 19 June 2013 (2013-06-19) cited in the application figures 1-3 paragraphs [0017] - [0026] -----	1-8

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2014/001538

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2009127934	A2	22-10-2009	NONE
US 4975797	A	04-12-1990	CA 2004444 A1 16-02-1991 US 4975797 A 04-12-1990
JP H05299269	A	12-11-1993	NONE
EP 2605255	A1	19-06-2013	EP 2605255 A1 19-06-2013 US 2013147589 A1 13-06-2013 WO 2013090158 A1 20-06-2013